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EXECUTIVE SUMMARY

Nearly eight years ago, on August 2, 1990, Iraq invaded Kuwait, marking the beginning of what is now known as the Gulf War. Within a week of Iraq's act, the United States began the largest single deployment of troops to a foreign country since the Vietnam era. The consequence of fighting this high-tech air and ground war was a quick and decisive victory, with relatively few casualties and no apparent acute effects from offensive use of the chemical or biological weapons that many had feared Iraq would use. However, the long-term impact of deployment to a desert environment on those troops, their families, government agencies, and the public was immense and unanticipated. At first, the significance of these health problems was minimized by many inside and outside of the government. It may be that our pride and confidence in our military's seemingly near-perfect performance was so great that nothing, not even the emerging health problems of many veterans of this war, was allowed to diminish this victory. The decisive outcome and the lack of anticipated widespread casualties from offensive use of chemical or biological weapons led many to look only at what was known at the time and see it as reinforcement of the common assumption that nothing happened connected with that deployment that would later affect the health of many Gulf War veterans.

In many ways, the story of the Gulf War experience can be seen as a microcosm for continued concerns regarding our nation's military preparedness and ability to respond effectively to health problems that may arise after deployments. This investigation found that in the Gulf War, U.S. military forces were not fully prepared to fight a war in which chemical or biological weapons might be used, and that this lack of readiness continues today. Both the Department of Defense and the Department of Veterans Affairs have given insufficient priority to matters of health protection, prevention, and monitoring of troops when they are on the battlefield and thereafter when they become veterans. The Department of Defense and the Department of Veterans Affairs have been negligent by failing to collect information adequately about, keep good health records on, and produce reliable and valid data to monitor the health care and compensation status of Gulf War veterans who are now ill. These agencies must find effective ways to manage and share information and work together to ensure that Gulf War veterans who face troubling health problems are helped—not hindered—in getting the health care and assistance they deserve.

BACKGROUND

This report tells the story of the events of the Gulf War that potentially have affected the health of some who served there and of the government's actions in response to those health problems. It is about foresight, it is about bureaucracy, and it is about accountability. It reflects a year-long

bipartisan special investigation by a team of experts assembled by the Senate Committee on Veterans' Affairs in the spring of 1997. The Committee on Veterans Affairs has actively conducted oversight on Gulf War veterans concerns since 1993, including holding committee and field hearings and issuing a 1994 staff report on this issue. The Special Investigation Unit on Gulf War Illnesses (SIU) examined the policies and actions of the U.S. government that have had an impact on the current health of the men and women who served during the Gulf War. The SIU's investigation encompassed specific areas of concern: the Department of Defense's (DOD's) plans and policies; the intelligence community's role; health risks encountered by U.S. troops during the war; record keeping before, during and after it; and the Department of Veterans Affairs' (VA's) accountability to and responsibilities for Gulf War veterans. At the same time, the SIU staff looked at the broader issues of the government's responsiveness to veterans' concerns and the ability of the DOD and VA to develop strong information and policy links. In the course of this investigation, the Committee held hearings in Washington and across the country. The SIU staff made numerous site visits to VA and DoD facilities, reviewed voluminous materials, and met with countless government employees, veteran service organization representatives, health professionals, scientists and researchers, and Gulf War veterans and their families. These investigative efforts by the SIU staff provided valuable insights into how to better prepare troops for future deployments, how to monitor troop health during deployments, and how to respond to veterans' health problems after those deployments.

Many veterans who served in Operations Desert Shield and Desert Storm are suffering from a range of physical disabilities, chronic ailments, and unexplained illnesses. In the period following the Gulf War, many ill Gulf veterans report having been told when they sought medical treatment that their ailments were "all in their heads." But, it is clear that many Gulf War veterans are suffering from very real physical problems, many of which are still evolving and the cause of which remains unclear. Effective treatments in many cases have yet to be identified, and even where treatment could be helpful, it is not uniformly provided to ill veterans. Veterans and their families are frightened about the long and short term consequences of these health problems. They are very concerned as to whether steps could have been taken before, during, and after the Gulf War deployment that might have prevented or minimized these health effects. They are concerned that lessons learned from the Gulf War will be applied in future conflicts to adequately warn and subsequently protect troops from avoidable environmental and manmade health risks. They also are concerned that individuals who develop health problems after serving in the Gulf War are encountering significant problems in obtaining adequate health care and timely compensation benefits from the government. Executive branch efforts, particularly on the part of the Departments of Defense and Veterans Affairs, that effectively address the problems described in this report are key to ensuring that Gulf War veterans get the help they need and to ensuring that veterans of future conflicts will not suffer the experiences of those from the Gulf War.

KEY FINDINGS

The SIU's investigation found that the perception that no one in government is helping or is concerned about the health problems of Gulf War veterans had some merit in the past. This investigation also revealed that many of the concerns described above remain well-founded. The progress that might be expected given the passage of time, amounts of money spent, and programs put in place to assist ill Gulf War veterans is not what it should be. While there does not appear to be any single "Gulf War syndrome," there is a constellation of symptoms and illnesses whose cause or causes eludes explanation at this time. It is beyond the expertise of this investigation to draw firm conclusions on the many ongoing scientific debates as to the causes of Gulf War veterans' unexplained illnesses, and these inquiries likely will continue for many years. There is a great need to monitor those veterans who are ill, and who may become ill in the future, to assess whether they are getting better or worse and to define better the long-term health effects they may experience. And, there is a need to eliminate the continuing profound delays and bureaucratic hurdles that Gulf War veterans encounter in their attempts to obtain compensation benefits for health problems that appear to be connected to their Gulf War service.

The SIU's investigators found that there is insufficient evidence at this time to prove or disprove that there was an actual low level exposure of any troops to chemical weapon nerve agents or that any of the health effects some veterans are experiencing were caused by such exposure. There is reliable evidence that there were chemical weapons at least at one site, Khamisiyah, that was destroyed by U.S. troops during the Gulf War, although this fact was denied by U.S. officials for many years. These denials appear to be the result of a negligent failure to investigate the facts fully and promptly, but there is no evidence to date that they resulted from a concerted conspiracy of silence. There is also reliable evidence that one individual suffered injury from exposure to mustard agent. However, new information continues to surface about previously unknown aspects of the extent of Iraq's chemical weapons capabilities during the Gulf War. For example, in June 1998, United Nations weapons inspectors uncovered evidence that Iraq also had missile warheads containing the deadly nerve gas VX, a fact that Iraq up to that time had consistently denied. The SIU also found that the Department of Defense needs to improve substantially its ability to forecast, identify, and respond to a wide range of battlefield exposures that can trigger adverse health effects. Concurrently, the VA must be better prepared to deal with the consequences of a variety of battlefield exposures, including but not limited to chemical and biological agents, which may become evident in affected veterans years after such exposures occur. Moreover, veterans of the Gulf War—both those still on active duty and those who have separated from military service—continue to encounter serious obstacles to obtaining medical care that addresses their needs in an appropriate and timely way. Too often, the burden on the ill Gulf War veteran (and indeed, on any ill veteran) to successfully negotiate VA's often-confusing bureaucratic maze to obtain compensation benefits or health care services is overwhelming and a severe barrier to obtaining help. The areas where improvements are needed fall into the following four broad areas:

I. PREPAREDNESS SHORTFALLS FOR EFFECTIVE DEFENSE AGAINST BATTLEFIELD HAZARDS EXISTED BEFORE AND DURING THE GULF WAR AND CONTINUE TODAY

When examining the range of possible Gulf War troop exposures to substances in the environment that may have caused adverse health effects, it is important to keep in mind that no war is entirely analogous to an industrial accident. This is especially true in terms of the range of precautions that can be taken and the actions that can be expected of commanders or their troops when they are under fire or threat of attack. In hindsight, of course, many things are clear that could not have been foreseen at the time, but the lessons learned from the past should not be ignored. The threats that Gulf War troops faced from potential chemical or biological warfare and from exposure to environmental hazards were not new to the Gulf War. Much could have been done by the Department of Defense and the Department of Veterans Affairs to plan for, respond to, and minimize potential troop health risks from these factors. Despite lessons learned about readiness shortfalls during the Gulf War, the DOD still is not fully prepared to fight a war where the threat exists of exposure to chemical or biological weapons. And, in the words of a scientist who has studied the effects of depleted uranium and other battlefield exposures on Gulf War veterans' health, DOD needs to ensure that in deployments the military "stops doing stupid stuff" when using chemicals, solvents, pesticides, depleted uranium, and other substances that can cause adverse health effects in persons exposed to them. Moreover, much could have been done at the VA, (particularly given its past history with veterans exposed to ionizing radiation or Agent Orange) to respond much more effectively with comprehensive planning and prompt program implementation once reports of ill Gulf War veterans began to surface.

Good information, especially intelligence information, is critical to the success of any military operation. In the Gulf War, more effective intelligence analysis and dissemination would have aided the U.S. troops conducting demolition of the Khamisiyah weapons depot, which has been shown to have been a storage site for Iraqi munitions containing nerve agents. Weaknesses in information sharing, problems with coordinating information stored in multiple databases, and incomplete file searches were critical shortcomings that contributed to this problem. With good information in hand, U.S. military commanders and their troops could have acted to minimize the range of risks they faced and the aftermath of the destruction could have been carefully monitored. Moreover, the SIU found that the lack of access to good, timely information impeded scientists' attempts to reconstruct the Khamisiyah event once the DOD eventually acknowledged that it appears that chemical weapons had been destroyed there. However, even the best intelligence and information sharing does not guarantee that troops will not be faced with chemical or biological warfare on the battlefield. Troops need to be prepared to detect reliably the presence of chemical and biological weapons and to conduct effective military operations in an environment where chemical or biological weapons may be used. This investigation confirmed that U.S. forces did not have those capabilities at the time of the Gulf War, a shortcoming which has not been fully remedied today.

The SIU found that pre-deployment training for chemical and biological warfare was, and still is, inadequate. The industrial base on which the military relies to produce protective clothing,

detection equipment, and medical vaccines and antidotes, was and likely still would be slow to respond to the needs of a major deployment in which the threat of chemical or biological weapons use exists. These and other shortfalls in preparation and in equipment capabilities have contributed to apprehensions among Gulf War veterans about their health. For example, a large number of false alarms for chemical weapons agents were sounded by detection equipment that were known to be triggered by many common battlefield substances. The resulting confusion led many serving in the Gulf War theater to be uncertain as to whether these devices were in fact warning of the presence of chemical weapons. Steps have been taken to remedy these shortfalls and some improvements have been made. Much more needs to be done to ensure that troops are well trained in the use of detection equipment and protective clothing and in minimizing risks to themselves from other potentially toxic exposures to battlefield substances like depleted uranium.

The Department of Defense's failure to plan adequately for foreseeable problems is mirrored by many inadequacies in VA's dealings with ill Gulf War veterans. The SIU found that it is difficult for Gulf War veterans to comprehend and comply with the VA's complex and confusing rules and regulations for obtaining health care or compensation benefits. Within the VA there also is widespread misunderstanding of its own policies, programs, and processes related to Gulf War veterans. Some VA health care providers do not know what needs to be done when performing veterans' physical exams required for their participation in VA's Persian Gulf Registry. In addition, not all of VA's compensation benefits staff grasp what is required to process properly Gulf War-related compensation benefits claims. This situation has contributed to poor program planning and implementation across the board for Gulf War veterans.

Finally, a forward-looking approach to understanding, identifying, and treating health effects from potentially toxic environmental exposures is key to being prepared for troop illnesses that may follow future deployments. The mission of the Department of Defense is focused on war fighting; the Department of Veterans Affairs takes care of veterans after they leave military service. Neither, however, performs the basic public health function of observing, investigating, and preventing health problems that may arise in the context of war. To help address this, it is time to consider the need for and feasibility of a national center for the study of military health, with an emphasis on post-conflict health concerns and illnesses. Such a center could draw upon the best available scientific expertise from inside and outside of government to evaluate and monitor issues related to post-deployment health concerns such as outreach and risk communication, record keeping, research, utilization of new technologies, and health surveillance. In this inherently difficult yet important area of military health, research that is conducted before illnesses occur, not after the fact, can go far to ensuring prompt and effective medical treatment, to preventing adverse health effects in the first place, and in providing clear information to veterans who may be adversely affected by such exposures.

II. INSUFFICIENT PROGRAM MONITORING HINDERS THE DEPARTMENT OF DEFENSE'S AND DEPARTMENT OF VETERANS AFFAIRS' EFFECTIVENESS IN SERVING GULF WAR VETERANS

DOD and VA have expended considerable effort, albeit sometimes reluctantly, in responding to the plight of Gulf War veterans. Both agencies did eventually take steps to address the health problems that Gulf War veterans identified. Both agencies implemented programs, such as registries for ill Gulf War veterans, that were an attempt to help identify the nature and extent of veterans' health problems. If, however, the measure of success is a solid record of ongoing and effective follow-up and monitoring efforts to determine whether Gulf War veterans are receiving the best possible care, then the DOD's and VA's programs and policies affecting Gulf War veterans have serious defects.

Failure to ensure that troop training and equipment would effectively address the range of contingencies, particularly battlefield exposures with potential health effects that the Gulf War presented, contributed to military readiness problems. In addition, there were at the time the Gulf War ended and still are nearly eight years later, serious shortfalls in the VA's monitoring and evaluation of its Gulf War veteran programs. The SIU's investigation found that the VA does not ensure actual implementation of the directives it issues from headquarters to the field on how to handle Gulf War veteran compensation claims or provide health care services. Although VA has created programs for Gulf War veterans, often at the direction of Congress, it does not regularly use reliable mechanisms to monitor the effectiveness of those programs. This failure means that the VA cannot reliably plan for the future or accurately report to the public and to Congress on program status. In addition, the DOD and VA need to make it a priority to monitor programs that provide health care to Gulf War veterans with undiagnosed illnesses, track treatment effectiveness over time, and ensure that all programs minimize barriers to timely and effective veteran participation. Finally, in order to establish a clear framework for the compensation and health care needs of Gulf War veterans, the VA should contract with an independent scientific body, such as the National Academy of Sciences, to conduct ongoing reviews of scientific literature on Gulf War veteran illnesses and health problems for purposes of providing a scientific basis to assist VA in making presumptive compensation determinations for Gulf War veterans.

III. THE DEPARTMENT OF DEFENSE'S AND THE DEPARTMENT OF VETERANS AFFAIRS' FAILURE TO COLLECT INFORMATION, RETAIN RECORDS, AND GENERATE VALID DATA ANALYSIS IMPEDES EFFECTIVE RESPONSES TO GULF WAR VETERANS

Underlying many of the problems now facing Gulf War veterans is the lack of basic data from and about that deployment. In part, this is because much useful information was never collected in the first place. In part, it is because many official documents that did record key health and operations data no longer exist or cannot be found. Even with good intelligence, a high level of preparedness to face chemical or biological weapons threats, and effective program monitoring, the ability to fully address potential hazards to troop health depends on keeping and preserving accurate records. The inability to retrieve records of events occurring during military operations—including the health

status of deployed troops—impedes the efforts of health care providers and researchers who need that information or are trying to reconstruct those events years later.

For Gulf War veterans with unexplained illnesses, the impact of this lack of information is profound. The absence of data regarding battlefield exposures limits the ability of scientists to conduct research on possible links between conditions during the Gulf War and the symptoms many Gulf War veterans now experience. This lack of data also hinders health care professionals who try to provide effective treatment to Gulf War veterans. Finally, the lack of records also impedes timely processing of compensation benefits claims because supporting information to demonstrate service connection for the veterans' health problems is unavailable.

Perhaps even more critical is the VA's chronic and pervasive inability to generate valid and reliable data about the Gulf War veterans it serves. Repeatedly, this investigation found that the statistics generated by VA databases were inaccurate and inconsistent, and that too many times the VA simply could not answer questions about Gulf War veterans such as how many have undiagnosed illnesses, how many of those veterans also are receiving compensation benefits for that condition, how many are receiving health care, and whether those who have received care at VA facilities in the past are getting better or worse. This lack of data quality and integrity related to Gulf War veterans is, moreover, representative of a larger problem with VA's information systems that has serious implications as to VA's current and future ability to provide veterans with the services that it is mandated by law as its core mission to supply.

IV. THE DEPARTMENT OF DEFENSE AND DEPARTMENT OF VETERANS AFFAIRS MUST MAKE COOPERATION AND COORDINATION A TOP PRIORITY TO ENSURE TIMELY AND EFFECTIVE SERVICE FOR GULF WAR VETERANS

The SIU's investigation found comprehensive coordination and communication problems in the ways that both DOD and VA currently provide services to Gulf War veterans. Within DOD and VA there are many offices and departments that share the mission of serving Gulf War veterans but see themselves as responsible only for their portions of that mission. In practice, however, citizens view government agencies not in isolation but as parts of a single entity working toward a common goal. It is with an integrated, goal-oriented government that all veterans—especially those from the Gulf War who are ill—should have to deal. Because the military service member of today is the veteran of tomorrow, there must be a continuum of programs, services, information sharing, and care between the Department of Defense and the Department of Veterans Affairs that attains that reality. Thus, the DOD and VA should plan jointly so that from the time individuals enter military service, steps are taken to prevent and monitor situations that may result in adverse health effects after their military service ends. In addition, offices within these agencies need to, but do not always, consistently interpret statutory and internal program guidance in ways that ensure that the mission of serving Gulf War veterans is effectively and properly carried out.

The DOD's and VA's insufficient cooperation and coordination on Gulf War issues has been paralleled by the apparent reluctance at times of both agencies to seek outside input and assistance

on their programs for those veterans. For example, these agencies have not always consistently and fully implemented comprehensive input on a timely basis from peer review panels when those agencies have engaged in primarily scientific pursuits on behalf of Gulf War veterans. This was true for the initial DOD/CIA efforts to develop a computer model of the Khamisiyah explosion and a theory about the amount and extent of chemical weapon nerve agent possibly released into the atmosphere in that event. In turn, public announcements as to the potential number of veterans who may, according to this theory, have been exposed to some level of chemical agent were made before all the underlying information and assumptions were subjected to comprehensive peer review, and the flaws and limitations of that theory were not also made public.

There are positive developments indicating that the DOD has learned from the diminished credibility and public criticism that were consequences of its failure to address fully Gulf War veterans' concerns. Establishment of the Office of the Special Assistant for Gulf War Illnesses (OSAGWI) in 1996 has increased the flow of information to veterans and the public about various events during the Gulf War that may have affected the health of the veterans who served there. OSAGWI has also made efforts to solicit from Gulf War veterans their concerns about their health and possible exposures and should continue these efforts. The new Gulf War Oversight Board, created in April of 1998 by the President, chaired by former Senator Warren Rudman and with former Secretary of Veterans Affairs Jesse Brown serving as vice-chair, will provide a vehicle for continued monitoring of OSAGWI's work in the future.

There also are positive signs that new leadership at the VA has the will and the means to address and remedy the problems identified in this report. Just as the DOD has begun to apply lessons learned from the variety of Gulf War investigations, so too is the VA beginning to overcome the institutional inertia that characterized the early stages of its Gulf War programs.

CONCLUSION

The men and women who have served in our nation's military deserve better than what ill Gulf War veterans have experienced. They deserve to get answers from the government when they ask legitimate questions about what has happened to them during their deployment. They deserve to have the government promptly and fully investigate if the answer to those questions is not known. They deserve to have access to appropriate medical care in a timely and effective way and they deserve to be confident that their reports of health problems will be treated seriously and without contempt. They deserve to have funding of scientific research awarded in a scientifically sound and impartial way. When applying for service-connected disability compensation, Gulf War veterans deserve to have their claims reviewed and resolved promptly and with a minimum of bureaucratic hurdles for them to clear.

The government failed to meet these reasonable expectations in the past and, as a result, lost credibility with many Gulf War veterans, members of Congress, and the public. The lingering effects of that lost credibility make it much more difficult for the DOD and VA to be seen as fully responsive now to the needs of Gulf War veterans in implementing effective programs. Those agencies now must work even harder to demonstrate their empathy with and responsiveness to Gulf War veterans' health problems. To ensure that Gulf War veterans in the future receive quality and timely service from the DOD and particularly from VA, the DOD and VA should report back to the appropriate committees of Congress one year after the release of this report to describe the status of their efforts to implement the recommendations made here and to correct any other deficiencies identified in this report.

Some questions Gulf War veterans have about their health may never be answered. Scientific experts likely will debate for years the causes of these veterans' unexplained illnesses. But the search for answers should not supplant the primary responsibility of the Departments of Defense and Veterans Affairs to ensure that these veterans receive timely and effective health care and appropriate compensation benefits. This is an opportunity to learn the lessons from the Gulf War so that during or after a future conflict the mistakes of the past will not be repeated. America's Gulf War veterans, who may never know the origin of their illnesses but who nevertheless put themselves in harm's way when their country called, deserve no less.

RECOMMENDATIONS

I. PREPAREDNESS SHORTFALLS FOR EFFECTIVE DEFENSE AGAINST BATTLEFIELD HAZARDS EXISTED BEFORE AND DURING THE GULF WAR AND CONTINUE TODAY

1. The Secretary of Defense should create a single focal point in unified commands to gather, analyze, and report all intelligence information in support of any military operation in order to avoid the information sharing and communications failures that occurred during the Gulf War. The Director of Central Intelligence must fully coordinate and cooperate in ensuring this unified approach.
2. Training of and instructions to intelligence analysts at the Central Intelligence Agency, Defense Intelligence Agency, and Department of Defense should ensure awareness of historical and collateral facts and situations that may affect how they interpret and handle intelligence data.
3. The Secretary of Defense must make chemical and biological warfare training a high priority to remedy equipment, medical, and other readiness shortfalls that occurred during the Gulf War and continue today.

4. The Secretary of Defense should establish troop training and safety programs to minimize possible health hazards from contact with depleted uranium.
5. The Assistant Secretary of Defense for Health Affairs should develop awareness and treatment doctrine to identify possible troop exposures to depleted uranium (DU) on and off the battlefield and fund research into the health effects of DU exposure. The Departments of Defense and Veterans Affairs should also utilize the existing VA Depleted Uranium Medical Follow-Up Program to provide timely and in-depth medical evaluations to active duty troops and veterans with DU injuries.
6. The Assistant Secretary of Defense for Health Affairs, in collaboration with VA and the Department of Health and Human Services, should develop and implement integrated policies and programs that incorporate health lessons learned from the Gulf War, including data collection and retention, surveillance, and protection and monitoring of troop health during deployments.
7. The Secretary of Defense should establish a program to improve the capacity for rapid and early detection of exposures that may affect troop health during and after deployments, such as through funding the U.S. Centers for Disease Control and Prevention to develop technology to rapidly screen persons exposed to a wide range of chemical toxicants, including chemical warfare agents.
8. Congress should direct an independent scientific body, such as the National Academy of Sciences, to evaluate the need for and feasibility of a new national center for the study of military health, with an emphasis on post-conflict health concerns and illnesses.
9. The Secretary of Veterans Affairs should contract with an independent scientific body, such as the National Academy of Sciences, to provide an ongoing review of the scientific literature to assess the nature of associations between illnesses and exposure to toxic agents and environmental or other wartime exposures as a result of service in the Persian Gulf War for purposes of determining a service connection relating to such illnesses.

II. INSUFFICIENT PROGRAM MONITORING HINDERS THE DEPARTMENT OF DEFENSE'S AND DEPARTMENT OF VETERANS AFFAIRS' EFFECTIVENESS IN SERVING GULF WAR VETERANS

1. The Secretary of Defense and Secretary of Veterans Affairs should undertake a major effort to monitor on an ongoing basis the treatment provided to ill Gulf War veterans, especially those with unexplained illnesses, to determine whether those veterans are getting better or worse over time. Both agencies should evaluate and revise existing health care programs to remove or minimize barriers to timely and effective veteran participation in them. The Secretary of Defense and Secretary of Veterans Affairs also should jointly develop and implement methods

to monitor the health status of Gulf War veterans over time to provide early detection of future illnesses which may emerge years later, such as higher rates of cancers.

2. A new Assistant Secretary at the Department of Veterans Affairs should be created with responsibility for overseeing programs for addressing battlefield illnesses and other health issues that arise in connection with past and future deployments. Among this official's responsibilities would be oversight and coordination of research, treatment, and compensation efforts in this area.
3. The Secretary of Veterans Affairs should develop and implement joint training programs for compensation claims decision makers, examining physicians, Board of Veterans' Appeals decision makers, and others who coordinate or administer Gulf War veterans programs to ensure a common awareness and understanding of programs and activities involving unexplained illnesses.
4. Quality assessment of Gulf War veterans' compensation claims at the Department of Veterans Affairs should be conducted and validated by expert teams drawn from the Compensation and Pension Service, the Board of Veterans Appeals, and the Office of General Counsel. The Secretary of Veterans Affairs should implement and monitor corrective action.
5. The VA Office of the Inspector General should undertake a comprehensive assessment of VA medical facilities' compliance with Veterans Health Administration Central Office health care policies and programs on Gulf War veterans and should monitor corrective action taken.

III. THE DEPARTMENT OF DEFENSE'S AND DEPARTMENT OF VETERANS AFFAIRS' FAILURE TO COLLECT INFORMATION, RETAIN RECORDS, AND GENERATE VALID DATA ANALYSIS IMPEDES EFFECTIVE RESPONSES TO GULF WAR VETERANS

1. The Secretary of Defense should reinforce compliance with current statutory and regulatory requirements that all records, logs, and other documents related to wartime and other military operations that are permanent records under the law are retained, and require that all unified commanders demonstrate this duty is being implemented and understood as a priority at every level in that command.
2. The Secretary of Defense should implement a personnel tracking system, such as that now being developed by the U.S. Army Center for Health Promotion and Preventive Medicine, in order to track and identify where individual service members were located during military operations.
3. The Secretary of Veterans Affairs should direct development of a consolidated examination protocol for Gulf War veterans that can be used both to determine eligibility for service-

connected disability compensation and provide necessary data for participation in the VA's Persian Gulf War Registry program.

4. The Secretary of Veterans Affairs should utilize team and case management approaches to serving Gulf War veterans with unexplained illnesses so that claims processors and health care providers jointly participate in and provide input to service-connected benefits eligibility decisions.
5. The Secretary of Veterans Affairs should require all Veterans Health Administration medical facilities to provide information to Gulf War veterans on how to apply for compensation benefits when they communicate to those veterans the results of their Persian Gulf Registry examination. All Veterans Benefits Administration regional offices should be required to provide Gulf War veterans with information on how to participate in the VA's Persian Gulf Registry program when they communicate with those veterans on compensation claims they have filed.
6. The Secretary of Veterans Affairs should expand the current Persian Gulf Registry to fully comply with the requirements for a Gulf War veteran national data base that was mandated by Congress in the Veterans Health Care Act of 1992.
7. The Secretary of Defense should direct that complete and accurate medical information is collected and maintained on all troops, from base-line physical examinations to all immunizations and administration of medical products occurring on and off the battlefield. This includes directing that reservists, as well as active duty military personnel, who are deployed receive health assessments before and after deployments.
8. The Secretary of Defense and Secretary of Veterans Affairs should, in collaboration with the national, state-based birth defects registry under development, establish a birth defects registry for military service members to gather statistics on possible reproductive health effects stemming from battlefield exposures.

IV. THE DEPARTMENT OF DEFENSE AND DEPARTMENT OF VETERANS AFFAIRS MUST MAKE ONGOING COOPERATION AND COORDINATION A TOP PRIORITY TO ENSURE TIMELY AND EFFECTIVE SERVICE FOR GULF WAR VETERANS

1. The joint DoD/CIA Khamisiyah plume modeling effort, and future similar efforts, should be peer reviewed by experts from inside and outside of government and the results of that peer review made public.
2. The Secretary of Veterans Affairs should create in each of VA's Veterans Integrated Service Networks a working group on Gulf War illnesses that should meet at least quarterly to provide

input on implementation of VA health care and compensation programs for Gulf War veterans. Members should include Gulf War veterans, veterans advocates and representatives from veterans service organizations, VA Persian Gulf physicians and coordinators, and senior Veterans Health Administration and Veterans Benefits Administration officials whose responsibilities include implementation of these programs.

3. The Secretary of Defense and Secretary of Veterans Affairs should maintain compatible information systems, collect registry information that can be meaningfully analyzed and compared, and implement methods for regular exchange of information on the health status of and effective treatments for Gulf War veterans.
4. The Department of Defense, in consultation with the Environmental Protection Agency and the Centers for Disease Control and Prevention, should make available to military commanders environmental intelligence about factors that could adversely affect troop health and thereby impede the successful achievement of military missions.
5. The Secretary of Veterans Affairs should direct that veterans be provided clear and candid information about pertinent environmental risks they may have experienced during deployments that may have had an adverse impact on their health.
6. The Secretary of Defense and Secretary of Veterans Affairs should contract with an independent scientific body to evaluate treatment protocols that have been useful for persons in the general population who suffer from illnesses similar to Gulf War veterans' unexplained illnesses and to recommend funding of appropriate clinical programs and research in this area. The Secretary of Defense and Secretary of Veterans Affairs should only fund Gulf War health research pursuant to an impartial, scientific peer review process, except in the case of the most serious and extreme circumstances.
7. The Secretary of Defense and Secretary of Veterans Affairs should independently report to the appropriate committees of Congress on progress made to implement the recommendations and remedy deficiencies identified in this report within one year of the date this report is issued.

INTRODUCTION

"No one commits America's Armed Forces to a dangerous mission lightly . . . Standing up for our principles will not come easy. It may take time and possibly cost a great deal. But we are asking no more of anyone than of the brave young men and women of our Armed Forces and their families."

*— Statement of the President addressing the Nation before sending
U.S. troops to support Operation Desert Storm, August 8, 1990*

The President and his advisers understood the challenge facing American troops in August of 1990 and believed that the U.S. military was fully ready to meet that challenge. Tactically and strategically there was every reason to be confident. What no one knew was that some basic components of the American combat machine—specifically chemical and biological warfare readiness, health care readiness and monitoring, and health records management—were strained.

In the years following their deployment, many Gulf War veterans began reporting illnesses or health problems they believed were related to their service in the Gulf. As far as many of these veterans were concerned, neither the Department of Defense (DOD) nor the Department of Veterans Affairs (VA) was exercising appropriate diagnostic or prescriptive health care in response to their symptoms. The frustration many Gulf War veterans were experiencing from the inadequate responses of these two federal agencies was exacerbated by a troubling lack of health records from the war. In addition, information began circulating that suggested that there were events during the war which may have exposed some troops to health hazards yet were not fully documented in intelligence and operational records, had not been investigated, or were known but not acknowledged.

By 1992 and 1993, it was clear that there were problems with the way the Defense Department was telling the Gulf War story. It was also during this time that a new factor in the public exchange of information—the Internet—first became active. Web sites and chat rooms served as conduits for anecdotes, medical news, messages, exchanges of information that were sometimes factually correct and sometimes not, and simple pleas for help from Gulf War veterans and their families. There were stories of problems with the administration of a drug distributed to troops to lessen the effects of a chemical attack and accounts of faulty chemical weapons agent detection alarms.

Lacking any hard evidence to the contrary from DOD and doubting the limited information that was released by DOD and VA, veterans who were sick, the news media following their stories, and

others began using the newly-coined phrase "Gulf War Syndrome" to describe a growing list of physical symptoms many Gulf War veterans were experiencing. This concept of an unexplained but somehow linked set of illnesses caught the public's attention and brought the concerns of Gulf War veterans in the United States to the front pages of newspapers around the world. To many of these veterans who had been hailed in parades around the country, the Gulf War was no longer a singularly celebrated victory in the past—it had become an event with hazy and ominous dimensions for the future.

Congress soon took up the challenge and began to take action both to find out what had happened to veterans in the Gulf War that might have triggered their illnesses and to enact measures to provide them with medical and other assistance. For example, in 1993 and 1994 the Senate Banking Committee issued reports on its inquiry into U.S. exports in the 1980s to Iraq of materials that can be used in the manufacture of chemical and biological weapons and of possible links to Gulf War veterans' health problems. The Senate Committee on Veterans' Affairs took an early interest in the health problems that Gulf War veterans were developing and the government's responses, holding hearings, issuing reports, and sponsoring legislation. Committees of the House of Representatives have done the same.

Several other investigations into Gulf War veteran illnesses have also occurred or are still underway. Among these are studies carried out by a Defense Science Board panel in 1994 and by the Presidential Advisory Committee on Gulf War Veterans' Illnesses, which was established in May 1995 for an initial one year term and extended until October 1997. At the Department of Defense, the Office of the Special Assistant for Gulf War Illnesses was established in late 1996 and in February of 1997 the Director of Central Intelligence established the Persian Gulf War Illnesses Task Force to provide intelligence community support on questions related to possible chemical and biological incidents during the Gulf War. In April of 1998, the President established a Gulf War Advisory Board to conduct oversight of DOD's ongoing investigations into possible detections of and exposures to chemical or biological warfare agents and environmental or other factors that may have contributed to the illnesses of Gulf War veterans. Veterans service organizations and other non-governmental groups have also played key advocacy roles on behalf of ill Gulf War veterans. The reports and other products of all of these groups contain a broad spectrum of conclusions and opinions about the government's role and responsibility during the Gulf War for the subsequent health of that war's veterans.

And yet, despite many investigations and the passage of time, no clear understanding from an overall government perspective emerged as to what may have caused these veterans' illnesses, what should be done to treat them, and how a similar situation can be avoided in the future. To help bridge this gap, the Senate Committee on Veterans' Affairs created a bipartisan special investigation unit (SIU) in April of 1997 to undertake a comprehensive and detailed review of the situation.

What the SIU investigation found almost from the beginning was that the concept of a "syndrome," usually defined as "a group of symptoms that together are characteristic of a specific disorder, disease, or the like,"¹ does not accurately describe what is collectively referred to as "Gulf War illnesses." Instead, these veterans experience a variety of symptoms, illnesses, and disorders that do not appear to fit a particular pattern. Some of these medical personnel can readily identify; some defy conventional diagnosis. The SIU's approach to this situation was not unlike that of a news story, in which the basic questions explored are "who, what, when, where, why, and how?" For the purpose of this investigation that meant: who is sick; what is the nature of the illnesses, symptoms, or disabilities; when did they become sick; where did the illnesses or symptoms originate; why were avoidable health hazards in the Gulf not prevented; and how can the government best help Gulf War veterans now?

The SIU's defense-intelligence investigative team analyzed in detail the where, when, and why of Gulf War events, seeking links between the planning and operational side of the war and possible sources of health hazards. This team conducted an exhaustive survey of the equipment, policies, and information networks that surrounded and supported the troops in their various missions. It was through this part of the investigation that more was learned about the intelligence gaps, biological and chemical hazards training shortfalls, equipment deficits, and record-keeping shortcomings that led to possible health risk exposures. This evidence showed that certain specialized pieces of equipment designed to detect and warn of chemical weapons agents were not up to the task. It led the SIU to conclude that the Department of Defense at first neglected to fully investigate the destruction of a chemical weapons depot and later may have overstated the findings from its attempted computerized reconstruction of the event.

A second SIU team examined the VA's Gulf War health and benefits programs to determine the efficacy of the VA's examinations, diagnoses, and follow-on care, as well as the VA's procedures for determining benefits eligibility and claims adjudication. This team asked: "How did the VA initially respond to Gulf War veterans' health claims, is it doing a better job now, and will it be more responsive in the years to come?" The VA team learned that despite the VA's Gulf War registry and despite written policies for health care protocols for Gulf War examinations, data from the registry and exams often was not properly collected or analyzed during the years following the registry's establishment in 1993. The team conducted extensive in-field interviews and facility visits, and the results of its investigations reveal wide disparities among VA services with respect to appropriate care for Gulf War veterans.

This aspect of the investigation identified many shortcomings in the VA's health care and benefits delivery processes that have not served Gulf War veterans well from the earliest days of their complaints. Time and time again, the SIU's investigators found instances of poor judgement, inaccurate data, missing files, and bureaucratic barriers at VA medical centers and clinics that deprive Gulf War veterans in particular of timely and compassionate attention and treatment (although these problems at VA affect other veterans as well). While it would be unfair to paint all

VA facilities, staff, and managers with a broadly critical brush, some of the problems the investigators discovered call into question the ability of the VA to remedy its failures and provide proper care to Gulf War veterans.

The SIU's health-science team focused on the medical elements of this investigation—the morbidity, mortality, and epidemiology, or the who and what of the Gulf War illnesses story. This team looked at how DOD's health-related decisions prior to and during the Gulf War deployment may have affected the health of Gulf War veterans. They described what kinds of health threats Gulf War veterans could have encountered, including pesticides, oil well fire toxins, fumes from diesel engines and tent heaters, sand-fly-borne leishmaniasis, and potential reactions to vaccines as well as drugs such as pyridostigmine bromide. The team also described the health problems of Gulf War veterans and consulted with scientific experts to learn even more about how Gulf War exposures might be associated with illnesses. This team looked at how Gulf War veterans are being diagnosed and treated by DOD and VA, and what types of research are being funded to learn about reasons for these illnesses. Perhaps one of the most important lessons learned as a result of the health-science aspect of this investigation was how DOD's failure to keep records during the Gulf War is severely limiting the ability of researchers to learn more about these illnesses. The absence of good records also hampers the VA's ability to treat ill Gulf War veterans and to make the best possible benefits decisions for them.

The SIU completes its work with this report, but the Committee's oversight of this important issue will go on. This report represents a concerted effort to answer basic questions that have long been asked by Gulf War veterans, their families, Congress, and the public as to why these veterans are ill and, what is more important, how they can get better. This report comprehensively identifies weaknesses in the Defense Department's policies, plans, and procedures that may have caused Gulf War personnel to be exposed unnecessarily to certain health risks. It also identifies shortcomings in the VA's methods and policies for providing compensation benefits and health care to veterans of the war.

This report would be incomplete, however, if it did not commend the good work being done by so many dedicated men and women in VA, DOD, CIA, and other agencies and non-governmental groups, including veterans service organizations, who have worked and continue to work hard on behalf of Gulf War veterans. The investigative staff could not have accomplished all it did, in the time available, without the cooperation of countless individuals whose personal caring and professionalism are focused on relieving the anxiety, the pain, and the heartbreak evident among many Gulf War veterans and their families. The SIU equally owes a debt of gratitude to the many Gulf War veterans and their families who took the time to provide the investigation with invaluable information about their experiences. This report is for them.

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REVIEW OF DEFENSE DEPARTMENT AND INTELLIGENCE COMMUNITY ACTIONS, GULF WAR VETERANS' HEALTH, AND IMPLICATIONS FOR THE FUTURE

INTRODUCTION

Key to determining why and how some Gulf War veterans have developed health problems since their deployment to the Middle East in 1990 is gaining an understanding of the state of U.S. military preparedness for conducting operations in that environment. Such an understanding must also be considered in the context of the perceived threat that Iraq might use chemical or biological weapons (CBW) in that war. Moreover, the lessons learned from that experience are critical to helping ensure that in the future no veteran's health is adversely affected during military service by circumstances that can reasonably be avoided or prevented.

In the fall of 1990, as American troops and allies began to arrive in the Persian Gulf region to initiate Operation Desert Shield, U.S. intelligence resources were already well aware of Iraq's ability to manufacture and use chemical and biological weapons. The news media was rife with speculation about the possibility of an Iraqi chemical weapons strike. There was good reason for this: the Iran-Iraq war during most of the 1980s left no doubt that given the opportunity, Iraq would employ chemical weapons on the battlefield. Awareness of the impact that chemical weapons could have on fighting forces had been an element of U.S. military training doctrine long before the Gulf War, but defense against chemical warfare had not been a priority during actual troop training.

The possibility that biological weapons could be used against coalition forces was also of concern to the U.S. government. While it was generally believed that chemical agents could be detected and, to some degree, countered, the United States' ability to detect biological weapons was almost nonexistent. Iraq's known chemical and biological production and storage facilities were, therefore, high on air strike priority lists.

By December of 1990, the likelihood of a ground war—and with it the possibility of chemical or biological warfare—triggered a decision to vaccinate some U.S. troops against anthrax. Department

of Defense and Food and Drug Administration officials were also developing guidelines for use of pyridostigmine bromide (PB), which was hoped would counter the effects of some chemical nerve agents, and for use of a botulinum toxoid vaccine. (For expanded information on these topics, see Chapter Three.) Fox vehicles, which are German-manufactured systems to detect the presence of chemical weapons, were brought into the theater during Operation Desert Shield. The M8A1 chemical alarm—a freestanding or vehicle mounted device—was also widely distributed throughout the region. Intelligence suggesting that Iraq could launch CBW-armed missiles into well-populated areas around the theater of operations heightened in-theater awareness of the need for good CBW protection.

Intelligence reports showed that Iraq had stockpiles of chemical and biological weapons scattered across the country. Strategies were developed by the Joint Chiefs of Staff (JCS) to attempt to neutralize as much of Iraq's chemical and biological production and capacity as possible during the Gulf War's air campaign phase, which began on January 17, 1991. The public was riveted by almost-real-time images of U.S. laser-guided munitions crashing into bunkers and other Iraqi military installations. These images, and reports of the destruction of Iraqi chemical and biological weapons production and storage sites, would again come under scrutiny many years later in attempts to reconstruct what happened during the war.

When the ground war finally got underway on February 24, 1991, the speed with which it was executed caused large numbers of U.S. troops to sweep through Iraqi defenses so fast they could not always fully account for what they had just encountered. An objective known to the military by one name often had another name to intelligence-gatherers, and yet another name that was commonly used by local residents. As a result, post-war cleanup plans, including those directing demolition team operations, were sometimes vague in details about specific areas to be cleared.

This chapter is built on several underlying findings. The first is that U.S. forces operating in the Southwest Asian theater during Desert Shield and Desert Storm were not always adequately supported by reliable or timely intelligence and communications. Good intelligence is a critical element both in the direct prosecution of war and in determining acceptable day-to-day operational risks for the soldiers, sailors, airmen, and Marines who may be called on to fight. This chapter's centerpiece case study, the demolition of the Khamisiyah ammunition complex in southeastern Iraq in March 1991, is an example of how intelligence and communications failures before, during, and after that event had not only the potential for placing U.S. personnel at an unacceptable level of risk, but in fact may have jeopardized the health of many American troops.

Even with the best intelligence, U.S. forces could still be faced with chemical or biological weapons or other materials (such as depleted uranium) with potentially hazardous side effects to those who use them or work around them on and off the battlefield. Therefore, the SIU investigation took a hard look at DOD's policies and plans for training, warning, and protecting troops from the hazards of such agents and materials. The results of this aspect of the investigation showed serious

training shortfalls in chemical and biological agent awareness and in other hazardous materials training doctrine. There were glaring deficits in the ability of fielded alarm systems to provide reliable warnings of impending chemical or biological agent exposures. There was poor medical record keeping with respect to potential health-risk exposures. And there was a critically inadequate supply of personal protection equipment available.

Finally, the SIU looked at record keeping as a tool for helping piece together events before, during and after the deployment. Such records can yield information relevant to veterans' health claims and can provide a scientific foundation for future health-risk research. The investigative staff found that the Department of Defense failed to maintain adequate records of critical health-risk events before, during, and after the Gulf War. This failure has brought into question for many the government's efforts to provide the best possible health care and benefits to Gulf War veterans. The failure to keep and maintain adequate records also undermines the ability of scientists to study a broad constellation of in-theater health risks with any degree of confidence in the available data.

In short, without good planning and sharing of intelligence, without adequate preparation in training and materials, and without adequate record keeping, neither the Department of Defense nor the Department of Veterans Affairs can adequately account for events or conditions that may ultimately have affected the health of Gulf War veterans or may affect veterans of conflicts in the future.

THE KHAMISIYAH WEAPONS DEPOT DEMOLITION

The Khamisiyah weapons depot was a large facility in southern Iraq targeted for destruction by U.S. forces in early March of 1991. The story of Khamisiyah is one of confused location identities, inaccurate records, conflicting personal recollections, possible chemical exposure health risks, and claims of Pentagon cover-up after the fact. It illustrates issues common to many other events during the Gulf War. Following the narrative of the Khamisiyah incident is a discussion of other possible similar events, the effectiveness of chemical detection systems used at the time, and related battlefield health risk issues such as depleted uranium.

March 2-4, 1991—The Khamisiyah main depot complex (see maps reproduced at Appendix A) consisted of approximately 100 weapons storage bunkers distributed in an approximately nine square kilometer area and a smaller area—a kidney-shaped depression approximately 1,000 feet long and 300 feet across (widely referred to as the "pit") about two kilometers southwest of the larger complex. It is important to distinguish between the bunker and pit sites, since eyewitness accounts and contemporaneous intelligence reports did not always accurately describe the place and time of events in the Khamisiyah area in early March of 1991. Explosive ordnance disposal (EOD) teams from the 37th Engineer Battalion and the 307th Engineer Brigade arrived at the main bunker complex on March 2, 1991 with the purpose of investigating and demolishing what they believed at the time was one large weapons storage facility. The teams destroyed 37 bunkers in the main complex on

March 4. Prior to the detonations, troops from the 37th Engineer Battalion and the 307th Engineer Brigade inspected each bunker using M8A1 alarms designed to detect the presence of a range of chemical weapons agents, including mustard, sarin, tabun, and soman.²

M8A1 CHEMICAL DETECTION ALARMS

The M8A1 is a stand-alone or vehicle mounted device composed of a sensor and a horn which, when connected by a long wire, can be detached and set up some distance from the sensor. There has been considerable debate about the effectiveness of the M8A1, particularly in light of evidence that the device can be "tricked" into falsely sounding by a variety of non-lethal agents, such as diesel and turbine engine fumes, pesticides, and fine, wind-blown particulates. Only once during demolition activity on March 4, 1991 when the 37 bunkers were exploded in the main Khamisiyah depot did a M8A1 chemical alarm sound. The alarm caused many, although not all, of the units present to put on full chemical protection gear (also known as "Mission Oriented Protective Posture Level-4" or "MOPP-4"). Chemical protection training regulations require all military personnel to proceed to MOPP-4 when chemical alarms sound. However, many troops at Khamisiyah felt this was just one of numerous false alarms that had occurred since the war began and did not do so.

Some soldiers also conducted tests to confirm the presence of chemical agents using a device called the M-256-A1 Chemical Agent Detector Kit, a hand-held card containing a variety of reactive chemicals that respond to the presence of certain agents by changing color. One test showed a partial positive reading for "persistent blister agent" but additional tests with other kits led those using them to conclude that no chemical agent was in fact present.³ Over the next six days the engineers prepared the depot for a final demolition of the entire facility.⁴

March 9, 1991—On March 9, 1991, during a second reconnaissance of the Khamisiyah depot and surrounding area, members of the 37th Engineer Battalion discovered stacks of 122mm rockets in the open pit-like area south of the main bunker complex. The rockets, covered by canvas tarps and dirt, were located along the pit's southwestern wall. Soldiers of the 37th, along with two explosive ordnance specialists, began preparing the pit for destruction. In the process, they opened crates that were found to contain "unmarked rockets colored olive drab," and they concluded that the rockets did not contain a chemical agent. This conclusion was based in part on the fact that M8A1 detectors that were used in the pit did not signal that any chemical agent was present.⁵ Moreover, although members of the 37th Engineer Battalion had a general knowledge that chemical weapons could be present at any given site, as discussed below they were not equipped with timely information from intelligence sources that caused them to specifically look for such weapons at the Khamisiyah depot.

CRITICAL SITE INFORMATION NOT PASSED TO DEMOLITION TEAM AT KHAMISIYAH

Information from human intelligence sources made available at the time to military decision-makers by the CIA warned of the possibility of chemical weapons in the Khamisiyah area.⁶ A report of an interview with an Iraqi prisoner of war declared that chemical weapons were present at "Objective Gold," the name that the Army used to identify the Khamisiyah area.⁷ The Khamisiyah site, this time referred to as "Tall al Lahm," also appeared on a "Suspect Chemical Weapons Site" list prepared by U. S. Central Command (CENTCOM). This list was provided to Army Central Command (ARCENT) as part of a request to determine by March 4 whether chemical or biological munitions were present at seventeen sites suspected to contain them.⁸

While this important intelligence was made available to military decision-makers, it is unclear to what extent any of this information reached the battalion, company, or unit level. For example, ARCENT failed to coordinate intelligence when an XVIII Airborne Corps message based on DIA information, dated 26 February 1991 and titled "Possible chemicals on OBJ. GOLD," was sent to the 24th Infantry Division Mechanized and the 101st Airborne Division. That data was not sent to the 82nd Airborne Division which was ultimately assigned to the demolition of Khamisiyah.⁹

Intelligence also conflicted as to whether Iraqi chemical munitions were or were not marked with any consistency. In February of 1991, messages were sent by the XVIII Airborne Corps and the 20th Engineer Brigade to subordinate commands notifying units that a particular color pattern or number of rings could identify chemical munitions.¹⁰ SIU investigators learned that members of the 37th Engineer Battalion based their inspection of the bunkers and pit at Khamisiyah for chemical munitions on information consistent with this notification. These troops were not in the XVIII Airborne Corps chain of command and they did not receive a warning about the destruction of chemical ordnance published by the XVIII Airborne Corps on February 20, 1991. That warning stated that "at this time there are no known markings/color scheme on Iraqi chemical and biological munitions."¹¹ Another message sent by the CIA to DOD's intelligence (J-2) and operations (J-3) directorates in Riyadh through the Joint Intelligence Liaison Element on March 6, 1991 noted that the Iraqis in fact did not specifically mark munitions to indicate that they contain chemical agent. That message never reached the 37th Engineer Battalion.¹²

March 9-10, 1991—On March 9 and 10, 1991, soldiers of the 37th and the 307th set explosive charges among the cases of rockets in the pit at Khamisiyah. Due to the large size of the main Khamisiyah depot and other Iraqi munitions storage sites being destroyed, available supplies of demolition explosives usually used for such purposes were limited. This shortage caused the EOD personnel in the pit to resort to the use of a variety of foreign-made demolitions products, including Czech-supplied detonation cord. Affecting their actions were several considerations, including on-site evaluation that chemical weapons were not involved, the time constraints of the project (driven in part by command orders to conclude operations quickly and return home), and the limited supplies of explosives. In light of these, the engineers' goal was not to completely destroy the rockets but to

"demilitarize" them, essentially breaking them apart and rendering them useless. This would not be the procedure used if the presence of chemical weapons had been suspected. In that case, total destruction by fire would have been the aim and a more elaborate process, using appropriately experienced personnel, would have been employed.

March 10, 1991—The 37th and the 307th completed the preparation of the pit and of the remaining bunkers and warehouses to the north in the main depot. They primed the charges and then departed south toward Saudi Arabia. They were at least 20 km (12.4 miles) away from Khamisiyah when the depot and pit exploded. The main explosion also generated secondary, or sympathetic, explosions among nearby munitions, which sent shell fragments and intact projectiles to distances up to 10 km away from the facility, well beyond the buffer zone estimated by the engineers but still well out of range of any of the departing troops.¹³

March 12-13, 1991—Even after the two sites had been destroyed, there was no conclusive evidence at the time that chemical weapons had been involved. When U.S. soldiers visited the pit two days after the destruction of the rockets and stood amidst the debris, no chemical alarms sounded during their visit. Those soldiers reported no acute physical reactions that would normally be associated with an encounter with a nerve agent. However, information gathered later in the year by the United Nations Special Commission on Iraq (UNSCOM) and during UNSCOM's subsequent inspections (detailed below) provide evidence that munitions filled with the nerve agents sarin and cyclosarin were, in fact, destroyed at Khamisiyah in March of 1991.

To independently evaluate whether the 122mm rockets destroyed by U.S. troops at Khamisiyah contained chemical warfare nerve agents, SIU investigators interviewed DOD, CIA, DIA and other intelligence community personnel about the type of munitions found at Khamisiyah. Information also was gathered about the general purity and shelf life of Iraqi chemical munitions, the condition of the munitions at Khamisiyah, how and when they were transported from Iraq to that site, and the circumstances under which detection alarm reports by coalition forces were made. Investigators also reviewed volumes of classified and unclassified materials on the topic of chemical weapons published by various government agencies. The most valuable information available to the SIU staff in reaching its findings on this issue was, however, that produced by UNSCOM in the course of its site inspections of Iraq over the past several years.

ARMY INSPECTOR GENERAL INVESTIGATION OF KHAMISIYAH

The Army Inspector General (IG) investigated the Khamisiyah demolition and on October 10, 1997, issued a report finding "no empirical evidence" that chemical munitions or agents were present during the demolition operation. The Army IG also found no "conclusive evidence that U.S. Army ground units either knew or suspected that they were destroying chemical munitions."¹⁴ Further, the IG found "no conclusive evidence that supports or refutes the conclusions of the Intelligence community" as to whether there were chemical munitions at Khamisiyah.

The IG report also stated that if low level exposure of troops did occur at Khamisiyah, it "was not of immediate military significance" and "was less than that necessary to cause an onset of acute physical symptoms."¹⁵ There are grounds to support the Army Inspector General's findings that there does not appear to have been any direct evidence available at the time when the EOD teams were in the Khamisiyah pit indicating that chemical munitions were present. However, the IG's report is derived only from contemporaneous accounts of the Khamisiyah demolition and does not, for reasons that are unclear, also take into consideration information that had been generated from UNSCOM inspection team investigations of the area. As described below, UNSCOM's on-site investigations determined that sarin and cyclosarin in fact were present at Khamisiyah based on their on-site discovery in late 1991—some months after the demolition—of chemical-filled warheads and related debris.

UNSCOM CONCLUDES CHEMICAL WEAPONS WERE AT KHAMISIYAH

As part of a broad internationally-sanctioned discovery process, United Nations Special Commission inspection teams visited Khamisiyah at least five times between October 1991 and August 1997. Their findings are summarized below:

1991—At the first inspection in October of 1991, UNSCOM found rockets at the Khamisiyah pit and determined that they contained a mixture of sarin and cyclosarin. UNSCOM inspectors tested at least one chemical rocket at that time and also noted the presence of over 300 more leaking and damaged rockets. According to UNSCOM, the chemical potency of the liquid in the warhead was so degraded it was necessary to place a sensitive detection device called a Chemical Agent Monitor just inches away from a leaking 122mm rocket in order to register a positive reading for the chemical agent sarin.

1992—UNSCOM inspectors discovered many rockets along the pit's south wall (sometimes described as a berm, or earthen retaining wall) that had been bulldozed by the Iraqis some time after the previous inspection.

1993—UNSCOM inspectors shipped about 500 rockets from Khamisiyah to a destruction facility at Al Muthanna, where they were drained of sarin/cyclosarin and then demilitarized.

1996—In May of 1996, UNSCOM found plastic burster tubes, which are components of munitions containing chemical agent, and other evidence that chemical rockets had been in a main depot bunker that was destroyed by U.S. forces on March 4, 1991, a week before the pit explosion.

1997—In August of 1997, another inspection of the bunker discovered in 1996 revealed that more sarin-filled rockets remain buried underground at that site.

UNSCOM RATES IRAQ CW SARIN PURITY AS HIGH AS 75 PERCENT

Based on Iraqi production documents found by UNSCOM during an inspection of the Al Muthanna chemical weapons production and storage facility in Iraq, the purity of Iraqi sarin produced during the Gulf War ranged from 40 percent to 75 percent. During their follow-on investigations in Iraq, UNSCOM teams found and tested a number of 122mm rockets found at the Khamisiyah pit. Determining the chemical's purity several months or years after the Khamisiyah event provides clues as to the potential lethality of the weapons at the time of destruction. Many factors, including temperature, humidity, type and size of container, and storage procedures, can affect the quality of a chemical agent. Based on available evidence, the SIU investigators could not draw specific conclusions about the potential lethality of any of the chemical-filled rockets discovered at Khamisiyah. However, according to UNSCOM, the purity of the sarin/cyclosarin mixture in the 122mm rockets found at Khamisiyah that were filled in December of 1990 was about 60 percent. Iraqi chemical production records recovered by UNSCOM indicate that this chemical agent was part of a production run of about 60 tons of sarin/cyclosarin that was placed into over 8,000 122mm shells. UNSCOM's officials estimated the purity of the agent at the time of the demolition of Khamisiyah was about 50 percent.¹⁶

UNSCOM authorities found that Iraq shipped, either by rail or truck, 2,160 122mm rockets to Khamisiyah in early January of 1991 and stored half of them in a bunker that subsequently was destroyed on March 4 by U.S. troops. Sometime between January 10 and January 15, the other half of that cache was moved to the pit area.¹⁷ The Iraqis have provided two explanations for the movement of these munitions to Khamisiyah: (1) they were moved for safety reasons because the rockets were leaking and (2) they were moved to avoid being destroyed by bombing during the Gulf War itself.¹⁸ UNSCOM personnel also told SIU staff that the Iraqis have recently declared that the rockets were initially stored in two bunkers.¹⁹ However, UNSCOM inspectors have not been able to find another bunker at Khamisiyah that confirms this.

UNSCOM also learned that in January of 1991 Iraq moved over 6,000 mustard-filled 155mm-artillery shells to the An Nasiriyah ammunition storage area, located approximately 30km northwest of Khamisiyah. They were part of a group of 13,500 projectiles that were filled with mustard in 1990, with a purity that ranged from 85 to 90 percent. U.S. intelligence sources stated that sometime in January or February the munitions were transferred to an area outside of Khamisiyah and covered to avoid overhead detection. However, these munitions were neither found nor destroyed by U.S. personnel in the area. The Iraqis showed members of the October 1991 UNSCOM inspection team these mustard-filled shells. All of the shells were eventually transferred by UNSCOM to Al Muthanna for destruction.

Much, if not all, of the controversy that has surrounded the demolition of Khamisiyah likely could have been avoided had the Department of Defense and the intelligence community thoroughly investigated the information available about it in 1991. The following chronology, derived from

unclassified documents and government publications, details information available inside the U.S. government about Khamisiyah in 1991:

April 1991—The U.S. government intercepted an Iraqi report claiming U.S. forces had destroyed the Khamisiyah depot on April 1 and 2. The Iraqi information was incorrect; the report referred to the destruction of the 37 bunkers in the main Khamisiyah depot on March 4, 1991.

May 16, 1991—Iraq declared to the United Nations that 2,160 sarin-filled rockets had been destroyed at “Khamisiyah stores” and 6,240 mustard-filled 155mm-artillery shells remained intact at “Khamisiyah stores.”

May 17, 1991—Iraq gave the location of “Khamisiyah stores (Nasiriyah)” at 3046N/04630E, which is near Khamisiyah. This declaration was widely distributed inside the State Department, the Department of Defense, and the intelligence community.²⁰

August 1991—The CIA published a highly classified intelligence assessment on Iraqi noncompliance with UN Security Council resolutions that listed Khamisiyah as a known CW storage site.²¹

October 1991—The UNSCOM inspection team was led by Iraqis to a number of 122mm Iraqi sarin/cyclosarin rockets in a pit near Khamisiyah and over 6,000 155mm mustard rounds in an open area west of Khamisiyah. These were the same shells that had been initially transported to An Nasiriyah in January 1991. The Iraqis also told the inspectors that coalition troops had destroyed chemical weapons in a bunker at Khamisiyah earlier that year.

November 1991—The UNSCOM report was made available to the DIA, but it was dismissed as containing Iraqi deception for two reasons: (1) confusion over whether or not the inspectors were actually taken to Khamisiyah or the depot nearby at An Nasiriyah and (2) a belief that the Iraqis may have placed the chemical weapons there as part of an effort to conceal their chemical and biological weapons programs.²²

The Arms Control Intelligence Staff (ACIS), which was the intelligence community's interagency coordinating organization at the time, disseminated a report throughout the intelligence community and the Department of Defense that included Iraqi claims about the destruction of Khamisiyah. That same month, ACIS distributed an internal CIA cable that described the demolition, identified Khamisiyah as being the same site as one known within the intelligence community during the Gulf War as Tall Al Lahm, and reported that Army Central Command had provided information placing the 24th Mechanized Infantry Division near Tall Al Lahm. Remnants of U.S.-manufactured and deployed M-48 shaped charges had been recovered at the site, indicating that American forces had been present during the destruction. ACIS sent a message to the 24th Mechanized Division advising them about Khamisiyah and asking if their troops were involved in the demolition. The 24th

Mechanized Division did not respond to the message, although it is unclear why, and ACIS failed to follow-up.²³

MISIDENTIFICATION OF KHAMISIYAH SITE KEY TO INTELLIGENCE CONFUSION

The fact that the area now referred to as Khamisiyah had been commonly identified within the intelligence community as Tall al Lahm appears to have been a key factor hindering timely dissemination and use of intelligence information about the area. Tall al Lahm refers to another town just west of the ammunition storage area. The Iraqis referred to the area as Khamisiyah, a somewhat larger town east of the facility. To the 37th Engineer Battalion, it was known as Objective Gold. However, the National Security Agency database referred to the area as Al Khamisiyah.

The lack of coordination of names and data bases concerning Khamisiyah led to confusion about who destroyed the depot, whether or not it was a chemical weapons site and if the site was truly Khamisiyah or An Nasiriyah. The Central Intelligence Agency has acknowledged these shortcomings and has made a number of recommendations regarding shared use of a primary database for location names and spellings, development of which should be a priority to help avoid similar mistakes in the future.²⁴

EXTERNAL PRESSURES PROMPTED U.S. GOVERNMENT INVESTIGATION INTO KHAMISIYAH

The information about the events at Khamisiyah described above only recently came to light because of pressure from veterans, Congressional investigations, the media, and others. The following chronology describes actions taken by the U.S. government as a result of that pressure:

March 1995—The CIA was directed to conduct a thorough review of intelligence during the Gulf War.

May 25, 1995—The Presidential Advisory Committee on Gulf War Veterans' Illnesses (PAC) was established.

September 1995—The CIA reported to the DOD Persian Gulf Investigation Team (PGIT) that the Khamisiyah demolition was a possible chemical release event. The report was based on a review of the 1991 UNSCOM report on Khamisiyah and the development of a comprehensive summary of Iraqi chemical weapon production and storage facilities. A search was made of the newly-constructed DOD Environmental Support Group (ESG) unit locator database to find units that were located in and around Khamisiyah in early March 1991.

October 1995—The PGIT reported that the ESG unit locator database search revealed that the 37th Engineer Battalion had reported its location in March 1991 at coordinates near Khamisiyah.

However, the PGIT was unaware that the mission of the 37th Engineer Battalion had been to search out and destroy weapons stockpiles and did not conduct a follow-up investigation.²⁵

January 1996—Khamisiyah was mentioned by the CIA as a possible chemical weapons storage and release site during a briefing to the National Security Council staff. The National Security Council staff directed that CIA and the Department of Defense work together to pursue this issue aggressively. Further information linking U.S. military personnel to the destruction of chemical weapons was uncovered, including imagery that revealed bunkers at Khamisiyah had been destroyed between March 1 and March 8, 1991 and cables indicating that UNSCOM inspectors found evidence of U.S. demolition charges at Khamisiyah.

March 10, 1996—A definitive connection was made five years to the day after the Khamisiyah “pit” demolition when a CIA analyst heard a tape recording of a radio show during which a veteran who had been with the 37th Engineer Battalion at Khamisiyah described the demolition of an Iraqi facility.²⁶

March 19, 1996—CIA and DOD officials met with UNSCOM personnel to discuss Gulf War illnesses issues. At the meeting UNSCOM mentioned its intent to revisit Khamisiyah. UNSCOM reinspected Khamisiyah in May 1996 and found high-density polyethylene inserts, burster tubes and fill plugs which are used in chemical weapons and whose presence suggested that chemical rockets were destroyed when the bunker was exploded on March 4, 1991.²⁷

June 21, 1996—After five years of insisting that no chemical weapons had been deployed by Iraq during the Gulf War, DOD publicly announced that in fact chemical weapons had been present at least at Khamisiyah and that it was a site that had been destroyed by U.S. troops.

September 25, 1996—A joint hearing of the Senate Committee on Veterans Affairs and the Senate Select Committee on Intelligence on the Khamisiyah incident was held.

November 1996—The Secretary of Defense created the Office of the Special Assistant for Gulf War Illnesses (OSAGWI).

INTELLIGENCE OPERATIONS SCRUTINIZED

In order to determine the adequacy of the intelligence provided to the troops at Khamisiyah, it was necessary first to investigate how intelligence was provided to our troops during the Gulf War. Before the Gulf War deployment in 1990, approximately 200 people, including DIA and contractor support, staffed the J-2 Intelligence Directorate at CENTCOM headquarters at McDill Air Force Base in Tampa, Florida. Beginning in April 1990 there was increasing concern about activities in Iraq and by July, the J-2 believed that Iraq was on the verge of invading Kuwait.²⁸ At CIA, the National Intelligence Officer for Warning also reported that Iraq was likely to invade Kuwait.

INTELLIGENCE OPERATIONS WERE NOT FULLY INTEGRATED AND COORDINATED

Within days of the August 2, 1990 Iraqi invasion of Kuwait, a National Joint Intelligence Center (NJIC) was established in the Pentagon to coordinate intelligence operations between CENTCOM and the intelligence community in Washington. The NJIC operation included representatives from the Joint Chiefs of Staff, National Security Agency, Defense Intelligence Agency, and imagery and other intelligence community collection entities, but the Central Intelligence Agency initially refused a desk at NJIC. Later, the CIA became part of the team, but continued to operate separately from its headquarters in Langley, Virginia, instead of with NJIC at the Pentagon.

CIA, JOINT INTELLIGENCE LIAISON ELEMENT NOT PLUGGED-IN TO ALL INTELLIGENCE OPERATIONS

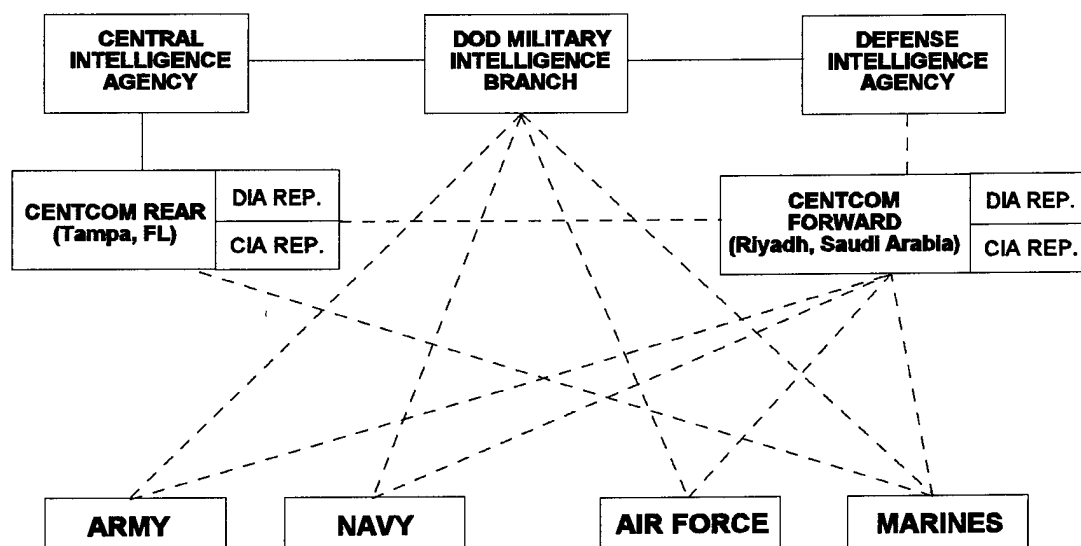
This lack of coordination of intelligence assets also occurred in the Gulf. The CENTCOM Joint Intelligence Center (JIC) in Riyadh, Saudi Arabia consisted of a variety of subgroups, including Operations, Targeting/Bomb Damage Assessment, Collections, DIA, and CIA. However, CIA intelligence personnel also operated out of a Joint Intelligence Liaison Element (JILE) in Riyadh. Further, the CIA senior representative to CENTCOM never went to the Gulf. Instead, the JILE chief became the senior representative from the CIA. The JILE representative was rotated into and out of the Gulf every thirty days, affecting information continuity. All these circumstances adversely affected the CIA's relationship with intelligence operatives at headquarters in Riyadh.²⁹ To further complicate intelligence coordination, military operations support also came in the form of eleven National Military Intelligence Support Teams (NMIST) comprised of intelligence officers from the various commands supporting CENTCOM.³⁰ Thus, the quality of intelligence coordination and effectiveness between the J-2 and the services depended on the services' input and the ability of the particular military personnel assigned to the J-2.³¹ The result was that the J-2 should have been the focal point for intelligence information, but was not. (See diagram at Figure 1.)

JOINT AGENCY EFFORTS BEGIN TO RESURRECT GULF WAR INTELLIGENCE

Since the Pentagon announcement in June of 1996 that U.S. military personnel may have been exposed to chemical warfare agents as a result of the Khamisiyah demolition, the CIA Persian Gulf Illness Task Force, OSAGWI, the Army Inspector General, the CIA Inspector General, and DOD's Office of Intelligence Oversight all have been tasked to retrieve and reconstruct the intelligence available about Khamisiyah to the 37th Engineer Battalion at the time of the demolition. As part of this effort, the CIA and DIA have declassified numerous previously highly classified documents about Khamisiyah.

From these efforts, it appears that intelligence support for this incident fell into three categories: (1) intelligence about Khamisiyah as a potential chemical weapons site; (2) intelligence community

Figure 1. Intelligence Operations Lines of Communication During the Gulf War



assessments about the types of Iraqi bunkers that were likely to house CW; and (3) intelligence about the manner in which Iraq marked its chemical weapons. CIA's Khamisiyah: A Historical Perspective on Related Intelligence, published in April of 1997, provides an exhaustive reconstruction of intelligence available during the Gulf War. In his introductory note to the paper Director of Central Intelligence George J. Tenet stated:

"This paper . . . illustrate[s] that intelligence support associated with Operations Desert Shield and Desert Storm—particularly in the areas of information distribution and analysis—should have been better. Key issues include problems with multiple databases; limited sharing of "sensitive" but vital information; and incomplete searches of files while preparing lists of known suspect CW facilities."³²

The Army Inspector General was more critical, stating:

"The [personnel] directly involved in the destruction of the Khamisiyah Ammunition Supply Facility in March 1991 did not have all the information available about the facility. Although it is impossible to determine if possession of this additional information would have had an impact on the course of events, the fact remains that information suggesting the facility might house chemical munitions was available at high levels of command."³³

Based on the evidence described here, the SIU finds that the decision-making process and organizational structure of the intelligence elements in DOD and the CIA lacked coordination and effectiveness. For example, in May 1986, intelligence sources indicated that chemical weapons were moved to Khamisiyah during the Iran-Iraq war. Shortly thereafter, a November 1986 CIA intelligence assessment concluded that chemical weapons were stored during the Iran-Iraq war "at the southern forward ammunition depot located at Tall al Lahm."³⁴ However, this estimate also reported on "a new generation" of bunkers, subsequently dubbed "S-shaped" bunkers because of their unusual shape, that were deemed by analysts to most likely serve as storage sites for Iraqi CW. The bias toward S-shaped bunkers by the intelligence community led analysts to keep Khamisiyah off CW facility lists before the Gulf War because it had no S-shaped bunkers.

The intelligence community concluded in 1991 that Iraqi reporting about Khamisiyah actually referred to An Nasiriyah because it did house such a bunker.³⁵ Good analysis would have included a search of all intelligence reporting and products, including historical references. The information that Khamisiyah was a warehouse for Iraqi CW during the Iran-Iraq war should have been sufficient evidence to highlight it as a potential CW site.

MITRE REPORT

In the fall of 1996, the Assistant to the Secretary of Defense (Intelligence Oversight) (ATSD (IO)) was charged by the Deputy Secretary of Defense to provide an independent analysis of what intelligence information was available to DOD during the Gulf War about Khamisiyah and other potential CW incidents and then determine what was done with the information. The ATSD (IO) contracted with the MITRE corporation in December 1996 to produce the study with the expectation that a final product would be completed by May 31, 1997. The delivery date was subsequently extended to late 1997 and as of May 1998, the report had yet to be completed.

The SIU's staff monitored the progress of the ATSD (IO)'s investigation. After initial difficulties in obtaining access to the report, SIU investigators were allowed to read an incomplete version of the still highly-classified study. The SIU's investigators found the version of the report that it read to be a well-researched product, with sound findings and conclusions, particularly in discussing intelligence related topics. It would be helpful in shedding light on this issue if the Secretary of Defense in the near future releases the report in an unclassified, not just classified, form.

DOD/OSAGWI-CIA ATTEMPTS TO RECONSTRUCT KHAMISIYAH

BACKGROUND

Once DOD and CIA acknowledged the likelihood that chemical agents were present in some Iraqi weapons destroyed by U.S. forces, questions remained as to whether American personnel were actually exposed to any agent that might have been released during that destruction. DOD, through the Office of the Special Assistant for Gulf War Illnesses, and the CIA jointly produced and distributed a "plume" analysis of the March 10, 1991 pit demolition that represented what OSAGWI officials call "the worst case scenario" to try to determine whether any troops might have been exposed to some level of chemical agent and what level of exposure might have occurred.

What DOD and CIA label as a "plume," and what this report will also refer to by that term, is not a cloud of material that was ever actually observed at the time or can be definitively shown to have existed. It is a mathematically derived computer model used to produce a theory of what may have occurred when the chemical-filled rockets were destroyed at Khamisiyah. It should not be confused with the large clouds of smoke and debris rising above the large Khamisiyah munitions depot and the smaller rocket-filled pit when the various explosive charges were detonated as reported in numerous anecdotal eyewitness reports. From all accounts, the visual effect was dramatic, even from a distance of 10-15 km. The main depot, a complex several square kilometers in size, went up in spectacular fashion, with smoke rising high enough to be described as covering a good portion of the sky.³⁶ Eyewitness accounts of the smaller pit explosion—timed to begin in synch with the main depot's destruction—describe a significant cloud rising over the site, with rockets "cooking off" and flying out of the pit as their motors ignited from the concussions and heat of the explosive charges set on other rockets.

For the most part, these reports describe the short-term effects of the demolition process viewed from a distance. However, they do not accurately describe what could have happened to any chemical warfare agents released by the demolition. The Khamisiyah plume should also not be compared to the smoke plumes associated with the oil well fires. Those were the visible, well-documented, and long-lasting effects of Iraqi sabotage. In contrast, there were no on-site, immediate, and accurate measurements of releases from the Khamisiyah pit detonation. The absence of such data makes it necessary to rely on reconstructed weather and other data collected at the time to produce a theory as to what may have occurred when the chemical-filled rockets were destroyed.

The DOD/CIA modelers found, and the SIU's investigators concur, that as a result of the detonation some portion of the chemicals would have been instantly burned and vaporized. Some amount would have been aerosolized and sprayed into the atmosphere. Some of the sarin/cyclosarin would simply spill out on the ground and would be absorbed either into the ground or the debris from the explosion. That portion of the chemicals released into the atmosphere by the force of the explosion would become subject to the dynamics of wind and other meteorological conditions

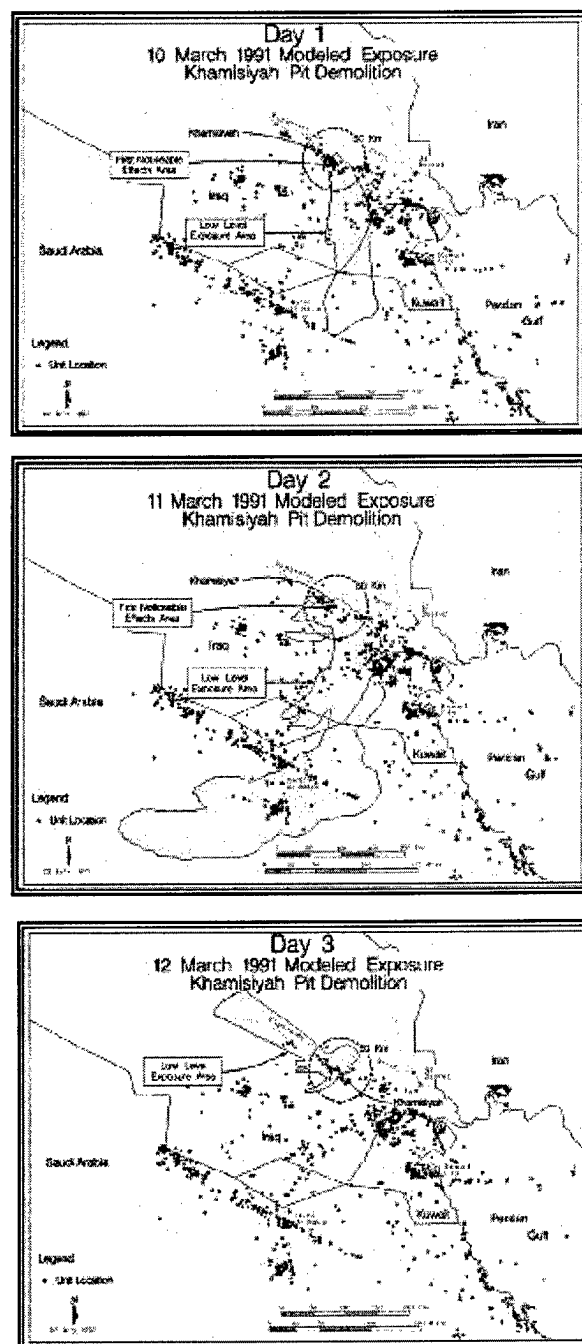
prevailing in the region. Rainstorms which were recorded as passing across the air mass bearing the airborne chemicals would have diluted that vapor cloud; cooler night air would have brought the plume closer to the ground, while warming morning air would add buoyancy to the plume and drive it back up into the atmosphere. Atmospheric pressure, variations in humidity and dew point, moisture on the ground, even heat and light reflections from sand and rocks, would influence not just the path of the plume. They would also affect chemical changes occurring within the plume. In particular, sarin is a substance that although initially lethal is unstable and degrades rapidly once exposed to the open air.

Four contractors and a team of CIA-sponsored scientists experienced in plume analysis developed and presented five separate plume results based on generally accepted transport and diffusion models.³⁷ The models were created with only the simplest of detonation and chemical source assumptions and somewhat limited historical meteorological data depicting generalized atmospheric conditions for the March 10-12, 1991 period of the detonation. The various diagrams and depictions of the Khamisiyah plume model that were produced are wholly computer-generated images that were never confirmed by on-site, real-time observations. This computer model analysis was made public on July 22, 1997, in time for the Presidential Advisory Committee on Gulf War Veterans' Illnesses (PAC) to include the results in its report released in October of that year. (This model is reproduced at Appendix B.)

"SUPER PLUME" OF ALL FIVE MODELS DEVELOPED TO SHOW "WORST CASE SCENARIO"

In the published analysis, the results from all five plume models were overlapped and the outermost perimeter of the resulting "super plume" was used to mark the maximum possible boundary of chemical exposure potential. (See Figure 2.) This "union" model was selected over one that showed the "intersection" of the five plumes, which would be a region smaller than that of the union model but include an area common to all five plume models. The resulting area indicated by the "super plume" was compared to unit locations supplied by the U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM). Based on this information, assumptions were made as to which troops were located in the area indicated by the "super plume" model during the three-day period after the Khamisiyah demolition and who might have potentially come into some contact at any level with chemical agent. In turn, letters were sent by OSAGWI to at least 100,000 Gulf War veterans advising them of a potential for a low-level exposure to chemical weapons agents released during the destruction of the Khamisiyah pit area. (See copy of letter at Appendix C.) The language contained in the OSAGWI letter to veterans was noncommittal, only suggesting that low level exposure of those who received it was a possibility but making no more definite statements than that.

Figure 2. Modeled Exposure of the Khamisiyah Pit Demolition



Nothing in the DOD/CIA plume analysis supports a conclusion that any members of the U.S. armed forces serving in the Gulf War theater at the time of the depot demolition were exposed to levels of chemical warfare agents sufficient to trigger the onset of acute symptoms. This is consistent with the available evidence from the event and its aftermath and the physical condition of those in the vicinity, none of whom are reported to have developed acute effects. The SIU found, however, that there appear to be numerous flaws in the methodology used that also make it questionable to rely on the July 1997 DOD/CIA plume model analysis in drawing firm conclusions about the scope of possible low-level exposures from the Khamisiyah pit demolition. The SIU finds that the available data, as used in this model, is insufficient to state with certainty that any member of the U.S. armed forces was exposed to low levels of chemical weapon agents or that if exposed, whether that exposure was at a level sufficient to cause adverse health effects now or in the future. This nevertheless leaves open the possibility that in the future, medical science and long-term research may identify new evidence that could support a different conclusion, and research efforts in this area should continue.

The SIU's investigators, with the assistance of a consultant with expertise in the physics of plume modeling, independently analyzed the assumptions and methodology on which the DOD/CIA plume modeling effort was based and the circumstances under which it was produced. In reviewing the DOD/CIA plume model, SIU investigators also consulted extensively with experts in plume transport and diffusion models who were equipped with several atmospheric and meteorological data sets reflecting conditions in the vicinity of the Khamisiyah pit on March 10, 1991. As a result, the SIU does not believe that the DOD/CIA scientists used available on-site information or supportable assumptions sufficient to adequately recreate the pit demolition. Instead, these assumptions produced model results that likely overestimated by a considerable degree the probable area in which sarin and cyclosarin that may have been released by the Khamisiyah demolition could have been dispersed. From this review, the SIU concludes that the results of the DOD/CIA analysis were published in July of 1997 before the study was complete, accurate, and scientifically sound. In doing so, and in its reluctance to express concerns about the scientific soundness of the product as it existed at that time, it appears that the government may have ended up doing more to confuse and alarm Gulf War veterans, both those healthy and ill, than to help them.

QUESTIONABLE METHODOLOGY WAS USED IN DEVELOPING THE "SUPER PLUME" MODEL

There are numerous inconsistencies and information gaps in the methodology on which the DOD/CIA plume analysis is based. Several examples arose just from a Khamisiyah pit demolition experiment conducted by DOD at Dugway, Utah on May 28, 1997:

1. The pit itself was not accurately reconstructed. A wall (or "berm") of the pit that closely bordered the stacks of 122mm rockets at Khamisiyah likely would have deflected or absorbed part of the explosive forces created when the 37th Engineer Battalion detonated the explosives placed on those rockets. It is also likely that the wall would have absorbed a portion of the chemicals ejected

by the explosions. That wall was not recreated, although the materials and manpower to do so were available at Dugway.

2. The test demolition occurred on a flat test range, circumstances that did not replicate the pit's particular micro-atmospheric conditions. Equipment used to capture droplets of simulated agent was positioned close to the detonation and there was no attempt to track the plume more than several hundred yards downrange. By January 1998, some six months after the plume analysis was made public, DOD/CIA plume modelers acknowledged this data deficiency and were in the process of adding the micro-meteorological information to a new plume analysis.

3. Accounts from Explosive Ordnance Disposal personnel at Khamisiyah depicted a random, almost haphazard technique for placing C-4 explosives in the rocket stacks and the use of detonation cord to augment the C-4 explosives that were available. According to those accounts, some charges were placed on rocket motors, some on warheads, and some just on top of the stacks. Dugway personnel did not appear to have attempted to replicate the irregular pattern actually used at Khamisiyah, choosing instead to apply charges in a methodical fashion to a stack of 25 custom built replicas of Iraqi 122mm rockets. Earlier in the testing phase, Dugway personnel detonated individual rockets and then smaller stacks of rockets in order to establish some parameters for the final test. In addition, and with no explanation given, test personnel placed several concrete-filled rocket cases throughout the stack. No rationale for the presence of these concrete dummy rockets has ever been given despite several requests by SIU investigators for an explanation. It would seem that a well-designed test explosion would attempt to replicate the actual event as closely as possible so as to develop the most sound model. However, from the SIU investigators' on-site observations, the experiment as it was set up omitted or changed key elements of what is known about the physical makeup of the Khamisiyah pit and the way in which it was destroyed. These changes make it questionable that the results of the Dugway test accurately replicated the Khamisiyah detonations or provided data on which reliable models can now be based.

4. Concurrent with the Khamisiyah pit demolition on March 10, 1991, Army EOD teams were demolishing a larger bunker area approximately 3 km north, and upwind, of the pit. SIU investigators questioned DOD/CIA and Dugway scientists about possible effects on the Khamisiyah plume from material ejected into the atmosphere from the larger explosion. Those individuals at the time discounted any effect from that explosion on a plume from the Khamisiyah explosion. However, by December of 1997, they had reconsidered this position and by January of 1998, DOD/CIA modelers were in the process of revising their assumption data to take possible effects from this second explosion into account in constructing a new model.

Meanwhile, the Pentagon over a period of months increased its estimates of the numbers of troops potentially exposed to chemical agents released during the Khamisiyah demolition. In 1996, Defense Department officials publicly took the position that no U.S. troops were exposed to any level of chemical weapons agent. By early 1997, the Pentagon had revised its position to state that 20,000

personnel were possibly exposed. In the July 1997 analysis based on computer modeling of the Khamisiyah event, the number again was revised upward to possibly involve approximately 100,000 troops exposed to some level of chemical weapons agent. By early 1998, DOD analysts were suggesting that the number could rise beyond 110,000 in the group of those potentially exposed to some level of chemical weapons agent. None of these estimates of troop numbers include any estimate of the level of exposure that might have occurred.

In addition to the flaws in the modeling process described above, also of concern is the fact that the DOD/CIA report on the plume model was not subjected to a rigorous peer review prior to its release, especially given the highly public profile attached to the finished product. No attempt to undertake a peer-review process for the modeling analysis was done until late in the fall of 1997, well after the report had been publicly released as a final product, and that process consisted of a single session lasting less than two days. Had outside experts from the academic and scientific community been a part of the model's development on an ongoing basis, they could have provided some perspective on and reviewed the efforts being undertaken by the government contractors who performed the modeling. Their input could have avoided some of the defects that the SIU investigators identified in the modeling process. At a minimum, the lack of rigorous peer review may have contributed to the fact that the model's limitations at the time of its public release were not also made clear.

Based on all the available evidence, the SIU finds that the theoretical model of the Khamisiyah demolition presented in July 1997 by DOD and the CIA was fundamentally flawed. The final product lacked adequate peer-review and the report's worst-case scenario assumptions were not supported by direct evidence. The Office of the Special Assistant for Gulf War Illnesses confirmed in an April 1998 response to questions from the SIU that more time for analysis of the Khamisiyah incident would have been preferable, but that "we had an obligation to make our findings public . . . to reduce the uncertainty many veterans were feeling."³⁸ The result, however, was that the Department of Defense appears to have overstated the number of personnel potentially exposed to low-levels of chemical agents following the Khamisiyah pit demolition. And, it did so without effectively communicating the model's hypothetical nature. Moreover, although the July 1997 DOD-CIA model was the basis for notifying almost 100,000 veterans of a potential exposure, on-going modeling has already caused the DOD and the CIA to redraw the original model's boundaries and makes even that theory subject to change in the future.

AFTAC, A KEY MODELING RESOURCE, NOT INCLUDED IN MODELING PROCESS

In reviewing the modeling effort, SIU investigators contacted U.S. Air Force Global Weather Central and the Air Force Combat Climatology Center seeking more information on the weather conditions that prevailed at Khamisiyah on March 10, 1991. They, in turn, directed SIU investigators to the Air Force Technical Assistance Center (AFTAC) to obtain the most accurate USAF weather data for the time period in question. Based at Patrick Air Force Base in Florida, AFTAC has been the

Defense Department's lead office for meteorological analysis of the effects of nuclear and other high-yield explosive devices for more than fifty years. AFTAC also keeps historical global weather data and works in conjunction with the National Center for Atmospheric Research in Boulder, Colorado to provide such data to other federal and international agencies. While not known exclusively as a plume-modeling agency for Khamisiyah-like detonations, AFTAC nonetheless is well regarded among modeling agencies employed by DOD as a source of sound atmospheric modeling techniques.

AFTAC RECREATED KHAMISIYAH METEOROLOGY

At the SIU's request, AFTAC produced in May of 1997 a basic wind and weather analysis of the 100 square mile area centered on Khamisiyah for the dates March 1-12, 1991. This report depicted winds and weather from the earth's surface up to 18,000 feet, and included cloud cover and precipitation reports for the first twelve days of March 1991. As a complement to the weather depiction, AFTAC analysts prepared a simple plume diffusion model ("simple" in that the analysts only modeled the movement of the air mass surrounding Khamisiyah and did not factor in nerve agent chemistry) using the Khamisiyah pit's geographic coordinates to define the plume source. This first AFTAC-produced model indicated a plume track that moved south and then east over portions of northern Saudi Arabia, Kuwait, and the Persian Gulf. This first AFTAC model showed a plume that purportedly would have covered an area that included Navy personnel located on ships in the Persian Gulf and citizens of Kuwait City on the coast. (See AFTAC plume chart at Figure 3.) AFTAC next produced a comprehensive plume model adding sarin source information, which was provided to the SIU in December of 1997. The comprehensive AFTAC model depicts a plume with some of the short-range (within fifty miles) overlapping aspects of the DOD/CIA plume, but covering a much smaller geographic area in which low-level chemical exposure may have occurred. This area also extends further into Kuwait than is the case with the DOD/CIA "super plume."

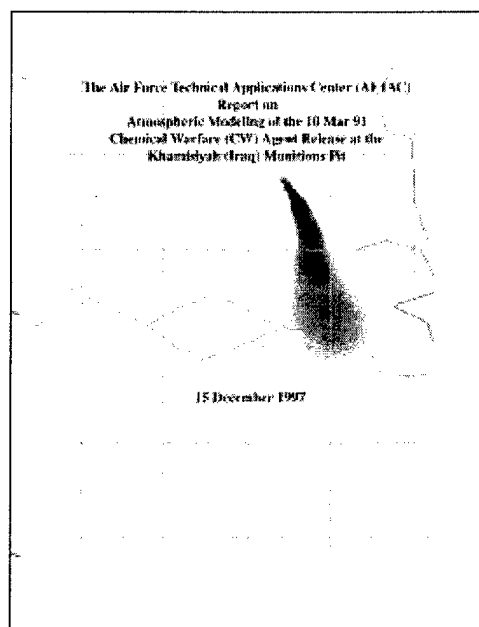
AFTAC MODEL DIFFERS FROM OSAGWI/CIA RESULTS

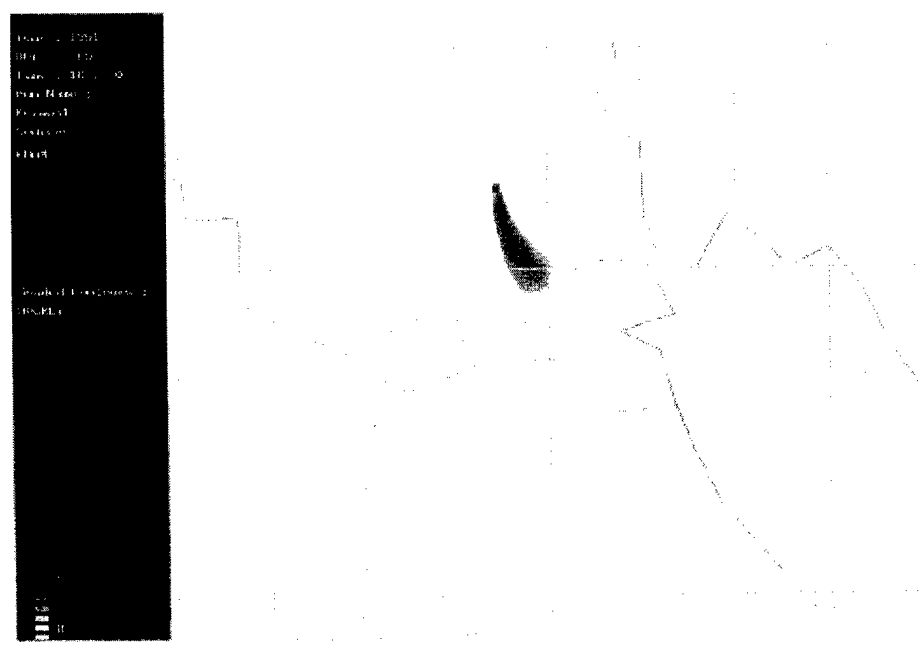
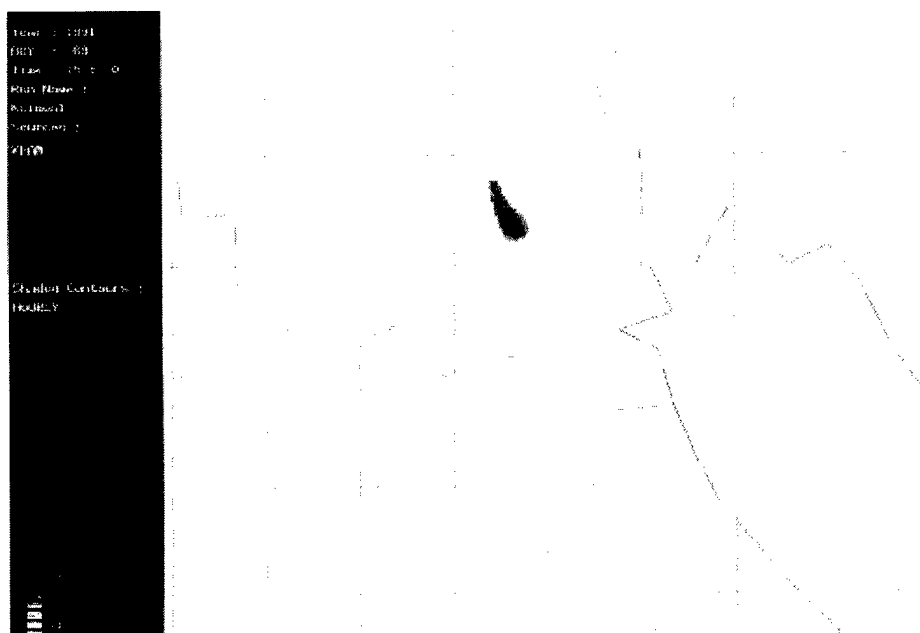
A physics expert retained as a consultant to the SIU produced at the SIU's request a report, reproduced at Appendix D, analyzing the DOD/CIA and the AFTAC modeling efforts. This report expresses a high degree of confidence in the methodology and data development used by AFTAC. The AFTAC analysis does not draw any conclusions about the number of people potentially exposed or levels of exposure anyone might have experienced. As noted above, both AFTAC plume models appear to overlie a number of unit locations not included under the DOD/CIA plume model. It is important once again to emphasize that at the time of the Khamisiyah demolition no personnel—whether they were close to the explosion or at the distance indicated at the extreme outskirts of the DOD/CIA-modeled plume—reported experiencing any acute symptoms indicating exposure to a chemical warfare agent.³⁹

LESSONS LEARNED FROM THE KHAMISIYAH MODELING EFFORT

The AFTAC products, which were peer-reviewed, have substantial merit, deepening the SIU's concern that DOD/CIA did not carefully review their model of the Khamisiyah event before releasing their report on July 22. Given the defects that SIU investigators detected in the July 1997 model on which OSAGWI's notification letters were based, the SIU believes it would have been wiser and in the best interest of veterans for OSAGWI to have publicly discussed the progress of the plume analysis in July and its limitations made clear. Issuance of potential exposure notices should have been delayed until a peer-review process had adequately reviewed the conclusions that could reasonably be drawn from that model. Despite these flaws, the DOD/CIA plume modeling effort was a long overdue attempt to investigate what happened at Khamisiyah. It is likely that individuals within DOD and the CIA were aware of certain aspects of the event after 1991 and prior to 1996 even while public pronouncements indicated otherwise. Although it was not until June of 1996 that the government admitted publicly that the Khamisiyah site included chemical weapons, from available evidence there does not appear to have been a concerted attempt by the government to suppress the facts surrounding the Khamisiyah destruction. However, the failure for years to investigate fully once the allegations of presence of chemical weapons agent in proximity to U.S. troops were made was at least negligent and should not happen again.

Figure 3. The Air Force Technical Applications Center (AFTAC) Report on Atmospheric Modeling of the 10 Mar 91 Chemical Warfare (CW) Agent Release at the Khamisiyah (Iraq) Munitions Pit

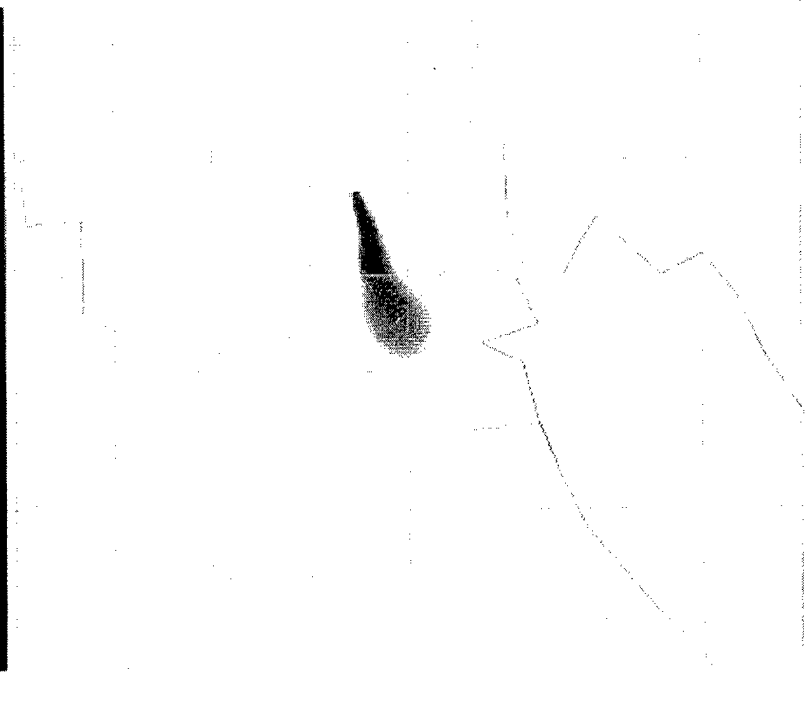




Year : 1991
Run : 00
Time : 23 : 0
Run Name :
Source :
Source :
Result

Elapsed Time :
Result :

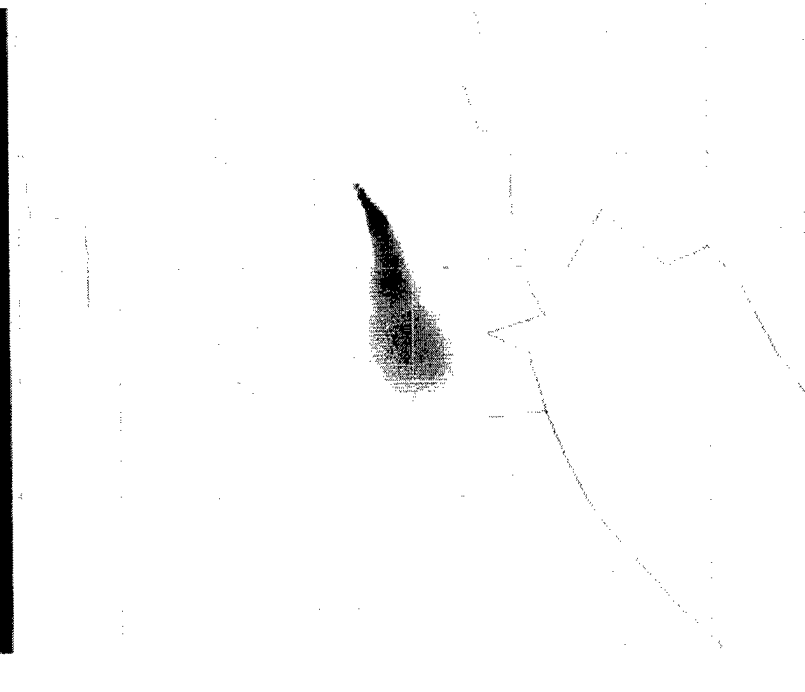
11



Year : 1991
Run : 00
Time : 00 : 0
Run Name :
Source :
Source :
Result

Elapsed Time :
Result :

11





ARE THERE OTHER KHAMISIYAHS?

From analysis of information produced during UNSCOM inspections, the SIU finds, based on available data, that in addition to Khamisiyah, An Nasiriyah appear to be the only location in the Kuwaiti Theater of Operations where chemical weapons were fielded during the Gulf War. There is no indication of the presence of Iraqi biological weapons in this area. Moreover, Khamisiyah appears to be the only facility in the theater of operations where coalition personnel destroyed chemical weapons. There are several sites in the region that have been the subject of inspections and debate about their potentials as chemical or biological weapons storage:

1. The Ash Shuaybah Ammunition Storage facility near Basrah had been listed as one of seventeen suspect chemical weapons storage sites by the intelligence community before the Gulf War because it housed a twelve-frame bunker and an S-shaped bunker of the type in which U.S. intelligence long believed Iraq stored chemical weapons. This facility is a probable candidate for an event involving release of chemical agent because coalition bombing during the Gulf War destroyed the twelve-frame bunker and severely damaged the S-shaped bunker. Ash Shuaybah was not inspected after the war by coalition forces because it was located in Iraqi-held territory.⁴⁰ However, UNSCOM did inspect Ash Shuaybah in August 1997 and found no sign that chemical weapons were stored in the S-shaped bunker, the twelve-frame bunker or any other storage unit. Based on the evidence available to date, this does not appear to be a site involving release of chemical agent.
2. Maymunah Munitions Depot, just north of the 32nd parallel and near Basrah, was declared by the Iraqis in June 1997 to have contained 4,100 122mm sarin/cyclosarin-filled rockets during the war. According to UNSCOM, the 122mm rockets stored at the facility were part of the same production run as the Khamisiyah rockets, and were housed in two bunkers during the war and removed afterward by the Iraqis. The bunkers were not S-shaped or configured for chemical weapons; Maymunah was not on the targeting list of possible chemical weapons sites or bombed during the Gulf War. The SIU finds that Maymunah was not a site that could have caused chemical or biological weapon exposure.
3. The CIA announced in July, 1997 that there "may have been a release of chemical agent from Ukhaydir Ammunition Storage Depot, located near Karbala in central Iraq, as the result of aerial bombing on February 14, 1991."⁴¹ CIA and DOD have concluded that at least 104 mustard rounds were damaged during the bombing of Ukhaydir and then moved sometime later to Fallujah Proving Ground where they were found by UNSCOM inspectors in September 1991. The Special Assistant to the Director of Central Intelligence for Persian Gulf War Illnesses Issues briefed the Presidential Advisory Committee on Gulf War Veterans' Illnesses on September 4, 1997, that CIA's initial modeling of the Ukhaydir release did not indicate that any U.S. personnel were exposed. The closest coalition troop concentrations at the time were near Rafha, Saudi Arabia, nearly 300 kilometers south of Ukhaydir.

However, as of May 1998, the CIA and DOD were applying the Khamisiyah modeling approach to the possible chemical release at Ukaydir, as well as Muhammadiyat and Al Muthanna, two other known Iraqi chemical weapons sites bombed during the Gulf War. The SIU reserves judgement pending the results of the modeling efforts.

In addition, in June of 1998 UN inspectors recovered warhead fragments from a weapons destruction site at Nibai, Iraq (approximately 30 miles north of Baghdad) which were found to have significant amounts of the nerve agent VX, disproving Iraqi claims for years that it was unable to weaponize VX. To date, there is no evidence that weapons containing VX were at sites destroyed by coalition forces during the Gulf War, although the UN's continued work on these matters may produce additional information in the future.

CZECH/FRENCH CHEMICAL WEAPONS DETECTIONS REPORTS

The Khamisiyah demolition is significant because it represents the first concrete evidence that Iraq had chemical weapons in the Kuwaiti Theater of Operations. However, the announcement in July of 1993 by the Czech Republic that members of its highly regarded Special Anti-Chemical Warfare Unit (SPCHU) detected chemical weapon agents on two occasions in northern Saudi Arabia during the first days of Desert Storm was just as significant an event for many veterans who believe that CW exposure could be an explanation for the illnesses they have developed.

On January 19, 1991, SPCHU soldiers on a training mission with Saudi forces made three nearly simultaneous detections of a concentration of nerve agent between 0.05 and 0.003 milligrams per cubic meter in the air. (In comparison, CDC and DOD standards state that the threshold level for noticeable health effects from nerve agent is 1 milligram per cubic meter.) The three detections occurred approximately 40 kilometers apart near Hafar al Batin in northern Saudi Arabia. (Hafar al Batin is approximately 40 kilometers from the Iraqi border.) A chemical alarm went off; the Czechs put on protective gear in response. Czech chemical specialists took air samples from two of the three locations and verified the contents as a G-series nerve agent in their mobile laboratory. They were unable to determine if the G-series agent was sarin or soman, but concluded it was probably sarin. An all-clear signal was given approximately forty minutes after the initial warning. No physical signs of the effects of nerve agent exposure (such as contraction of pupils or watery eyes) were observed among the personnel at the scene and none of the participants reported any acute adverse health affects at the time.

CZECH DETECTIONS NOT VERIFIED BY ALLIES

Information about these detections was reported through Czech brigade headquarters to the joint command in King Khalid Military City. A situation report was then forwarded through the Saudi military to CENTCOM in Riyadh. A U.S. team using Fox chemical agent detection vehicles (which, as will be discussed later, were ill-equipped to confirm the presence of chemical agents in vapor

detection mode) was sent to the detection area about four hours after the incident occurred. They were unable to confirm the detections. Although there were Syrian, Egyptian, French and English units in the area who possessed equipment equally sensitive to that of the Czechs, none of these forces reported any confirmed detections during this period.⁴² The Czech government also announced in July of 1993 that its chemical unit was led on January 24, 1991, by Saudi officials to a puddle of liquid 60cm by 200cm in the sand in an area about 10 kilometers north of King Khalid Military City in northern Saudi Arabia. Using a portable laboratory, the Czech unit determined the liquid to be mustard agent. No samples were taken for additional testing and the site was left as it was, unmarked. The Czech chemical unit filed a situation report. However, CENTCOM logs for January 24-26 that may have noted the incident are missing. In November of 1993, members of the Czech chemical detection unit informed a Congressional delegation, led by Senator Richard Shelby (R-AL), of another detection of mustard agent in King Khalid Military City on January 21 or January 22, 1991. This incident is mentioned in a CENTCOM chemical log for January 23.⁴³

CZECH EQUIPMENT VERY SENSITIVE

The SPCHU equipment was of Czech and Russian origin and able to detect nerve agent at much lower levels than equipment used by U.S. troops. The 1993 Shelby "Report on Trip to Investigate Persian Gulf Syndrome" stated the Czech equipment included: "a GSP-11 chemical agent detector/alarm which provides continuous monitoring capability; the portable CHP-71, a chemical analyzer used as a backup for the GSP-11; a portable laboratory which uses a litmus paper detection method, as well as other wet chemical analysis; and a mobile laboratory."⁴⁴ However, DOD critiqued Czech equipment in a declassified article from the August 2, 1994, edition of the *Military Intelligence Digest*, stating that the Czech "automatic chemical agent detectors were determined to be extremely sensitive to nerve agents, but not sensitive to interferents normally encountered on the battlefield."⁴⁵

CZECHS POINT TO BOMBING RESIDUE AS CHEMICAL SOURCE

The Czechs suggested that coalition bombing might have been a cause of the nerve agent detections on January 19, 1991. In 1993, DOD published an English language translation of a Czech Ministry of Defense report of the Czech chemical detections. The Czech defense battalion commander's activity report for January 1-February 28, 1991, states:

"During the period in question, toxic dust concentrations of Yperite and Sarin chemical agents were detected several times around the brigades, as well as in King Khalid Military City (i.e. within the military encampment in which the unit is billeted), probably as a result of allied strikes against chemical munitions depots in Iraq."⁴⁶

Coalition forces had bombed An Nasiriyah, located about 150 kilometers from Hafar al Batin, on January 17, 1991. Based on information provided by UNSCOM inspections, it now appears that

Khamisiyah and An Nasiriyah were the only locations in southern Iraq where CW munitions were deployed during the Gulf War but that coalition bombing did not result in the destruction of any chemical weapons at An Nasiriyah. A U.S. intelligence assessment of chemical and biological warfare in the Gulf provided in 1994 to a Defense Science Board panel investigating Gulf War illnesses listed the following possible sources of the nerve agent detected by the Czechs on January 19: deliberate overt or covert use by the Iraqis; accidental releases through leaking weapons; unintentional releases as a result of coalition actions; and a deliberate release unrelated to military operations.⁴⁷

DID THE FRENCH DETECT MUSTARD AGENT?

CENTCOM log entries indicated that French forces stationed in King Khahlid Military City detected mustard agent in that area on either January 20 or 21, 1991. French personnel contacted the Czech unit in the area, who confirmed the detection. There are no records of a Czech reporting of this incident.⁴⁸ According to information given to the Shelby delegation, French military personnel also detected nerve and mustard agent at a logistics facility 27 kilometers south of King Khahlid Military City on either January 24 or 25, 1991. French chemical detection alarms were activated at two locations approximately 100 meters apart. Litmus badges on the protective suits worn by French troops registered the presence of mustard agent. According to the French, Czech chemical units were called to the scene and confirmed the presence of a mustard or nerve agent. This information was provided by a French military officer to the French chain of command and appears in CENTCOM logs, but has never been officially confirmed by the French government. The Czech chemical unit did not report these events. However, the detections were reported to CENTCOM headquarters and appear, along with the Czech detections, in CENTCOM chemical logs.⁴⁹

SENATE INVESTIGATORS MEET WITH ALLIES

Members of the SIU's investigative staff accompanied OSAGWI personnel on a fact-finding trip to the Czech Republic, France and Great Britain in September of 1997. The delegation met in Liberec, Czech Republic, with the commanding officers of the First Chemical Protection Brigade. During the discussions, a member of the Czech chemical unit that was deployed to the Gulf reconfirmed that on at least two occasions during the Gulf War, Czech units detected chemical agents: the G-series nerve agent (sarin or soman) detection on January 19, 1991, and the mustard agent detection on January 24, 1991. However, the officer was unaware of the source of the detections. In France, government officials did not acknowledge or confirm any of the CW detections made by their military personnel during the Gulf War.

It is unlikely, now nearly eight years after the Gulf War, that the actual source for the Czech or French detections will ever be found. Many veterans continue to believe that chemical exposure resulted from fallout of coalition bombing of Iraqi chemical weapons sites in the first days of the Gulf War. DOD continues to discount these claims. Nevertheless, OSAGWI has embarked on an effort similar to the Khamisiyah venture to model the release of mustard and nerve agents from Ukhaydir,

Muhammadiyah and Al Muthanna in central Iraq. This effort may help inform veterans as to whether they may have been exposed to some level of chemical agent during their service in the Gulf. The SIU finds that the Czech chemical agent detections, particularly those of January 19 and January 24, are credible, but only at very low levels and the presence of these agents does not appear not to have resulted in adverse health effects to the Czech soldiers involved.

WEAKNESSES IN CHEMICAL AND BIOLOGICAL READINESS

In testimony before the Committee on January 29, 1997, General Norman Schwarzkopf, the CENTCOM Commander during the Gulf War, defended his strategy against possible Iraqi use of chemical and biological weapons by stating:

"In planning our military campaign against Iraq six years ago, we focused on our enemy's strengths and weaknesses. The one area in which they far exceeded our capabilities was in chemical and biological warfare. We knew they had a very large stockpile of chemical weapons and had embarked upon a program to develop biological weapons. Further, they had demonstrated their willingness to use such weapons both in the war against Iran and in campaigns against the Kurdish population in northern Iraq.

"The measures we took to eliminate the enemy's chemical and biological threat were both active and passive. The active measures were the destruction of known storage and production sites in the earliest stages of the strategic air campaign and also the systematic destruction of the enemy's chemical delivery systems, which consisted of their air force and principally their artillery.

"The passive measures that we took were all designed to protect our troops with the absolute finest technology available at the time. It should be remembered that this technology was designed to fight in a chemical environment created by the Warsaw Pact. As protection against biological agents, our soldiers were immunized against many diseases and some were further immunized against the two biological agents we suspected the Iraqis might use."⁵⁰

Despite General Schwarzkopf's statements, the SIU found a lack of command emphasis on chemical and biological defense prior to the Gulf War that resulted in readiness shortfalls during the war. These shortfalls contributed to veterans' sense of uncertainty and suspicion that chemical or biological agents may be causing their symptoms. Equipment and training shortfalls resulted in false alarms from the M8A1 Alarm System and the Fox vehicle. Vaccine shortages resulted in incomplete administration of vaccines to only a portion of the troops. Shortages in protective clothing shortages

were managed by extending suit wear time and altering established procedures, but these modifications, born of necessity, also contributed to veterans' uncertainty about their protection.

DOD has recognized these shortfalls and increased both the funding and visibility of chemical and biological defense. Budgets for procuring and developing more sensitive detectors and more lightweight clothing, for example, have increased substantially. However, chemical and biological defense is not routinely addressed or summarized in readiness reports to higher commands, which does little to increase its training priority for the field commanders who are ultimately responsible for a ready force.

Preparedness for defense against a CW attack was not a high priority for DOD in the years preceding the Gulf War. Historically, DOD has allocated less than one percent of its budget to chemical and biological weapons defense.⁵¹ A lack of command emphasis on chemical and biological weapons defense resulted in part from military and policy makers' focus on deterrence of nuclear threats during the Cold War. Unit commanders have the authority to reallocate funds in their Operations and Maintenance (O&M) accounts, which support a diverse range of DOD readiness and quality of life priorities. As a result, commanders could, and did, re-route funds designated for purchase and maintenance of chemical and biological defense equipment to other command priorities or operations needed to fight a conventional war.⁵² A further disincentive to train in chemical/biological protective clothing is its discomfort and the diminished operational performance that results from that discomfort.⁵³

GAO CRITICAL OF CHEMICAL/BIOLOGICAL TRAINING PROGRAMS

In a March 1996 report, GAO examined U.S. forces' preparedness for chemical and biological defense by assessing rotations of units through Combat Training Centers from fiscal years 1989 to early 1990 (before Gulf War preparations were underway). GAO found that over 70 percent of the units were considered untrained by their commanders in ten of the fourteen tasks related to chemical and biological defense. These tasks included commanders' use of chemical and biological intelligence information (60 percent untrained), donning protective gear (73 percent untrained), unmasking procedures (100 percent untrained) and administering first aid (83 percent untrained). GAO also found that joint forces, such as the one created for the Gulf War, were seldom trained on common protocols for chemical or biological attacks.⁵⁴

THE U.S. MILITARY WAS NOT WELL-PREPARED FOR CW ATTACKS IN THE GULF WAR

Commanders' emphasis on their units' CW preparedness changed when faced with an actual threat of chemical attack from Iraq, which had already used such munitions on its enemies and even its own people. Troops deployed to the Gulf underwent many hours of training in donning their protective gear. In addition, a strategy of deterrence was employed by informing Iraq that a first use of chemical weapons causing mass casualties against coalition troops would result in an attack "by all means that

we [the coalition] have available at our disposal," according to testimony by General Schwarzkopf before the Committee.⁵⁵ However, years of inattention could not be overcome in the few months leading up to the conflict. As the following statement shows, DOD officials acknowledge that the lack of preparedness at all levels was due to the absence of information available on the readiness of the troops for chemical attack:

"As Desert Shield deployments began, OSD [the Office of the Secretary of Defense], the services and the Joint Staff quickly realized that they had virtually no information on training status and chemical defense equipment levels of the deploying forces . . . We simply had no system in place to tell if our units had too little equipment or had surpluses. To help manage the problem, the Joint Chiefs of Staff directed the establishment of a special General Officers Council to coordinate the equitable distribution of equipment and to start building a database from scratch . . . The lack of NBC readiness reporting created a tremendous amount of work and significantly delayed decisions to accelerate production of critical equipment."⁵⁶

THE INDUSTRIAL BASE WAS SLOW TO RESPOND TO PRODUCTION NEEDS IN SUPPORT OF CW PREPAREDNESS

Industrial production of chemical protective suits had to increase from pre-Gulf War production of 33 thousand suits per month to 200 thousand suits per month. Such a surge, according to DOD, required nine months for the chemical suit industrial base to reach required maximum production.⁵⁷ Anticipating shortages in the existing stocks, the Defense Personnel Support Center awarded suit contracts in August and September 1990. However, by the end of March 1991, about one month after hostilities had ceased, only 25 percent of the scheduled suits had been delivered.⁵⁸ These shortages led to making adjustments in the field such as extending the wear time of MOPP gear beyond optimal shelf life and delaying use of full MOPP protection until an attack actually ensued.⁵⁹ For example, Army personnel present at the Khamisiyah demolition reported to SIU staff that they only had one set of MOPP gear in their possession, instead of the required two sets.⁶⁰ Had they been exposed to a detectable level of chemical warfare agent during the demolition, they would have had to withdraw from the area because their only set of MOPP gear would have been contaminated. A subsequent GAO report released in March 1996 showed that units continued to lack critical chemical and biological equipment, including protective clothing, detection paper, and decontamination supplies.⁶¹

Logistical support and planning for administering vaccines against biological weapons was worse than for the chemical detection equipment. DOD did not have a plan in place to determine which vaccines needed to be administered, when they were to be given, and to whom.⁶² Although the vaccine for anthrax was an FDA-approved drug, DOD was only able to vaccinate about 150,000 of the almost 700,000 service personnel in theater. The vaccine for botulism, which has not been fully

approved by the FDA, was administered to only about 8,000 service personnel.⁶³ (The use of vaccines for CBW defense in the Gulf War is discussed in more detail in Chapter Three.)

TRAINING AND TECHNOLOGY LIMITATIONS

Limitations in technology and training for chemical and biological equipment led to inconclusive evidence and misleading conclusions regarding the deployment of chemical and biological agents. Appendix G provides a list of chemical protective equipment deployed to the Gulf War. Some key limitations of equipment used during the Gulf War are described below.

M8A1 Alarm Systems Sounded Frequent False Alarms

The frequency with which M8A1 Alarm Systems sounded falsely during the Gulf War led to a sense of complacency towards the alarms (in some cases, resulting in troops simply turning them off) and confusion as to whether chemical agent had been used or was present in the vicinity. This alarm system is a remote, continuous air sampling device designed to detect nerve agent vapors and warn personnel of its presence with both audible and visible signals. The alarm sounds during required maintenance procedures and is also designed to be very sensitive so that nerve agent releases above a certain threshold do not go unnoticed. However, this high degree of sensitivity also reduced the system's selectivity, so that it often would alarm when it detected substances that were not nerve agent. Unfortunately, these included many substances and conditions that were very prevalent during the Gulf War, including high temperatures, high concentrations of sand, diesel and gasoline exhaust, insecticides, paint fumes, and cigarette smoke.⁶⁴ Although it is impossible to determine the total number of false alarms, over 12,000 of the systems were deployed to the Kuwaiti theater of operations. Taking into account these numbers, there could have been tens of thousands of false alarms or alarms sounding solely for maintenance purposes during the Gulf War.

Fox Vehicle Readings May Have Resulted in More Questions than Answers

Ineffective use of the German-made Fox vehicle also led to inconclusive findings of chemical agent. (See Appendix H for more detailed discussions of Fox vehicle capabilities.) DOD procured from Germany 60 Nuclear, Biological, and Chemical (NBC) Reconnaissance Systems, known as the "Fox." The first Fox vehicle arrived in the Kuwaiti theater of operations in September 1990, and the last arrived in the middle of February, a short time before the onset of the ground war.

Although the Department of Defense believed the Fox, "was the most sophisticated and technically complex piece of chemical detection equipment that the U.S. used in Operations Desert Shield and Desert Storm,"⁶⁵ its actual performance did not measure up to expectations. Built to run in the European countryside, on its roads, and over similar terrain, the Fox was not the best choice for the desert conditions encountered during the Gulf War. Further complicating its use was the fact

that the training provided to the American operators was not thorough enough to enable them to develop the expertise necessary to utilize the Fox capabilities to the fullest.

Time and again, case narratives prepared by OSAGWI (discussed more fully later in this Chapter) describe situations in which the Fox vehicles provided false positive readings that led veterans to believe that they had been exposed to chemical agent. (These instances are addressed in Appendix H.) The lack of adequate training prior to the Gulf War and the resulting inconclusive readings from the Fox vehicles put DOD in the position of refuting veterans' assertions that CW was used, despite positive readings produced by the Fox. Either scenario reduces DOD's credibility and contributes to suspicions that DOD has a bias against agreeing with veterans and "admitting" that CW was deployed during the Gulf War.

Biological Agent Detection Capabilities Are "Rudimentary"

The Department of Defense has described its biological agent detection capability during the Gulf War as "rudimentary."⁶⁶ DOD had no standoff capability for detecting biological agent, which means that troops would have had no advance warning of a biological weapons attack. Further, point detection capability—the ability to identify an agent at the point where contamination is occurring—could only provide confirmation of an attack thirteen to twenty-four hours after the attack had occurred. While this capability would have provided some help in treating biological casualties, the Army has reported that had a biological attack occurred it would have created enormous casualties that would have severely overtaxed the U.S. medical system.⁶⁷ This investigation found no direct evidence that the Iraqis offensively used chemical or biological weapons during the Gulf War. Nonetheless, it is imperative that shortfalls in U.S. military readiness to address such threats are identified so that our troops are truly prepared for a chemical or biological attack. DOD's efforts to address some of these shortfalls, including its current plan to vaccinate all forces against anthrax, are addressed below.

Chemical and Biological Weapons Visibility and Funding

Public awareness of weapons of mass destruction has been raised by their use in the Iran-Iraq War, the threat of their offensive use during the Gulf War, and the 1995 Tokyo subway attack using sarin. Other instances that have heightened awareness are false alarms such as the anonymous package labeled "anthrax" that was delivered to the B'nai B'rith in Washington, D.C. on April 24, 1997 and the March 1998 controversy over two individuals in Las Vegas who obtained what was thought to be anthrax bacteria. These incidents, combined with instability of post-Cold War regimes and shifting regional power balances, underscore what the Congressionally-established Counter Proliferation Program Review Committee stated in its May 1997 report: "The potential for catastrophic use of NBC weapons is greater than it has been in many decades."⁶⁸ Budgetary constraints have also increased the threat of weapons of mass destruction. According to a former director of the CIA Nonproliferation Center: "Most nations today see the increasing sophistication,

hence the cost, of conventional weapons as unreachable . . . A growing number of countries look to cheaper weapons-of-mass-destruction programs as a deterrent or even an offensive capability against a larger, more conventionally capable opponent."⁶⁹

STEPS TAKEN BY DOD TO INCREASE CHEMICAL AND BIOLOGICAL WEAPONS DEFENSE READINESS

In light of the increased threat, DOD has increased funding, set up task forces to identify and recommend solutions to logistical shortfalls, established DOD-wide chemical and biological defense material requirements, and made upgrades to detection and protection equipment. The following summarizes those efforts:

JOINT DOCTRINE DEVELOPMENT AND FUNDING LEVELS FOR CBW DEFENSE

A Joint Doctrine for NBC Defense, which was not present during the Gulf War, was published in 1995.⁷⁰ However, DOD still lacks adequate doctrine and policy for defense of ports and airfields against chemical and biological weapons attacks.⁷¹ The May 1997 Report of the Quadrennial Defense Review recognized a funding shortfall in chemical and biological defense and recommended a budget increase in that area, particularly for protective measures against chemical weapons.⁷² In its 1999 budget submission, DOD increased its procurement and research budgets for chemical and biological defense by almost \$151 million.⁷³ In its 1999 to 2003 planning documents, DOD projects a total \$731 million increase in CB defense.⁷⁴ However, it is unclear if these increases will be sufficient to achieve adequate levels of readiness in this area.⁷⁵

DOD TO DEVELOP SERVICE-WIDE PROTOCOLS

DOD is working to establish chemical identification requirements that will be generated jointly and validated across all services. The study, known as JCHEMRATES IV, will reflect a combat scenario of a recently developed war game in which offensive use of chemical weapons is assumed. Although originally expected to be part of the February 1998 Annual Report to Congress, the study was still in draft when the annual report was written.⁷⁶ A Joint Service Materiel Group has developed a joint service nuclear, biological and chemical defense logistics support plan outlining short-, mid-, and long term strategies to resolve sustainment issues.⁷⁷

ARMY CHEMICAL FORCE TO BE STRENGTHENED

The Army is increasing the relative size of its chemical force structure by taking smaller personnel reductions in chemical specialties relative to the entire force. Forces in chemical specialties have been reduced by 13 percent, while the rest of the active and reserve Army forces have been reduced by 28 percent.⁷⁸ An Army-commissioned study on chemical and biological defense lessons learned

identified steps to mitigate weaknesses in the program. Although a plan to implement the myriad of recommendations is being implemented according to a chemical school official, the SIU staff was unable to verify their progress.⁷⁹

NEW CHEMICAL AND BIOLOGICAL AGENT ALARMS ARE BEING DEVELOPED

An Automatic Chemical Agent Detection Alarm (ACADA) has been developed to replace the M8A1 alarm. It is designed to reduce the number of false positive readings and be able to detect mustard agent. DOD plans to begin fielding the ACADA in fiscal year 1998 and expects to have it fully fielded by fiscal year 2002.⁸⁰ To detect biological agents, three vehicle-mounted long-range detection systems have been fielded with the ability to track aerosol clouds indicative of a BW attack. Point detection capability for biological agents has also been increased with the fielding of 38 mobile Army Biological Integrated Detection Systems and 25 Navy Interim Biological Agent Detector shipboard systems. These point detectors decrease confirmation time from up to 24 hours in the Gulf War to about 30 minutes. Virtually all of these units are with reserve forces in the United States and those forces are not fully manned. In addition, DOD has short, mid- and long-range plans to improve the capabilities of these systems.⁸¹

DOD'S ANTHRAX VACCINATION PLAN

The most recent, and perhaps the most dramatic, attempt by DOD to increase preparedness against biological agent attack is its plan, announced in December 1997, to vaccinate the total force, currently estimated at 2.4 million members, against the biological agent anthrax. The vaccine is approved by the FDA.⁸² The SIU foresees significant logistical and record keeping challenges in implementing this program. This program should be monitored closely to ensure that future veterans have the benefit of appropriate health records and medical research relating to this vaccine.

In testimony before the Committee, GAO identified five lessons learned that DOD should consider to successfully manage the program. First, DOD must ensure the accuracy of personnel data systems to ensure that all service members receive the required vaccinations. Second, because DOD plans to administer the vaccinations in a decentralized manner at multiple locations, high level commanders need to emphasize the program's importance. Third, medical records documenting vaccinations must be complete. Fourth, DOD's centralized database for monitoring program implementation, currently under development, must be accurate. Finally, efficient inventory controls are necessary, particularly given the one-year shelf life of the anthrax vaccine. In its review of the Bosnia deployment, GAO found weaknesses in DOD's systems for identifying service members' locations, maintaining medical records and databases, and tracking inventory for a vaccine against tick-borne encephalitis, prompting these recommendations.⁸³ In addition, only one location in the United States currently produces anthrax vaccine, and it is unclear if that sole-source approach is capable of producing adequate usable amounts of the vaccine sufficient to meet DOD's needs.

LOGISTICAL AND TECHNICAL CHALLENGES

In its March 1998 annual report to Congress on NBC defense, DOD reported improvements in the industrial base supporting chemical defense equipment, which in the 1997 report was described as "extremely fragile." Despite improvements in the overall supply of NBC defense equipment, some critical items (such as chemical agent detectors and collective protection) remain at high risk, meaning the services have less than 70 percent of the required equipment on hand. In addition, the report noted, the services continue to have very little oversight over procurement and use of consumable items (supplies which are consumed in use, such as M8/M9 detection paper and chemical suits), and as such currently cannot readily determine the extent of such equipment shortfalls. The report concluded:

"Because of a lack of visibility of NBC defense items, unclear wartime requirements (given the post-Cold War environment), scarce Operations and Maintenance funds, and low priorities given to NBC defense stocks, the current quantity of DLA [Defense Logistics Agency] and AMC [Army Materiel Command] NBC defense war reserves have been reduced and will not support sustainment requirements during a full two MTW [Major Theater War, the planning factor under the National Military Strategy] scenario."⁸⁴

The services have increased the visibility of chemical and biological defense by making it a mandatory element for which commanders must provide comment in monthly combat readiness reports.⁸⁵ However, the comments are in a narrative section that is not routinely subject to statistical analysis or summary for higher headquarters. DOD has stated that this system was not intended to be a detailed management tool on all conceivable variables.⁸⁶ Although DOD prepares Joint Monthly Readiness Reports that juxtapose various war fighting scenarios against the readiness of units and their deployment schedule, they do not regularly assess chemical and biological weapons defense as a part of those scenarios. In addition, DOD summarizes readiness in quarterly reports to Congress, but these reports are not sufficiently detailed to provide an assessment of this aspect of readiness.⁸⁷

DOD MUST SET PRIORITIES FOR IMPROVING CBW PREPAREDNESS

DOD has recognized some of its weaknesses related to CBW defense readiness, established some strategies to resolve them, and increased funding which could offset many of the supply shortfalls. However, to the extent CBW readiness and training is funded by Operations and Maintenance Accounts, commanders will have the prerogative to divert funds intended for CBW defense toward other operational priorities to fight a conventional war. The SIU is not in a position to recommend that commanders' prerogative be limited in this regard, and indeed, recognizes both the advantage and necessity of such a prerogative. The SIU also recognizes that commanders face increasing challenges in maintaining their troops' readiness to fight in many areas because of increased

deployments to peace-keeping operations. Therefore, if DOD believes that CBW readiness is a high priority, and chooses to fund much of it through O&M accounts, it is imperative that a high priority be given to CBW readiness, so that unit commanders allocate limited resources to training and spare parts. One way to do this is to increase the visibility of chemical and biological defense readiness factors in the various reporting venues. This will also involve careful and vigorous oversight by DOD leadership of proposed strategies to ensure their implementation and effectiveness.

INFORMATION COLLECTION AND RECORDKEEPING SHORTFALLS DURING THE GULF WAR

DOD's mishandling of medical records, classified operational logs, and other evidence related to suspected chemical agent detections have hampered efforts to reconstruct events in the Gulf War that could shed light on potential causes of Gulf War illnesses. In addition, DOD's inability to track the location of units deployed throughout the theater has slowed and made less accurate the efforts to identify who might have been exposed to which potential hazard.

RECORDS MISMANAGEMENT COMPLICATES ANALYSIS OF GULF WAR EVENTS

The first casualty of the Gulf War may have been basic, required record keeping. Consequently, inadequate information has stymied the efforts of Gulf War illness investigators. For instance, missing records have hindered efforts to assess certain factors that may be associated with Gulf War veterans' illnesses. Critical evidence from several suspected detections of chemical warfare agents either disappeared or was routinely destroyed shortly after the war. Although DOD investigators believe that most chemical agent detections were false, the public credibility of such claims suffers in the face of missing evidence. Federal records laws and DOD regulations and policies provide clear requirements for retention of a variety of documentation—including in written, photographic, and electronic formats—that records for the future operations and activities related to wartime. The incomplete data and mishandled evidence from the Gulf War are irretrievable, but as another lesson learned, DOD must improve records management during future conflicts.

TROOP MOVEMENT AND MEDICAL RECORDS

During the Gulf War, DOD lacked a system to track the location of units deployed throughout the theater. Moreover, those records of unit locations that may have been made were incomplete or inaccurate. There was no system to pinpoint the location of individual servicemen, which now hinders epidemiological studies.⁸⁸ In 1992, the Army Center for Health Promotion and Preventive Medicine developed a troop Exposure Assessment Model that can be used to determine where troops were and to what they were exposed. The development is nearly finished and will, it is hoped, provide a reliable mechanism that can be used for future recording purposes. Absent this system, the DOD

in its Khamisiyah investigation was forced to assemble and debrief operations officers from the Army's 7th Corps to attempt to reconstruct unit locations over six years after the end of the Gulf War.

HEALTH SURVEILLANCE SHORTFALLS

Many of the soldiers deployed in the Gulf War theater did not have updated pre-deployment health status information or complete post-deployment physicals. The absence of this irreplaceable medical surveillance information not only makes it impossible to have a base line for any follow-up action, but also complicates epidemiological research.⁸⁹

In May 1997, GAO found that some improvements had been made in medical surveillance since the Gulf War but that shortcomings remained during the Bosnia deployment. (This issue is more thoroughly addressed in Chapter Three.) DOD also is developing a more automated medical record keeping system, which includes a dog tag-sized card, called a Personal Information Carrier (PIC). The PIC will store an individual's medical history, medical documents, X-rays and vaccination records. It has been prototype tested, and is scheduled for more extensive testing in 1998 and fielding in 1999.⁹⁰

VACCINATION RECORDS

Records of vaccinations received in theater and records of the use of pyridostigmine bromide (PB) are incomplete and generally unavailable. For example, FDA did not waive the requirement that DOD had to keep records on adverse effects from troop usage of pyridostigmine bromide (PB) as part of its waiver allowing DOD to administer this investigational drug during the Gulf War. (The PB and the FDA waiver process is discussed in Chapter Three.) Yet, as a Defense Science Board Task Force observed, "[a]lthough all units were given PB, the Department of Defense does not have records of which military personnel actually ingested PB, nor of how many tablets may have been ingested."⁹¹ Moreover, the SIU obtained via correspondence with the Deputy Secretary of Defense information about medical products (including vaccines, antitoxins, immune globulins and pharmaceuticals) that were fielded or administered during the Gulf War. DOD provided six pages of charts detailing the products fielded, the current manufacturer, license status and the number of doses fielded. However, DOD could not provide an accurate assessment of the doses administered to U.S. personnel in the Gulf. Instead, only an approximation of doses administered was provided for the anthrax vaccine, the botulinum toxin vaccine and PB. No information was available for other medical products.⁹² Lack of such basic medical information will preclude a definite epidemiological analysis of the impact of vaccines and drugs on Gulf War veterans' health and raises questions about DOD's ability to fully document future administration of drugs or vaccines to troops on a large scale.

RECORDS OF PESTICIDE USE WERE NOT KEPT

Although DOD carefully recorded the type and amount of pesticides shipped to the Persian Gulf, no records exist on how the pesticides were used. Again, the lack of data impedes researchers' efforts to compare environmental exposures to observed illnesses.⁹³

CENTCOM'S RECORDS MANAGEMENT SYSTEM IS INEFFECTIVE

Desk officers in Riyadh created approximately 180-210 pages of chemical weapons logs during the Gulf War. Veterans' groups, congressional committees, the press, and members of the public have sought these documents as critical evidence in the investigation of suspected chemical detections during the Gulf War. Despite a thorough investigation by the DOD Inspector General, the DOD has unearthed only 37 log pages. According to a report issued by the Office of the Inspector General, the remaining pages might have been improperly destroyed after reaching CENTCOM headquarters in October 1994. The investigators "could not establish a definitive explanation of what happened" to these pages. However, the report states that "the most probable explanation" is that they were destroyed "as part of an internal office relocation, personnel changes, and movement of the NBC records."⁹⁴

RECORDS MANAGEMENT ENFORCEMENT LACKING

The SIU requested the DOD IG Audit Division to pursue the problems it has identified with enforcement of proper and legally required records management procedures at CENTCOM. These appear to have been a major cause of the current lack of records related to the Gulf War deployment. As a result, the DOD IG Audit Division has recommended that records management be assessed by the CENTCOM commander under the DOD Management Control Program.

DEPLETED URANIUM

The Defense Department believes that depleted uranium-based (DU) weapons offered Gulf War troops the maximum available effective and efficient firepower for force projection. It is also used as protective armor on tanks to protect troops inside against enemy attacks. However, with the exception of the work being done at the VA Medical Center in Baltimore, there does not appear to be significant post-war research into DU's long-term health effects on military personnel. The OSAGWI January 1998 annual report confirmed the DOD's failure to properly train troops in proper DU handling procedures. The same report also noted the DOD's failure to notify troops potentially exposed to expended DU ammunition on the battlefield or during cleanup operations after the war. It is clear that more research should be done and that the Defense Department has been slow to conduct long-term studies of or effective training about DU as a post-battle hazard. (The health effects of depleted uranium are discussed in greater detail in Chapter Three of this report.)

As noted in the OSAGWI annual report, DOD experts were aware of the potential for radiation and heavy-metal exposure to DU ammunition before the war but failed to pass along this knowledge to the troops in the field. According to the report, DOD will be undertaking additional DU studies. There already exists some Army-developed evidence that dose levels produced by DU stores in the Bradley Fighting Vehicle may exceed the allowable limit established by the Nuclear Regulatory Commission (NRC) for the general public in some areas of the crew compartment, based on estimated annual occupancy times. While these levels appear to be at least an order of magnitude lower than the level established for radiation workers, the Army has stated it will work to reduce the levels to conform to NRC general public standards.⁹⁵

This information was available to the Army prior to the Gulf War, yet pre-deployment training and in-theater refreshers did not adequately impress soldiers with an understanding of depleted uranium's intrinsic properties or of safety procedures to be followed when handling DU ammunition or DU-damaged vehicles. There are a number of outstanding DU exposure cases that merit continued investigation and medical care and tracking. Especially if depleted uranium is to continue to be a factor in future conflicts, additional scientific research is necessary to obtain the fullest understanding possible of its potential health consequences to military personnel who may be exposed to it.

OSAGWI CASE NARRATIVES

In 1997, OSAGWI began publishing a series of case narratives and information papers on DOD's investigation into the potential exposure of troops to chemical and biological agents. As of May 1998, OSAGWI had released eleven case narratives examining specific cases of suspected chemical exposure and four information papers that provide background material on topics such as agent alarms and medical surveillance. This series of reports provides both the government and the public with insight on details of Gulf War events that may have had an impact on Gulf War veterans' health. However, it appears that the priority for determining what topics are addressed in the case narrative format is determined primarily by perceived outside pressure rather than an assessment as to what is believed to be most relevant and useful in addressing Gulf War veterans' illnesses. While the SIU acknowledges the need to be responsive to the public, it also believes that these case narratives should function as part of a larger strategic plan to identify potential causes of Gulf War illnesses. OSAGWI could further improve the success of the case narratives by addressing the following weaknesses: 1) OSAGWI's methodology for determining the likelihood of chemical exposure has been inconsistently applied, 2) the case narratives to date do not routinely include a lessons learned section; and 3) there appears to be a lack of coordination between products.

For example, the "U.S. Marine Corps Minefield Breaching" narrative shows an apparent lack of coordination by OSAGWI in ensuring that the information presented in the narratives is consistent. During minefield breaching operations of the 1st and 2nd Marine Divisions on the first day of the ground war, there were two separate accounts of chemical detections. Despite comments made by

a Marine general emphasizing the many months in Saudi Arabia spent training on the detection of chemical weapons, this narrative fails to recognize that operators of the spectrometer were not trained to perform the series spectrum analysis needed to confirm the presence of a chemical agent. An OSAGWI information paper on the Fox vehicle, however, cites this as a major limitation to the employment of the Fox during the Gulf War.

The Marine Breaching narrative also speaks of the Fox being "used for on-the-move vapor detection." It goes on to say that the Fox is not optimized for vapor detection, and several pages later it categorically states that the vapor detector mode is less sensitive than the human body itself in detecting the presence of a chemical nerve agent, noting that "[w]hile using the vapor detection method, human symptoms would most likely appear before the Fox . . . would alert." Clearly, this fact should have been cited in reference to Fox CW detections in other case narratives, but was omitted. In fact, as stated above, OSAGWI should have learned as much from the Defense Science Board June 1994 report, which stated:

"Although sensitive and specific for identification of ground contamination, the mass spectrometer system on board the FOX is not optimized for sampling and alerting to generalized airborne vapors of chemical materials. When operating in the air sampling mode, the FOX is not a suitable warning device; very high concentrations of chemical agents would have to be present, such that unprotected troops in the vicinity would be adversely and acutely affected."⁹⁶

Another example of lack of consistency in the case narratives is the narrative addressing the "Reported Mustard Agent Exposure" of PFC David Fisher. This case narrative inexplicably designates the event as only "likely" to have occurred instead of "definitely." The case narrative describes how PFC Fisher brushed up against an Iraqi munitions bunker and then later developed blisters on his arm consistent with mustard exposure. The term "likely" was used despite overwhelming evidence in the narrative supporting exposure to a blister agent (mustard liquid) and the separate investigation resulting in PFC Fisher being awarded a Purple Heart for his wound by the U.S. Army. Ironically, this narrative details the methodology for chemical incident investigations and all the criteria would appear to have been checked for a positive identification and confirmation; even the commander of the US Army Medical Research Institute of Chemical Defense at the time called it an exposure to although not an intentional use of CW agent by Iraq.

In contrast, the case narrative of the "Al Jaber Air Base" incident provides a fact scenario that is characterized as "unlikely" although the weight of the evidence produced supports a conclusion that chemical warfare agents were "definitely not" present. Here again, the Fox vehicle's MM-1 served as the initial alarm. However, at that time the MM-1 was in the vapor-sniffing mode, which, as noted above, is not as sensitive as the human body in detecting chemical weapons. The apparent absence of chemical agent was underscored by the fact that the two men riding on top of the Fox in

only MOPP-2 did not suffer any symptoms while the alert was occurring. M-256-A1 chemical weapons detector kits also failed to confirm any of the alerts, which were eventually explained away by an environment thick with black smoke from the oil well fires.

OSAGWI narratives produced to date also seem to treat inconsistently cases where there is no evidence of the presence of chemical agent based on detection equipment or laboratory analysis. For example, the "Tallil Air Base, Iraq" narrative was also deemed "unlikely" as opposed to "definitely not," and in this case absolutely no alarms, alerts or other aspects of chemical weapons usage were cited. The only evidence cited to support the conclusion was the presence of a large quantity of CW defensive gear. Similarly, presence of a chemical agent on a SCUD missile fragment retained as a souvenir by a soldier stationed near the King Fahd Military City, was also deemed "Unlikely" in the "Possible Chemical Agent on SCUD Missile Sample" case narrative despite multiple analyses of the sample showing that no agent was present. The soldier had reported to the PAC that the piece of metal from the SCUD would cause agent exposure symptoms to an unprotected person. However, since neither the chain of custody for the piece of metal, nor the reported symptoms when exposed to the metal, could be verified, OSAGWI assessed the incident as "Unlikely," as opposed to "Definitely Not," a chemical agent incident.

Two incidents described in the "Al Jubayl, Saudi Arabia" case narrative also lacked any positive detection of a chemical agent and were assessed as "Definitely Not" a chemical agent. In the first incident, components from an unexploded SCUD missile that hit the harbor near Al Jubayl showed negative test results for a chemical agent. The second incident, in which the brown T-shirts of Marines posted near an industrial base at Al Jubayl turned purple when exposed to unidentified noxious fumes, also showed no positive chemical agent readings. Medical symptoms reported by the Marines after their exposure to the fumes were not consistent with chemical agent exposure.

The case narrative of the Kuwaiti Girls' School incident (issued March 11, 1998) represents OSAGWI's best effort reviewed by the SIU staff as of May 1998. While this incident is ultimately labeled "Definitely Not" a case of chemical agent presence, it goes to great lengths to explain the initial confusion surrounding the preliminary identification of a noxious liquid found at that location as mustard agent. The case narrative presents a credible explanation of the way this occurred. It reviews all the evidence (including expert analysis of Fox vehicle MM-1 tapes), and the added fact that the girls' school was a SILKWORM missile testing and maintenance site, leading to the conclusion that the liquid was red fuming nitric acid (a substance commonly found in vicinities where missiles have been present) and not a chemical warfare agent.

The case narratives and information papers represent the most thorough and comprehensive investigation by the DOD of possible chemical warfare agent exposure events since the Gulf War. However, the case narratives also represent lost opportunities for DoD. It would be helpful if OSAGWI could produce a comprehensive document drawing lessons from these incidents and making recommendations similar to the CIA's Lessons Learned: Intelligence Support on Chemical

and Biological Warfare During the Gulf War and on Veterans' Illnesses. Instead, OSAGWI to date has only partially addressed this issue by including a brief lesson-learned section in its "1997 Annual Report." This segment is merely a summary derived from the case narratives and lacks the details that would make the description of lessons learned more evocative and useful. On March 20, 1998, OSAGWI announced that its investigators were working on 19 case narratives, two information papers, and two updated reports with the expectation that the results of a half dozen of these investigations would be released over the next three months. Topics of the cases include Czech/French chemical detections, a Khamisiyah update, oil well fires, depleted uranium, insecticides/pesticides and medical record keeping. It is hoped that the results of these inquiries will benefit veterans affected by Gulf War illnesses and that the weaknesses identified here in the case narrative process are corrected and improvements made in forthcoming products.

CONCLUSION

There is much evidence suggesting that the Department of Defense could have done a much better job of monitoring the health of its deployed personnel, training personnel to avoid or protect themselves against certain health risks, and reacting in a more timely manner to the post-conflict concerns of Gulf War veterans, active duty personnel, the news media, the public, and the Congress.

In the effort to move personnel and equipment to the Persian Gulf region, the Defense Department experienced logistical and technological shortfalls in personal protection equipment, including supplies of protective overgarments, effective chemical alarms, and Fox vehicles. There were significant communications gaps between DOD and intelligence community staffs which led to misdirections and lost opportunities to inform troops of possible chemical weapons threats. Records-keeping policies and procedures were inadequate and lacked accountability. The Khamisiyah demolition and follow-up were poorly coordinated and documented from beginning to end. This led to confusion about the event between DOD and intelligence community staffs, further fueling Gulf War veterans' skepticism the government's ability to be open and honest about possible causes of illnesses. All of these shortfalls must be addressed if the health of veterans of future conflicts is not to be brought into question by a potential lack of readiness, monitoring, and recordkeeping by the military.

RECOMMENDATIONS

1. The Secretary of Defense should create a single focal point in the unified commands to gather, analyze, and report all intelligence information in support of any military operation in order to avoid the information sharing and communications failures that occurred during the Gulf War. The Director of Central Intelligence must fully coordinate and cooperate in ensuring this unified approach.

2. Training of and instructions to intelligence analysts at the Central Intelligence Agency, Defense Intelligence Agency, and Department of Defense should ensure awareness of historical and collateral facts and situations that may affect how they interpret and handle intelligence data.
3. The joint DoD/CIA Khamisiyah plume modeling effort, and future similar efforts, should be peer reviewed by experts from inside and outside of government and the results of that peer review made public.
4. The Secretary of Defense must make chemical and biological warfare training a high priority to remedy equipment, medical, and other readiness shortfalls that occurred during the Gulf War and continue today.
5. The Secretary of Defense should establish troop training and safety programs to minimize possible health hazards from contact with depleted uranium.
6. The Secretary of Defense should reinforce compliance with current statutory and regulatory requirements that all records, logs, and other documents related to wartime and other military operations that are permanent records under the law are retained, and require that all unified commanders demonstrate this duty is being implemented and understood as a priority at every level in that command.
7. The Secretary of Defense should implement a personnel tracking system, such as that now being developed by the U.S. Army Center for Health Promotion and Preventive Medicine, in order to track and identify where individual service members were located during military operations.

2

ASSESSMENT OF GULF WAR VETERANS' HEALTH CARE SERVICES AND COMPENSATION BENEFITS AT THE DEPARTMENT OF VETERANS AFFAIRS

INTRODUCTION

The relationship between the Department of Defense and the Department of Veterans Affairs is as important today as it has ever been. With the winding down of the Gulf War in 1991 and the concurrent downsizing of U.S. forces world-wide, the number of men and women who are veterans eligible for VA care is significant. In taking a close look at the Department of Veterans Affairs and its role in ensuring the health and well-being of Gulf War veterans, the staff of the Special Investigation Unit traveled to numerous VA facilities across the country. (The VA facilities visited by the SIU can be found at Appendix J.) This effort included examining the VA's capabilities and plans for the care of Gulf War veterans, and ways in which the VA and DOD can work together to ensure that Gulf War veterans get the care and services they deserve. In conducting this investigation, the SIU examined the nature and extent of the health care services currently provided by VA to Gulf War veterans. The SIU also studied how VA's claims processing centers across the country (known as regional offices) review Gulf War veterans' compensation benefits claims and how VA ensures that those decisions are timely and accurate.

However, as this chapter describes, too many Gulf War veterans are dissatisfied with the health care they are receiving from VA. And, too few of those veterans currently are receiving timely responses to their claims or accurate determinations of whether a grant of compensation is warranted. The SIU found that although the VA purports to operate as a single entity on behalf of veterans, in practice it is a loosely linked group of bureaucracies that operate largely in isolation from one another. This organizational structure breeds communication lapses and bureaucratic hurdles that prevent the VA from providing effective and efficient service to Gulf War veterans.

The purpose of this chapter is to identify opportunities for improvement. In that vein, the SIU identified three key areas of concern that are common to the disability compensation and benefits programs administered by the Veterans' Benefits Administration and the health care services

provided by the Veterans Health Administration. This chapter's discussion of the SIU's investigation into VA's activities on behalf of Gulf War veterans should be read with the three issues set out below in mind.

First, there is a clear absence of a common philosophy and a practical approach to VA procedures, programs, processes, and policies related to Gulf War veterans. On the health care side, for example, there is no clear guidance for VA's medical staff for conducting standardized and thorough Persian Gulf Registry exams, while on the benefits side there appears to be a lack of understanding as to the proper standards to apply in processing Gulf War-related compensation benefits claims.

A second major problem common to VHA and VBA is the chronic failure within VA to adequately collect, analyze, and share information about Gulf War veterans who seek assistance from the VA. Without such basic cooperation and sharing of data, there can be no reliable evaluation of how the VA's Gulf War programs and policies are working. Without reliable evaluation of the programs, it is impossible for VA leadership to make necessary adjustments or respond to changing conditions. An inability to reliably evaluate the VA's legislatively mandated Gulf War programs means that Congress's oversight responsibilities are seriously impaired. Most importantly, absent reliable data and program evaluation it is impossible to ensure that individual Gulf War veterans are receiving appropriate health care treatment or that their compensation benefits claims are being processed in an accurate, consistent and timely manner.

Third, there is a pervasive lack of coordination at VA of the various services it has available for Gulf War veterans. This is not limited to programs for Gulf War veterans, for the VA already has identified coordination defects as an agency-wide problem affecting all veterans. However, the VA's solution to date largely has been to coin and repeat the slogan "One-VA." A VA that truly operates as a single entity should, of course, strive to speak with one voice. Unfortunately, this rhetoric all too often replaces effective action and insofar as Gulf War veterans are concerned, VA's mission remains unfocused. The result is internal agency conflicts, program insularity, and confusion and frustration on the part of the Gulf War veterans that the agency says are a priority for it to serve. Each of the problems identified here can be remedied. In some cases it will require a substantial commitment of VA's part to do so; in other cases progress is already being made. However, these weaknesses in VA's Gulf War veteran programs cannot, and should not, be ignored, for to do so would be to renege on this nation's commitment to help ill Gulf War veterans to the greatest extent possible.

OVERVIEW OF VA'S RESPONSIBILITIES TOWARD GULF WAR VETERANS

The government's responsibility to take care of individuals who serve in the defense of the United States and are injured as a result of that service can be traced to laws enacted by the Plymouth

Colony.⁹⁷ Caring for the war-wounded is as deeply ingrained in our nation's traditions as are voting and community service. Since the beginnings of our country, some measure of compensation from the government for disabled veterans has been available.

Qualifying for VA health care services or disability compensation benefits is not automatic. It requires that the veteran provide proof to VA that an injury or health condition was triggered by something that happened during the veteran's military service. Yet, as this investigation discovered, determinations of eligibility for health care services and for disability compensation benefits do not operate in a parallel fashion. This is particularly true for Gulf War veterans with unexplained illnesses or, as VA refers to them, "undiagnosed illnesses." Where compensation claims from Gulf War veterans who suffer from undiagnosed illnesses are involved, the adjudication of those claims often is a long, laborious, and complicated process. This is partly due to the unique issues raised by the possible connection between Gulf War service and the current health problems of some of those veterans for which a cause has not been determined. Also, as described in this chapter, the problems that exist in the delivery of health care services and compensation benefits are also a consequence of organizational priorities that were established at VA without providing personnel with adequate training, information and time to accomplish them. The situation is confounded by the fact that there is little coordination between VA's health and benefits components on Gulf War veterans' issues.

In the past few years, those in leadership positions at the VA have often described the department's overall performance goals in terms of a "One-VA" model—meaning that all parts of the agency, and particularly the benefits and health care areas, will work in unison for the maximum benefit of the department's customer, the veteran. VA leaders cite many examples of the success of the "One-VA" approach, including initiatives involving Gulf War veterans, and in recent years some positive changes have occurred. For example, teamwork between VA health care and compensation experts resulted in regulations to provide Gulf War veterans with undiagnosed illnesses compensation payments. However, in spite of this success story, the SIU's investigation found little evidence that VA's claims of a streamlined and more efficient approach to fulfilling its mission are reflected in VA's actual delivery of timely health care services and disability compensation to veterans, particularly where Gulf War veterans are concerned.

Although senior-level officials at VA, as at any organization, are responsible for implementing the policies they establish or articulate, the SIU found that a lack of internal oversight of VA programs is common and a lack of accountability the status quo. As the discussion below demonstrates, there unfortunately is little evidence that VA leaders are moving forward to implement fundamental changes in the department's administrative, organizational, or service delivery structures that truly embody a unified "One-VA" approach to the delivery of services to Gulf War veterans seeking care and compensation.

LACK OF COOPERATION BETWEEN VA'S HEALTH AND BENEFITS ADMINISTRATIONS HINDERS IMPLEMENTATION OF THE "ONE-VA" APPROACH

This investigation found that there are serious impediments to cooperation within VA, especially between the health and benefits administrations. This situation exists not because VA lacks the expertise necessary to fully understand and address the undiagnosed illnesses suffered by Gulf War veterans. It exists because the expertise and resources are fragmented. The Veterans Health Administration (VHA) has consistently failed to follow and track the progress of treatment of Gulf War veterans, even those who are service-connected for undiagnosed illness and who are categorized among VA's priority customers. Similarly, as correspondence from officials at the Veterans Benefits Administration (VBA) to the Committee has acknowledged, VBA has failed to maintain or provide records accounting for its use of resources to adjudicate claims from Gulf war veterans.⁹⁸

In VBA, policy guidance on Gulf War claims processing is provided to decision makers at VBA regional offices around the country from VA headquarters (known within VA as the "Central Office") by a team of policy and claims management experts called the Rapid Response Team. Rapid Response Team members respond to questions from regional office decision-making personnel concerning the adequacy of evidence presented in support of a compensation claim, including the physical examinations of veterans that are performed by VHA doctors on behalf of VBA. Yet, even though it is VHA doctors who have expertise regarding the conduct of these physical examinations, VBA's Rapid Response Team as of the writing of this report does not include among its personnel either a VHA Central Office Gulf War expert or any other VHA health care policy expert. Perhaps this is merely an oversight on VBA's part. Nevertheless, the SIU's investigators believe that this failure by VBA to take advantage of VHA's expertise in this way is a lost opportunity to help unify VA's approach to how Gulf War veterans' compensation claims are processed.

The lack of cooperative policy making between VBA and VHA was recently addressed in part by the joint issuance in February of 1998 of fully informed, basic guidance to VA's regional offices and medical facilities in the field. This guidance describes how to conduct physical examinations in support of Gulf War veterans' compensation claims for undiagnosed illnesses. It also addresses issues of fundamental concern such as to what extent a claimed condition should be investigated before being judged to be "undiagnosed."⁹⁹ This example illustrates the extent to which the "One-VA" concept easily could be realized in the day-to-day operations of VA where Gulf War veterans are concerned. That Gulf War veterans should be able to deal with "One-VA" is not only good policy, but it is necessary if VA is to provide adequate service to Gulf War veterans.

VA DISABILITY COMPENSATION AND THE GULF WAR VETERAN

In order to fully understand the problems Gulf War veterans are facing in obtaining timely compensation from VA, it is necessary to understand how the compensation claims system at VA is intended to work.

Service-connection for Disabilities and "Undiagnosed Illnesses"

The term "service connection" is used at VA, in the context of adjudicating compensation claims from any veteran (including Gulf War veterans), to refer to injuries incurred or diseases contracted during military duty or, if the injury or disease existed prior to service, for conditions aggravated by military service. "Disability compensation" is the monthly payment made by VA to a veteran who has been found, after the veteran has filed a claim and it has been resolved in the veteran's favor, to be disabled as the result of military service if that disability is found to be "ten percent" or more. At VA, the percentage of disability is derived from a regulatory "Schedule for Rating Disabilities."¹⁰⁰ This schedule contains ten grades, or percentages, of disability upon which compensation is paid. When a disability is determined to be service-connected, the percentage of disability assigned for the condition is based upon the average impairment of earning capacity resulting from the same injury in civil occupations.¹⁰¹

Under existing law, there are two ways in which veterans may establish service connection for a disability. These are called "direct service connection" and "presumptive service connection." "Direct service connection" means that the facts in a veteran's claims record establish that an injury or disease resulting in a chronic disability, which VA defines as one that has existed for at least six months, was incurred coincident with military service. Direct service connection can also be shown even though a physical condition existed prior to military service if the facts in the veteran's claims record demonstrate that the condition was aggravated by military service.¹⁰² In cases of "presumptive service connection," an adverse physical condition may be presumed by law to be related to military service, even if it is not shown to have occurred during or was aggravated by that service, if the chronic disability is manifested to a degree of ten percent or more within a certain time limit (usually within one year after the veteran was released from military duty). Presumptive service connection has the advantage of simplicity for the veteran and VA because it does not require documentary proof that the disability occurred in military service.¹⁰³

A precondition to successfully applying either of these two methods for establishing service connection is a diagnosis attached to the condition that the veteran claims is related to military service and is one for which compensation should be paid. However, many Gulf War veterans suffer from ill-defined symptoms and from symptoms that elude classic diagnostic processes. Therefore, Gulf War veterans are at a disadvantage under the conventional measures of service connection that require a diagnosis.

In order to take into account the unique character of Gulf War veterans' unexplained illnesses, statutory language was enacted in November 1994 providing that presumptive service connection may be granted to Gulf War veterans who are sick from illnesses that cannot be diagnosed.¹⁰⁴ Under this provision, service connection is to be granted when the Gulf War veteran suffers from a chronic disability resulting from one or more undiagnosed illnesses. The undiagnosed illness must have manifested itself during the veteran's active duty in the Southwest Asia theater of operations during

the Gulf War, or to a degree of ten percent or more disabling from the date the individual left the Southwest Asia theater through December 31, 2001.¹⁰⁵

Processing of Gulf War Veterans' Compensation Claims

The claims process begins with the veteran's completion of an application for disability benefits. When any veteran files a claim for compensation, that individual must diligently track the claim's status in order to get a timely and favorable result. According to VA regulations, the veteran is responsible for furnishing evidence supporting his or her claim. VA personnel in regional offices take the lead in the remainder of the process, sometimes assisted by representatives from veterans service organizations such as the American Legion, Disabled American Veterans, or Veterans of Foreign Wars. VA is responsible for identifying, gathering, and deciding whether sufficient proof has been assembled to result in a favorable determination that the Gulf War veteran's claimed health condition is service-connected. While VA is required to assist the veteran in developing the facts of the claim, the regulations also state that the requirement that the VA assist a veteran does not shift the ultimate responsibility to produce supporting evidence for the claim from the veteran to VA.¹⁰⁶

VBA's regional offices are the hub of the adjudication process for any compensation claim, including those filed by Gulf War veterans. Regional office personnel who review the veteran's claims record identify and gather evidence to determine what issues should be considered in deciding a claim. They also evaluate all the available evidence to rule on the veteran's eligibility to receive disability compensation. VA compensation decision makers must examine all the evidence in a veteran's record to address conditions that are specifically claimed as service-connected.¹⁰⁷ However, these same decision makers are also responsible for identifying issues that are not specifically claimed by the veteran but that are "inferred" from the face of the record. Inferred issues in this context are signs or symptoms that are unrelated to a diagnosis but nevertheless are evident upon review of the veteran's record.¹⁰⁸ In other words, within each claim by a veteran there may be inferred issues that must be considered for service connection in the same manner that claimed issues must be considered. This is especially important for Gulf War veterans with undiagnosed illnesses, because VA's criteria for compensation for undiagnosed illnesses provides that service connection is payable to a Gulf War veteran who exhibits indications of a chronic disability manifested by one or more signs or symptoms such as fatigue, muscle pain, abnormal weight loss, or menstrual disorders.¹⁰⁹

Thus, for any veteran to obtain a determination that he or she is entitled to compensation payments two threshold requirements must be met. First, a link must be established or presumed between the veteran's military service and the claimed or inferred condition. Second, the VA compensation decision-maker must find that the service-connected condition is at least ten percent disabling.

VA HEALTH CARE SERVICES AVAILABLE TO GULF WAR VETERANS

Like other veterans, those who served in the Gulf War are eligible to receive health care services from VA upon a determination that their condition is service-connected. But, Gulf War veterans with undiagnosed illnesses had difficulty establishing their eligibility to compensation payments prior to enactment of the statutory provision, described above, that provides a means for presumptive service connection. In light of this, VA sought to ensure that Gulf War veterans and active military personnel with complaints of illnesses associated with Gulf War service also have ready access to the VA health care system.

Even before the ground war started in February of 1991, VA began planning for the possibility that American military personnel might be deployed to Southwest Asia. In November of 1990, VA took steps to establish a system to track veterans who might become ill due to their military service.¹¹⁰ In 1992, VHA finally established the Persian Gulf Registry. The registry's purpose was to serve as a mechanism to assist VA in identifying possible diseases which may have resulted from military service in certain areas of Southwest Asia.

Because so many service members deployed to the Gulf War were National Guard and Reserve personnel, in 1993 Congress approved statutory authority for VA to expand its ability to provide health care coverage to include National Guard and Reserve personnel who served in the Gulf War. Under current law, they are otherwise ineligible to receive that health care.¹¹¹ This statutory authority dramatically changed the requirements for delivery of health care services to all Gulf War veterans. For example, Gulf War veterans, unlike other veterans, are not required to file or wait for decisions on their claims for compensation before being eligible to receive health care from VA. As discussed below, Gulf War veterans have the opportunity, unique within the VA structure, to receive free extensive and specialized physical examinations simply by virtue of service in the Gulf War and can also receive medical treatment for conditions VA physicians believe may be related to Gulf War service. This policy is commendable but, as described later in this report, it has not always resulted in delivery of health care to these veterans.

SPECIAL HEALTH CARE ELIGIBILITY FOR GULF WAR VETERANS

A key part of the legislation passed in 1993 was that Congress also authorized VA to provide health care services to Gulf War veterans who, while serving on active duty in the Southwest Asia theater of operations during the Gulf War, may have been or were exposed to a toxic substance or environmental hazard.¹¹² The health care services VA is authorized to provide to Gulf War veterans in VA facilities include hospital, nursing home care, and outpatient care. This is true regardless of a determination that a condition is service-connected, the veteran's age, or the veteran's ability to pay for that care. This extension of full health care to Gulf War veterans is a key feature of the 1993 legislation because payment by veterans for VA health care services is usually required except in limited situations such as medical care provided for a service-connected disability.¹¹³ Also, Gulf War

veterans are to be furnished medical care on an outpatient basis in a hospital or clinic ahead of most other nonservice-connected veterans. This priority in delivery of medical care to Gulf War veterans is similar to the priority service provided by law to former prisoners of war who receive medical care at VA facilities for nonservice-connected conditions.¹¹⁴

Although Congress created a means for Gulf War veterans to obtain certain health care services from VA that are not available to most other veterans, it also made clear in the 1993 legislation that the presumptions and priorities it created for Gulf War veterans applied solely to the provision of health care services and did not extend to other VA functions, such as compensation claims.¹¹⁵ Thus, the fact that a Gulf War veteran is eligible for health care services from VA under this statute does not constitute a basis for determining service connection for purposes of an award of compensation payments.

VBA'S DECISIONS REGARDING COMPENSATION CLAIMS PROCESSING OF GULF WAR CLAIMS HAVE BEEN INCONSISTENT AND COUNTERPRODUCTIVE

As public concern began growing over the possible health consequences to veterans from their Gulf War service, VBA management made several decisions to address their problems. However, as will be explained, these decisions were erratic, did not ultimately respond to the needs of Gulf War veterans, and resulted in lost opportunities to serve these veterans.

One very significant decision made in an effort to respond to Gulf War veterans was to consolidate adjudication of all Gulf War compensation claims based on environmental hazards in the Louisville, Kentucky regional office beginning in December 1992. VA has stated that consolidation of claims processing was done in order to allow decision makers in the Louisville office to develop an expertise in working with the unique issues that these claims raise, dedicate resources to what was believed would be more expeditious processing of the claims, and allow close monitoring of the claims to identify patterns and common health problems that may appear among Gulf War veterans.¹¹⁶

At the time VA designated the Louisville regional office as the focal point for adjudicating these unique claims, VA did not anticipate receiving many environmental hazard claims. Early information from DOD suggested that U.S. troops were not exposed to biological or chemical warfare agents and that DOD did not believe such agents were present in the theater of operations.¹¹⁷ However, the number of claims that were submitted by Gulf War veterans to the Louisville regional office quickly grew to the point that the office could not in fact process them in a timely fashion. For example, by October 1994, the Louisville office was averaging 357 days to process an original (first-time) claim for compensation from Gulf War veterans. At the same time, the national average for

all regional offices processing original claims was 176 days and VBA's goal for processing original compensation claims was 106 days.¹¹⁸

The growing concern among Gulf War veterans about their possible exposure to an environmental hazard and a potential link between that and their ill health resulted in an increasing workload that out-paced the Louisville regional office's and VBA Central Office's ability to respond in a timely manner. Finally, in October of 1994, VBA's Central Office designated three more regional offices to handle Gulf War veteran claims. The three new Gulf War regional offices were in Philadelphia (covering the eastern United States), Nashville (the southern area), and Phoenix (the western region), with Louisville now handling only the central part of the country. Each of these offices was referred to as an area processing office for Gulf War environmental hazards and undiagnosed illnesses claims. VA took this action because it believed that expanding to four area processing offices would restore the desired level of prompt service to veterans, distribute the workload more evenly, and enhance timely processing of the claims.¹¹⁹

Concurrent with the increase in the number of area processing offices designated to handle the increasing number of Gulf War veterans' claims, in November of 1994 Congress passed legislation authorizing payment of compensation to Gulf War veterans suffering from chronic disabilities resulting from undiagnosed illnesses. VA published regulations to implement the statute in February 1995.¹²⁰ Prior to this legislation, 10,736 Gulf War veterans already had received a final decision on their claims without the benefit of this new standard of review. To avoid penalizing them because they happened to have filed claims before the law came into effect, in July 1996 their claims were reopened to determine if a different outcome would result under the new standard.¹²¹ The four area processing offices thereupon undertook, in addition to review of new Gulf War veterans' claims, the readjudication of those thousands of completed claims. The readjudication was also intended to ensure that information about the claims had been properly entered into a specialized computer database system known internally at VA as the "Gulf War Tracker" which was developed to track Gulf War claims.¹²² However, by early 1997 the Nashville area processing office's share of Gulf War claims alone was so great that VBA management enlisted the assistance of the Cleveland, Ohio, and Muskogee, Oklahoma, regional offices to help Nashville with these readjudications. (15,638 claims were pending at Nashville compared to 7,111 claims at Philadelphia, 8,347 at Phoenix, and 8,246 at Louisville).¹²³

Readjudication of completed Gulf War claims was not limited to those that were decided without the benefit of the statutory provisions clarifying the standards to apply to undiagnosed illness claims. In March 1997, the President approved the request of the Secretary of Veterans Affairs to extend the presumptive period during which conditions on which Gulf War undiagnosed illness claims might be based from two years after the date of a Gulf War veteran's last active service in the Southwest Asia theater to December 31, 2001.¹²⁴ VA finalized regulations in April of 1997 to implement the extension of the presumptive period.¹²⁵ The result was that over 4,400 claims (some of which were part of the group of several thousand claims already subject to readjudication) that had been denied

because the claimed disabilities had appeared after the previous two-year presumptive period also required re-review to determine possible entitlement to benefits under the new presumptive period.

While these readjudication projects were underway, VBA management decided to reverse the centralization policy it had followed for nearly five years. The demands placed on the four area processing offices had overwhelmed their ability to process Gulf War veterans' claims in an efficient manner. Veterans and other interested parties such as Congress and veterans service organizations were also seeking increased Gulf War veteran access to the decision makers on their compensation claims.¹²⁶ On May 5, 1997, the VBA management informed all regional offices that they should no longer send Gulf War undiagnosed illness cases to the area processing offices and all cases that were awaiting action at the area processing offices would be returned by the area processing offices to the regional offices by June 1, 1997.¹²⁷ VBA Central Office personnel developed an implementation plan for this redistribution. Among other things, the plan attempted to respond to complaints from veterans and veterans service organizations about long processing delays. It also sought to address their objections that the reviews were being done at locations remote from where veterans lived, making it difficult for them to adequately follow up on their claim and provide new evidence if required. VBA's redistribution plan also was intended to minimize the impact on the regional offices from a new workload involving unique issues with which most compensation decision makers were unfamiliar as well as to maintain and eventually improve the level of service to Gulf War veterans.¹²⁸ At the time the decision to decentralize was made, there were approximately 9,700 Gulf War claims for which a decision had not been made.¹²⁹ These pending claims were added to the regional offices' existing workloads.

In making decisions and issuing policy directives and plans over the years concerning the distribution and processing of Gulf War veteran claims, VBA management did not seem to fully understand the regional offices' actual day-to-day experiences in dealing with these claims. In particular, they may not have fully understood the effect on the regional offices' operations when ordering readjudication of many Gulf War veterans' claim and later to decentralize Gulf War claims processing. One example is VBA management's response to changing demands on the organization when establishing milestones for completing the readjudication of approximately 11,000 Gulf War veterans' claims just discussed. At the Central Office-sponsored Gulf War claims training session in Cleveland in early June of 1997, VBA Central Office representatives instructed attendees that all readjudicated claims were to be completed by September 1—just three months later. This goal was set even though almost none of the regional office personnel had previously dealt with some of the issues that Gulf War claims uniquely raise and the readjudications were to be done on top of existing workloads. Not surprisingly, the September 1, 1997 target date was not met by any regional office. Central Office VBA management, perhaps realizing they had set an overly ambitious and unattainable goal, next announced in mid-September that these claims now had to be completed by the end of October 1997.¹³⁰ When this target date too had come and gone, the deadline for completing all readjudication claims was pushed back to December 31, 1997.¹³¹

As of May 8, 1998, 224 readjudication claims were still not completed.¹³² It appears that VA's attempts at goal setting for actions affecting priority groups like Gulf War veterans were done with the Gulf War veterans' best interests in mind. The fact that the milestone dates for completing the readjudication claims were adjusted a number of times reflects VA's recognition that these Gulf War veterans' claims require more attention than other claims. However, it is important and necessary in future setting of goals that VA fully understand the implications of plans made, ensures that those plans are realistic, and ensures resources adequate to implement them are available.

VBA's handling of the Gulf War claims readjudication process illustrates VA's overall problems with planning and allocating resources necessary to serve Gulf War veterans. Although Gulf War claims had been processed for almost two years at the Louisville regional office, VBA management seems to have assumed that the problems of claims processing could be addressed by merely expanding the number of regional offices working on these claims from one to four. This assumption proved to be unrealistic. When claims processing efficiency for all claims at the four area processing offices diminished as a result of increased workloads the result was transfer of claims from the area processing offices to other regional offices, again isolating veterans from compensation decision makers. In the end, the ultimate response to claims processing timeliness and efficiency problems was to send Gulf War veterans' compensation claims back to the regional offices that would have originally handled them if the attempt to centralize review of Gulf War veteran claims had not occurred.

Over a year after the decision was made to decentralize Gulf War claims from the area processing offices to the regional offices, the workload generated by Gulf War veterans' claims still strains the resources of many regional offices. For example, the SIU's investigators found some regional offices were devoting as many as one-fifth their total number of compensation decision makers to work on Gulf War claims, yet these claims accounted for only one to two percent of those offices' total workload. On the surface this appears to be a responsive gesture toward processing of Gulf War veterans' claims. However, every regional office visited by SIU investigators during the tenure of this investigation indicated that their ability to adjudicate claims from Gulf War veterans in a timely fashion and all other veterans' pending claims had been significantly reduced as a result of the redistribution of Gulf War claims to all regional offices. One explanation, discussed later in this chapter, is that VBA has not yet addressed issues of quality of Gulf War claims processing by fully training all compensation decision makers in the intricacies of processing claims involving undiagnosed illnesses.

INFORMATION MANAGEMENT PROBLEMS HINDER TIMELY AND EFFICIENT DELIVERY OF VA BENEFITS AND HEALTH CARE SERVICES TO GULF WAR VETERANS

For years, decisions affecting Gulf War veterans have been made by Congress and VA based in part on data collected, analyzed, and provided by VA. For example, beginning in April of 1995 and until August 1997, VBA provided this Committee and interested groups such as veterans service organizations a monthly report. This report contained statistics on the number and status of disability claims filed by Gulf War veterans who are sick due to undiagnosed illnesses and other illnesses resulting from exposure to environmental hazards during their service in the Gulf.¹³³ The report was based on data drawn from several sources within VA, particularly from VBA's disability benefits payment system database and the Gulf War Tracker. The information in these reports was widely assumed to be reliable and many policy decisions affecting Gulf War veterans were made based on them. Unfortunately, as the SIU discovered and as is discussed below, the data in these reports was flawed in many ways. The result of the inaccuracies has been that efforts to assist Gulf War veterans and make informed decisions regarding delivery of health care services and benefits to those veterans may have been adversely affected, or at least less than what might have been done.

One decision that was based in part on flawed data generated by VA was the determination by VBA, described above, to readjudicate the approximately 4,400 claims by Gulf War that had been denied based solely on the original two year presumptive period. At that time, VA felt that the readjudication of these claims was necessary because the extension to the presumptive rule would result in more veterans receiving compensation payments. However, only a few hundred grants of service connection for undiagnosed illnesses have resulted from the readjudication of these claims.¹³⁴ This suggests that data was poorly collected and managed so that many of the claims that had been recorded as denied because the veteran's undiagnosed illness fell outside the original two-year presumptive rule were in fact denied on other grounds.

In response to questions about the validity of its data from SIU investigators, VA acknowledged that it had not adequately collected and analyzed data sufficient for shaping informed decisions on Gulf War veterans. VA reached this conclusion by reviewing the sources of the information and comparing that data to what should have been identical data. For example, VA compared its data concerning the number of Gulf War veterans who were discharged from the military against DOD-generated data on discharged military personnel. The result of this comparison led VA to conclude that many more Gulf War veterans were receiving compensation payments from VA than was previously believed. For example, VA had generated and distributed reports, and had testified before Congress based on those reports, that in April 1997, 28,580 veterans were receiving compensation payments for service-connected conditions based on their service during the Gulf War. However, once it compared its claims data to DOD's data at the suggestion of SIU investigators, VA discovered that 69,613 Gulf War veterans—over twice what VA had believed to be the case—were in fact receiving compensation payments.¹³⁵

VA reacted swiftly when it discovered that the statistics on Gulf War veteran claims that it had made public and on which it and others had relied were inaccurate. VA's Acting Secretary at that time stated in a letter to the Chairman and Ranking Member of this Committee that he "[could] not

claim confidence in the data previously provided [to the Committee]. This is an embarrassment to the Department of Veterans Affairs."¹³⁶ The Acting Secretary immediately designated a senior executive under the leadership of VA's Assistant Secretary for Policy and Planning to serve as the Project Manager for management of Gulf War information. At the same time, the Acting Secretary appointed the Assistant Secretary for Policy and Planning as the Department's liaison to Congress on all Gulf War issues and to "coordinat[e] all departmental information pertaining to the Persian Gulf conflict."¹³⁷

VA must continue to improve its internal information systems so that accurate and reliable data on Gulf War veterans' claims can be produced, although it has not and will not be an easy task for VA at this point to do so. In addressing this problem, to date VA has succeeded in producing only basic data on Gulf War veterans on a quarterly basis but it is hoped that policy decision makers soon will be able to rely on complete, validated information when analyzing actions needed on behalf of Gulf War veterans. To accomplish this, VA must eliminate the internal problems that have hindered it in responding to Gulf War veterans' concerns in a timely and effective way. For example, to date VBA and VHA have been reluctant to provide VA's project manager for Gulf War veterans' data with full access to the information they administer despite the priority to do so established by the Secretary-Designate in September 1997.

Despite the Acting Secretary's commitment that the VA would correct its faulty data and would not use such statistics again until the information was proved valid, VA has continued to publicly release and use statistics about Gulf War veterans health care and benefits that are unverified. For example, in testimony before the House Committee on Veterans Affairs on February 5, 1998, VA's Under Secretary for Benefits cited statistics drawn from VBA's databases which remained of questionable validity. During that testimony the Under Secretary cited two different figures—2,306 and 1,590—as the number of VBA decisions granting service connection for undiagnosed illness.¹³⁸ The discrepancy in numbers was explained by the Under Secretary as due to the fact they were generated by unrelated data systems in VBA. Regardless of the reason for the discrepancy, neither figure matches the number validated by VA's project manager for Gulf War veterans' data (and the number that will be used for purposes of this report) of 1,492 undiagnosed illness compensation grants. This figure was publicly released by the Assistant Secretary for Policy and Planning less than a week before that hearing and presumably was available for use in VA's testimony at that time. Moreover, it is unlikely that this number could have increased by either 100 or 800 claims in a matter of days.¹³⁹

At the same hearing, VA's Under Secretary for Health stated that between 10 and 25 percent of the approximately 66,000 Gulf War veterans who have participated in the Persian Gulf Registry Program—that is, between 6,600 and 16,000 veterans—have been found by VA doctors to have unexplained illnesses.¹⁴⁰ These numbers are far greater than the VBA's estimated numbers of from approximately 1,600 to 2,300 Gulf War veterans who are service-connected for undiagnosed illnesses and raise the question why so few Gulf War veterans who have undiagnosed illnesses are receiving

VA compensation. In any event, any public use by VA officials of data that is known or should be known to be questionable seriously weakens VA's credibility as to its entire Gulf War program. VA's continuing failure to generate accurate data on the number of Gulf War veterans with undiagnosed illnesses suggests that VA at present cannot accurately determine who it serves and how it serves them. As discussed later in this chapter, this failure to resolve clear conflicts and contradictions in the information maintained in VBA and VHA has serious implications for service to Gulf War veterans.

INEFFECTIVE MONITORING OF HEALTH CARE AND BENEFITS ADMINISTRATION RESULTS IN INCONSISTENT DELIVERY OF VA BENEFITS TO GULF WAR VETERANS

It is one of VA's highest priorities to deliver health care treatment to all Gulf War veterans with service-connected disabilities. Yet VA, when asked in October of 1997 about the 1,360 veterans who its statistics indicated were at that time service-connected for undiagnosed illness, could not say whether those veterans were also receiving treatment for those illnesses. VA has collected data to determine if an individual Gulf War veteran has received inpatient or outpatient medical services at a VA facility, but the data does not indicate for what condition. In the case of a veteran with a service-connected undiagnosed illness who seeks inpatient or outpatient treatment for that service-connected illness, VA has been unable to consistently track whether the undiagnosed condition has improved or worsened.

Moreover, many more Gulf War veterans may be entitled to compensation for Gulf War veterans with undiagnosed illnesses than currently are receiving such benefits. There does not seem to be any coordinated effort at VA to date to determine why 6,600 to 16,000 veterans on the Persian Gulf Registry have been determined to have an unexplained illness yet far fewer veterans are receiving compensation for service-connected undiagnosed illnesses. When SIU investigators discussed this issue with VA officials, they could not explain why this situation exists nor did they know which Persian Gulf Registry participants with undiagnosed illnesses have filed claims for compensation.

VA has made no effort to monitor in an organized way the health outcomes of Gulf War veterans with undiagnosed illnesses on either the health registry or service-connected compensation rolls. VA has stated, however, that as of February 1998, 140,000 of the nearly 700,000 veterans who served in the Gulf War conflict¹⁴¹ have had their claims adjudicated to establish a service-connected disability and 243,000 Gulf War veterans have used VA medical facilities in some way since their return from the war.¹⁴² Both VA and DOD express concerns that valid scientific conclusions could not be made by tracking this inherently self-selected population of veterans choosing to file claims or use VA health care facilities. Nevertheless, the VA is missing opportunities to discover what, if any, similarities exist in the health status of the almost 40 percent of the total Gulf War veteran

population that has sought medical services at VA medical facilities by monitoring their health outcomes.

Analogous to VHA's ineffective monitoring of Gulf War veterans' health status is VBA's inability to effectively resolve claims filed by Gulf War veterans. SIU investigators interviewed many regional office employees across the country who almost universally noted the difficult and time-consuming nature of Gulf War veterans claims involving undiagnosed illnesses as compared to other claims. However, while these claims generally require the application of different rules and more attention to detail than do other claims, they do not generally involve the level of complexity or require the amount of resources that regional office personnel attribute to them. An exception to this is the question of how to handle claims involving undiagnosed illness when that issue is not specifically raised by the veteran but is inferred from evidence in the claims record.

Precisely because of its undiagnosed nature, questions about the causes of illnesses suffered by Gulf War veterans often are difficult to determine. During site visits to regional offices, SIU investigators reviewed a limited number of already-processed Gulf War veteran claims in which a finding of an undiagnosed illness was not part of the decision. However, in some of these claims SIU investigators identified symptoms in the veteran's claims record that were unrelated to a diagnosis and thus should have been considered inferred claims for "undiagnosed illnesses." It is likely that this circumstance is true for some number of claims other than those reviewed by SIU investigators, suggesting that at least some of the aggregate number of Gulf War veterans' claims may need to be revisited in the future either when veterans or their service organization representatives request reconsideration of the claims or if appealed to the Board of Veterans Appeals.

As described earlier in this chapter, VA believed it could best serve Gulf War veterans who filed disability compensation claims for undiagnosed illnesses by centralizing claims processing at four area processing offices because in doing so the expertise of the compensation decision makers at those offices would increase. Intense training efforts were conducted for these decision makers at the time VA designated these four area processing offices. However, VBA management's quality reviews repeatedly indicated that VBA decision makers at the area processing offices had not been able to produce adequate quality decisions. For example, in some claims there was a failure to consider all issues reflected by evidence in the record and decisions were made knowing that the record was incomplete.¹⁴³ In addition to producing incorrect decisions on many of these claims, internal VA reviews conducted between November 1995 and April 1997 also showed that because the four area processing offices that had been assigned the task of reviewing all Gulf War veterans' compensation claims were overwhelmed by the volume of claims related to exposure to environmental hazards, large backlogs of those claims developed.¹⁴⁴ This meant that Gulf War veterans were not receiving timely decisions on their claims.

When this large backlog triggered the May 1997 redistribution of Gulf War claims back to regional offices,¹⁴⁵ training for regional office personnel was provided. However, the SIU learned that

many employees in the regional offices who are now either making decisions on Gulf War veteran claims or are reviewing them for accuracy never received this training. As a consequence, Gulf War veterans, at least where the issue of quality of decision making on Gulf War veteran claims is concerned, may not be benefitting from VA's decision to redistribute Gulf War claims. Moreover, during site visits to numerous regional offices around the country, SIU investigators reviewed already-processed Gulf War veteran claims that had previously been validated as correct as part of the regional offices' quality assessment efforts since these claims were returned to them for processing. The SIU's investigators found inconsistent quality and numerous errors although these claims had already been validated as correct by the regional offices. Unfortunately, it does not appear that Gulf War veterans' claims are unique in this regard. VBA has recently identified an overall error rate of 36 percent in claims processed by VBA.¹⁴⁶ Because VBA employees stated to SIU investigators that they find Gulf War claims difficult because they are complex and involve many issues, the SIU believes that the error rate in Gulf War claims decisions is likely to be higher than 36 percent.

In view of these quality problems and the fact that each claim may also contain unaddressed issues that can be but may not have been inferred from the claims record, VBA's readjudication effort may create more problems than it solves if the ultimate result is large numbers of appeals to the Board of Veterans' Appeals (BVA). Additionally, when incorrectly processed claims are reviewed by the BVA, they may be remanded for correction to the regional offices where they originated. Appeals are easily the most expensive and labor-intensive component of VA's claims process.¹⁴⁷ However, the costs may be felt more by Gulf War veterans who must endure longer waits before receiving decisions on their claims. This may be especially true since early indications suggest that there may be a high remand rate on Gulf War veterans' claims¹⁴⁸ if they move into the appellate stage without adequate claims resolution. However, the SIU was unable to discern much interest in or efforts by or between the VBA and the BVA to plan for the possibility that many of the pending Gulf War claims may require remands. Much will depend on the Gulf War veterans' awareness about VA's claims process and motivation to pursue their claims at the appeal level in order to receive adequate resolution of their claims.

VA DOES NOT COMPLY WITH ITS OWN REGULATIONS AND POLICY DIRECTIVES

A primary role of the VA's Central Office is to develop regulations and policies that provide guidance as to what and how benefits and services are to be delivered to veterans. Policy makers and program administrators at the highest level in VA need to know if regional offices and medical facilities are actually implementing these instructions. The VA at the national level articulates well what must be done and what it is doing for Gulf War veterans with undiagnosed illnesses. Yet there is little evidence that these articulated policies are actually being implemented at the points where benefits and services are delivered to veterans: in regional offices and medical facilities.

Regional office personnel rely on thorough medical evaluations by VHA physicians in order to make decisions on veteran's compensation eligibility. Yet, all too often regional office personnel that

were interviewed by SIU investigators complained about the inadequacy of many medical evaluations and feel they have little influence over the inconsistent results of examinations. SIU investigators learned that examining physicians were able to conclude during a Persian Gulf Registry examination that a veteran had an undiagnosed illness. However, the same conclusion was not reached during an examination for compensation benefits, even though often both examinations are conducted by the same physician. Further, SIU investigators also found veterans' health records that listed "Gulf War Syndrome" or "Multiple Chemical Sensitivity" as a diagnosis upon completion of an examination for compensation benefits. However, VA does not recognize "Gulf War Syndrome" or "Multiple Chemical Sensitivity" as a treatment diagnosis for VA health care purposes or for compensation payment purposes. That this situation exists suggests that VA is not complying with its own definition of undiagnosed illnesses. It also suggests that VA is setting separate standards for the Persian Gulf Registry examination and the compensation examination to reach a determination that the veteran has an undiagnosed illness.

Another area in which the SIU identified significant failures on the part of the VA to follow its own regulations and directives is in the development and adjudication of inferred issues. As was mentioned earlier in this chapter, an inferred issue is a "sign or symptom" that is unrelated to a diagnosis which appears in the record but is not specifically articulated by a veteran as a claim for compensation.¹⁴⁹ In such situations, VA personnel reviewing a claim are required to consider the "sign or symptom" as if the veteran had specifically filed a compensation claim for that condition.¹⁵⁰ However, when SIU investigators examined Gulf War veterans' claims files at various regional offices, VA personnel in 16 out of 22 offices visited had failed to develop and adjudicate inferred issues. One regional office told SIU investigators that it is that office's policy that a veteran must specifically indicate that a claim is due to an undiagnosed illness or it will not be developed as such; this office consequently had never developed or adjudicated inferred issues in any Gulf War claims.

In addition to these problem areas, the SIU found numerous other failures on the part of the VA to follow its own regulations and directives. One of these involves the legal standards upon which claims for undiagnosed illness were denied. In some regional offices, VA personnel determined that veterans' claims for undiagnosed illnesses were not well grounded, meaning that they were not plausible or capable of being supported by proof or evidence.¹⁵¹ However, at a national training conference, VBA management personnel instructed that due to the unique nature of an undiagnosed illness and the difficulty in medically linking the illness to military service, Gulf War claims should be found well grounded in almost all cases.¹⁵² In addition, some undiagnosed illness claims that originally had been denied were again denied on re-review after the presumptive period's extension on the grounds that no new and material evidence had been submitted to support the claims. This is contrary to legal precedent holding that it is improper to employ a new and material evidence standard for issues in a veteran's claim that are being readjudicated under a liberalizing law (which in this case is the extended presumptive period during which a Gulf War veteran can qualify for compensation payments based on an undiagnosed illness).¹⁵³ Moreover, SIU investigators found upon review of Gulf War veterans' claims completed in the regional offices that compensation

decision makers failed to consider the veterans' symptoms under the undiagnosed illness regulation, even though the symptoms met the criteria for that consideration.¹⁵⁴ Additionally, VA personnel at some regional offices failed to conform to guidelines by prematurely adjudicating undiagnosed illness claims although the claims file had not been reviewed by the examining physician prior to completion of an examination nor had required specialist referral examinations occurred.¹⁵⁵ Based on this evidence, it appears that the VA's failure to comply with its own regulations and policies may be adversely affecting Gulf War veterans' abilities to qualify for the benefits Congress intended them to receive.

GAO's preliminary observations on medical care provided to Gulf War veterans are parallel to the SIU investigators' findings that VHA directives developed to make it possible for medical personnel to respond to the health care needs of Gulf War veterans are not being followed.¹⁵⁶ For example, VHA's Persian Gulf Registry directives list clinical procedures and policies to be followed in conducting physical examinations of Gulf War veterans and for ordering diagnostic studies to determine the scope of Gulf War veterans' illnesses. When the health registry examination process is completed and the veteran still has an illness that is undiagnosed, VHA directives state that the veteran should be referred for further evaluation to one of VA's four Gulf War Referral Centers located in Birmingham, Houston, Washington, D.C., and West Los Angeles.¹⁵⁷ Although VA directives are very specific as to what is required, the SIU learned that medical facilities across the country are confused over the directives to follow in assessing Gulf War veterans' health, when to do additional evaluations, and when to refer a veteran to a Gulf War Referral Center.

VHA directives establish that the health registry examination process be divided into two phases. Phase I is intended to serve as an opportunity to obtain a medical and occupational history from the veteran followed by a physical examination with additional diagnostic studies and tests conducted if needed. If at the end of the Phase I examination a Gulf War veteran still has an illness that is undiagnosed, a Phase II examination under VHA directives is required to perform supplemental laboratory tests and consultations.¹⁵⁸ Several Gulf War physicians told SIU investigators that they were confused over when to refer a Gulf War veteran to the second phase of the examination process. Other Gulf War physicians informed SIU investigators that they do not feel that the Phase II examination is necessary. Consequently, if some physicians do not understand the extent to which they are authorized to go in order to assess the health status of Gulf War veterans with undiagnosed illnesses, then some Gulf War veterans may not be receiving the level of medical attention required to overcome their health problems.

In testimony before the House Committee on Veterans' Affairs Subcommittee on Health, GAO reiterated that Gulf War veterans who do not receive a diagnosis after Phase II are to be referred for further evaluation at one of VA's four Gulf War Referral Centers. However, of the approximately 6,600 to 16,000 Gulf War veterans that VA reported as having undiagnosed illnesses, only about 500 have been evaluated at a referral center. Additionally, after a review of medical records and discussions with program officials, including physicians, GAO concluded that it did not appear that

VA's directives were being consistently applied by the medical facilities. For example, the GAO noted that physicians did not provide all of the tests to veterans that were called for in VA's guidance. Also, in several cases, the physician's diagnosis was simply a restatement of the veteran's symptoms.¹⁵⁹ These examples suggest that VHA's guidance to Gulf War physicians simply is not clear enough to result in proper compliance. When VHA physicians do not follow the medical protocols established to help them and Gulf War veterans understand the scope of the veterans' health status, then veterans are placed at greater risks of never receiving appropriate medical attention to overcome their illnesses.

INADEQUATE INTERNAL INFORMATION SHARING AT VA CREATES BARRIERS THAT HINDER EFFORTS TO DELIVER BENEFITS AND SERVICES

Communication problems between VA's Central Office and personnel in local facilities are pervasive across the country. These problems have yet to be adequately acknowledged or addressed at VA. The SIU's investigation indicates that VBA management program offices often do not communicate effectively with each other. VA Central Office program managers often do not communicate well with field level program managers; VA field level managers often do not talk to field managers in other regional offices. As discussed below, these failures to share important information and to collaborate based on that information contributes to an atomized approach to providing services which in turn fosters the frustration that Gulf War veterans often express in dealing with VA.

VA encourages Gulf War veterans to seek health care services and compensation benefits if they believe their health was adversely affected while serving in the military. For example, VA has held numerous public forums targeted at providing information to Gulf War veterans about VA services and programs available to them. However, Gulf War veterans seeking health care and compensation payments from VA are faced with two separate and distinct VA systems: the Veterans Health Administration, designed to provide health care, and the Veterans Benefits Administration, designed to provide compensation and pension benefits. The SIU's investigators determined that these two systems have not worked well together and that this lack of cooperation has an adverse impact on Gulf War veterans' ability to obtain both high quality health care and timely and accurate compensation decisions from VA.

A determination of service connection for a veteran's health problems often means more to that veteran than the ability to receive compensation payments. Such a determination means the difference between getting health care at VA medical facilities and not getting it, because veterans receive health care services from VA for conditions that are determined to be service-connected. The SIU, however, was not convinced that the VA fully understands this reality, since VA health care providers and claims processors do not share a common understanding of the process of determining whether a health condition is service-connected.

For example, the SIU found that Gulf War veterans are often confused over the relationship between the health care providers in VHA and the VBA regional office personnel deciding their compensation eligibility. When a Gulf War veteran elects to participate in the Persian Gulf Registry program, he or she undergoes a physical examination (including laboratory tests and specialist referrals where necessary) to determine his or her health status. If this same veteran has filed a claim for compensation, he or she often undergoes another physical examination (including laboratory tests and specialist referrals), again to determine that veteran's health status. Not only are these sometimes duplicative examinations, but the VA's failure to ensure that one examination will suffice for both Registry and claims processing purposes unnecessarily confuses the veteran. Some veterans believe that by participating in the Persian Gulf Registry program they are applying for compensation benefits. Some veterans also believe that by undergoing the Persian Gulf Registry examination they are fulfilling the requirement to undergo a compensation examination.

This confusion is easy to understand, since some portions of the examination, such as laboratory tests and specialist referrals, are identical, and the examinations often are administered by the same medical personnel. Often, there was a failure to understand that all veterans' health records are evidence to be considered in compensation claims. Officials at most of the medical facilities visited by SIU investigators stated that they do inform veterans about their possible eligibility for health care. However, SIU investigators found very inconsistent efforts among these facilities to inform Gulf War veterans about other benefits such as compensation that might be available to them, particularly when through Persian Gulf Registry examinations they are found to have undiagnosed illnesses.

SIU investigators interviewed the Veterans Registry Physician and Coordinator at each medical facility visited during the course of this investigation. Based on these interviews, it appears that many of these registry physicians and coordinators do tell the Gulf War veterans with whom they deal about their possible eligibility for compensation benefits. This may be attributed to the fact that approximately three-fourths of registry physicians interviewed also conduct or are responsible for compensation examinations. However, benefit information is not always provided to the Gulf War veteran in these situations. For example, one registry physician told SIU investigators that he feels that discussing benefits as part of a medical appointment distracts veterans from concentrating on how to improve their health. At least, however, at this physician's medical facility the letter sent to the veteran to summarize the results of the registry examination states that the Persian Gulf Registry examination does not automatically initiate a claim for compensation benefits. Further, the letter includes the address and telephone number of the nearest regional office from which veterans can receive assistance with filing compensation claims. The SIU found that while this may not be the optimal method of helping Gulf War veterans understand their potential eligibility to VA compensation benefits, it is a step in the right direction.

The SIU further found that the disconnect between the health care process and the compensation claims process begins at the highest level in VA, where personnel do not routinely or effectively communicate across organizational lines. One example occurred during a national

training program for regional office claims processors and decision makers. VBA Central Office's Director of the Compensation and Pension Service was asked at that meeting by the training program participants to take a leadership role in building a more cooperative relationship with the Department's health care officials in VHA. However, the Central Office official dismissed the suggestion and told the regional office staff present to work things out at the local level. With over 50 regional claims processing offices and hundreds of medical facilities, VBA management leaders have the opportunity to assert a much-needed leadership role in forging closer and more effective working relationships between VHA and VBA across the country. Instead, at least at the national training program just mentioned, VBA management has relinquished the opportunity to establish departmental policies that would apply to tens of thousands of VA employees nationwide and to increase cooperation, thereby making it more able to provide more efficient, higher quality service to Gulf War veterans. This lack of coordination from the top, compounded by conflicting local priorities at various VA facilities, make it more likely that Gulf War veterans will face unnecessary barriers to obtaining VA services during the very times when they need VA's help the most.

Communication problems in VA are not unique to the relationship between that agency's health care providers and its compensation experts. Communication problems can also be found in the relationship between Veterans Benefits Administration and the Board of Veterans Appeals, which functions as an appellate reviewer of compensation claim decisions made by the regional offices. However, BVA is not a separate entity like the Court of Veterans' Appeals, which provides judicial oversight of decisions made by the BVA. Instead, for example, the Chairman of BVA reports to the Secretary of Veterans Affairs and BVA employees are considered employees of VA. The BVA is viewed by many as an arm of VA since it shares resources with the rest of VA and already works with the VBA and its regional offices on many levels. Nevertheless, the SIU believes BVA can continue to provide an independent appellate review of VBA decisions while cooperating more in facilitating consistent quality service of Gulf War veterans.

However, BVA's internal resistance to cooperation is evident in the relationships between the BVA and other components of VA. For example, there has been little cooperation between the BVA and VBA to date on how to best handle the unique problems posed by Gulf War veterans' claims, especially on the subject of undiagnosed illnesses. Extensive policies and procedures have been developed by VBA, based on the applicable statutes and implementing regulations, which govern the adjudication of Gulf War claims. It would make sense that if a veteran disagrees with how his or her claim was adjudicated by a regional office and appeals to the BVA, the BVA would examine the veteran's claim, ensure that the regional office complied with all applicable laws, rules and policies, and apply these criteria in rendering its appellate decision. However, this is not always the case. In response to questions for the record from the SIU, the BVA asserted that it "is not bound by VBA manuals" nor to "Department manuals, circulars, or similar administrative issues, including VBA-VHA memoranda" in making decisions on appeals.¹⁶⁰ In practice, this means that Gulf War veterans encounter one set of rules and policies when their claims are adjudicated by the regional

offices on the merits and a different, not necessarily consistent, set of policies and rules when they seek appellate review by the BVA.

As has been discussed already, there is a higher remand rate for Gulf War veteran undiagnosed illness claims than for the overall body of all claims appealed to BVA.¹⁶¹ This disparity in remand rates may be caused at least in part by the differing standards applied by regional offices and by BVA. The BVA attempted to explain the high remand rate by stating that "anecdotal evidence suggests that the [sic] many of these claims had to be remanded because the regional offices had not yet had an opportunity to review the claims under 38 C.F.R. § 3.317 [the regulatory authority for undiagnosed illness]."¹⁶² However, it is questionable how Gulf War veterans' claims could reach the BVA without the standards of § 3.317 being applied given that this regulation dates back over three years to February of 1995. Based on SIU investigators' review of over 125 BVA decisions written from January 1995 to August 1997, the SIU concludes that the BVA is not applying the rules that VBA applies and can find no justification for this state of affairs to exist.

The SIU also found that a lack of information sharing within VHA has resulted in less than could be done to systematically follow-up on the medical care VA already has provided to Gulf War veterans. Others have raised this same concern and have criticized VA for not monitoring the treatment provided to Gulf War veterans. For example, in June 1997, GAO reported that VA did not have a mechanism for monitoring the quality of Gulf War veterans' care or their clinical progress after their initial examination. The report recommended that VA (as well as DOD) develop and implement a plan to monitor the clinical progress of Gulf War veterans in order to help promote appropriate and effective treatment and provide direction to the research agenda.¹⁶³ In response to GAO's recommendation, VHA leaders in Central Office suggested to medical personnel in the field that perhaps a case management approach to Gulf War veterans' medical care might improve the ongoing medical services provided to these veterans. Because case management would mean that a limited number of medical personnel would be responsible for following the medical care provided to Gulf War veterans, VHA encouraged its field personnel to employ this mechanism to ensure appropriate treatment is provided to Gulf War veterans when needed.

Unfortunately, SIU investigators observed (as has GAO) that nearly all of the VA medical facilities visited during this investigation made little or no effort to follow-up on the care they provided to Gulf War veterans.¹⁶⁴ Only two of the thirty-four VA medical facilities SIU investigators visited as part of this investigation utilized case management as an approach to following the Gulf War veteran's medical care. All other facilities visited did not use a case management approach to health care but rather assigned Gulf War veterans as a routine matter to the first available primary care group. Less than half of the medical facilities inspected assigned veterans routinely to primary care. One medical facility assigned all Gulf War veterans seeking a Persian Gulf Registry examination to primary care. However, if the primary care physician at that facility is not satisfied with the patient's progress, the veteran is referred to the medical facility's specialty clinic for Gulf War veterans. Although these other approaches may work in some instances, they do not ensure that the

primary care physician has been trained or is familiar with the specific health care needs of Gulf War veterans. Additionally, referral to a specialty clinic does not necessarily mean that treatment outcomes will be systematically collected and analyzed by others who may be providing medical care to the veteran.

INADEQUATE IMPLEMENTATION OF SERVICES AND BENEFITS FOR GULF WAR VETERANS

Based on the results of this investigation, it seems clear that VA must do a better job at planning and allocating the resources needed to adequately respond to Gulf War veterans' needs. To VA's credit and as was discussed earlier, since 1991 VA leaders have established priorities to facilitate the delivery of VA health care services to and disability claims processing for Gulf War veterans. This action was essential to respond to growing concerns over Gulf War veterans' health problems and the potential link between their health concerns and events or exposures during the Gulf War. However, the gap at VA between good intentions and real action quickly became apparent as increasing numbers of Gulf War veterans fell ill and sought the priority treatment from VA that they had been promised. As discussed below, the shortfalls in delivery of services to Gulf War veterans that have occurred since VA declared these veterans to be one of VA's top priorities are attributable to an early and ongoing failure to adequately plan for or fund Gulf War veteran programs.

Regional office personnel who are tasked with implementing programs established by VBA management to serve Gulf War veterans find that they are at times struggling between policy implications and practical realities. For example, VA policy requires a follow up examination be done on Gulf War veterans within 24 months of their last examination of record in claims where service connection has been awarded for an undiagnosed illness.¹⁶⁵ Regional office personnel expressed to SIU investigators uncertainty as to what to do when a Gulf War veteran's service-connected undiagnosed illness is later labeled with a known clinical diagnosis. Although VA regulations provide for the termination or reduction of benefits in such a situation,¹⁶⁶ regional office personnel stated to SIU investigators that they anticipate much resistance from veterans if their compensation payments are reduced or taken away altogether. Personnel at the regional offices have indicated to SIU investigators that VBA Central Office needs to enunciate a definitive policy in this area in the near future to avoid unnecessary hardships to Gulf War veterans and to guide regional office personnel who are helping those veterans. As of the writing of this report, the SIU was unable to ascertain whether Central Office personnel have provided guidance to regional office personnel on this issue.

Another example of a shortfall in implementing a program to ensure that Gulf War veterans receive the compensation benefits they deserve is demonstrated in the high remand rate evident in Gulf War claims that were appealed to the BVA during the period from January 1, 1995, through June 30, 1997.¹⁶⁷ As discussed earlier in this chapter, the BVA has indicated that it had to remand many Gulf War veterans' compensation claims to the regional offices because of a failure to review

the claims under the undiagnosed illness criteria. Some of those remands were necessary in order to give Gulf War veterans an opportunity to have their compensation claims reconsidered by the regional offices because of revised undiagnosed illness criteria that became effective in February of 1995, after their claims were sent to the BVA. However, it is unclear why regional offices are still referring Gulf War veterans' compensation claims without first considering the claim under criteria that has been in effect for over three years and identifying all claimed and inferred issues in the record. VA must ensure that the undiagnosed illness criteria that are already in place and any new regulations applicable to Gulf War veterans' claims are considered by the regional office decision-maker prior to forwarding the claims to the BVA.

The SIU is also concerned about another quality issue involving Gulf War veterans' compensation claims. VBA management delayed until February 1998 before conducting the first quality review of Gulf War claims since ordering redistribution of these claims to regional offices in May of 1997. Thus, regional offices were left to adjudicate these claims for many months with no oversight by the Central Office to evaluate the accuracy of decisions being made in these cases. Although all the regional offices had been conducting their own quality review of Gulf War claims during this time at the direction of VA's Central Office, the SIU's investigation found that those quality review programs often are ineffective and inaccurate.¹⁶⁸ A possible explanation for the ineffective and inaccurate quality review programs at the regional offices may be that they were operating without the basic technical expertise that Central Office oversight reviews would have provided. Additionally, without VBA management oversight, the regional offices could not know what, if any, resources needed to be allocated to the Gulf War program during this time, particularly to achieve the processing benchmarks they were instructed to achieve.

The administration of health care services at VHA has similar deficiencies that result in less than optimal service to Gulf War veterans. The entire Gulf War veterans health program in VA Central Office is the responsibility of only a few people who are also charged with other important VA health care issues such as VA's Agent Orange programs for Vietnam veterans and their children. Admittedly, personnel in any organization are often responsible for a myriad of assignments. In the case of Gulf War veteran programs, assigning too few personnel with too many conflicting priorities to implement them is not consistent with the priority placed upon these programs by VA and provides little flexibility to appropriately address emerging issues. Inevitably, conflicting priorities place strains on a small staff to the extent that some functions are not done well or simply not done at all.

VHA's response to DOD's announcement of the presence of chemical weapons at the Khamisiyah site, discussed in Chapter One, also demonstrates how implementing aspects of Gulf War veterans health programs from VA Central Office may not always receive the level of attention they merit. In July of 1997, SIU investigators were briefed jointly by DOD, CIA, and VA on the results of their plume modeling analyses of the possible release of nerve agent at the Khamisiyah site. At that meeting, VA officials responded to questions about DOD's release of a letter notifying over 100,000

service members of their potential exposure to some low level of nerve agent after the Khamisiyah incident. They said that background information on the incident would be sent to all VA medical facilities. Since many of these 100,000-plus service members are now veterans, this information would seem to be crucial for fully informed medical histories should these veteran seek medical services from VA for symptoms that they believe might be associated with nerve agent exposure. However, during site visits by SIU investigators to 34 VA medical facilities, only one physician acknowledged receipt of the information. The other physicians told SIU investigators that they learned about the letters from veterans themselves, and many indicated they were embarrassed not to have had advance notice from VHA of the letters. The information may have been sent to all VA medical facilities and for some reason did not reach the health care providers treating Gulf War veterans. However, this example suggests that the demands on the VHA Central Office staff responsible for Gulf War veterans' health care issues may be too great to ensure that health care information pertinent to Gulf War veterans is widely distributed at the service delivery level.

VA HAS UNDERESTIMATED WHAT IS NEEDED BY ITS VETERANS REGISTRY PHYSICIANS TO DELIVER PRIORITY HEALTH CARE SERVICES TO GULF WAR VETERANS

At each medical facility across the country, VA has designated a Veterans Registry Physician to be responsible for oversight and coordination of the medical aspects of the Persian Gulf Registry program, particularly in providing medical examinations for Gulf War veterans who participate in the registry. However, the SIU learned that non-physicians were conducting registry examinations at many of the medical facilities visited by SIU investigators. At nine medical facilities visited by SIU investigators, non-physicians (in particular, physician assistants and nurse practitioners) conducted registry examinations. At another medical facility, the Veterans Registry Physician did not know who was doing the examinations. Although all of the Veterans Registry Physicians interviewed by SIU staff indicated they reviewed the results of the examinations completed by non-physicians, a review of the clinical records indicated that examinations done by non-physicians were not consistently countersigned by the Veteran Registry Physician as required by VHA directives.

There are many possible reasons why examinations conducted by non-physicians were not approved and countersigned by the Veterans Registry Physician. First, 32 of the 34 Veteran Registry Physicians interviewed by SIU investigators stated they were assigned additional duties ranging from as little as two to as many as seven assignments, including the Agent Orange Registry Program, Ionizing Radiation, and compensation examinations. On average, responsibilities in four additional areas were assigned to Veterans Registry Physicians. Many of the Veterans Registry Physicians and Veterans Registry Coordinators interviewed by SIU investigators stated that their local medical facilities allotted them four hours per week, or about 10 percent of their time, to perform Gulf War related work. To keep pace with the Gulf War priorities, some of the Veterans Registry Physicians and almost all of the Veterans Registry Coordinators stated that they work extra hours or take work home without any additional salary or compensation. Thus, it is possible that Gulf War veterans may

not be getting priority health care because the physicians responsible for these veterans' care have many other duties that exceed the time available to fully address them all.

TRAINING TO VETERAN REGISTRY PHYSICIANS IS UNEVEN

It is fundamental that adequate training enhances an individual's ability to master assigned tasks. To encourage this, the VA's Office of Inspector General recommended in December of 1994 that VHA provide education and relevant in-service training seminars to VA employees who deal with Gulf War-related issues.¹⁶⁹ VHA responded to this recommendation by stating it was in the process of developing a series of annual medical education seminars for VA health care staff who provide care for Persian Gulf veterans. These seminars are designed to provide updated, state-of-the-art information on specific health issues and topics related to diseases endemic to the Persian Gulf area.¹⁷⁰

VHA did develop and provide three national training programs—in Baltimore, Maryland in 1995 and in Long Beach, California in 1996 and again in 1997—targeted for clinical staff who are responsible for conducting Persian Gulf Registry examinations. However, SIU investigators discovered from interviews with officials at the medical facilities they visited that only about half of those interviewed who did these examinations have attended any of the training programs. In attempting to understand why these physicians are not receiving national training, SIU investigators were told that local managers believed the individuals attending the national training seminars would share the information obtained at those training seminars with the Veterans Registry Physicians. Unfortunately, this did not always occur, leaving some Veterans Registry Physicians without the latest medical information available within the VA health care system for treating Gulf War veterans. The VA, and certainly Gulf War veterans, would benefit if all personnel responsible for providing health care services to Gulf War veterans are informed and fully trained on the health issues arising from military service in the Gulf War.

VA'S NATIONAL LEVEL PROGRAM MANAGERS DO NOT EXERT SUFFICIENT OVERSIGHT OF IMPLEMENTATION OF GULF WAR VETERAN PROGRAMS AND SERVICES

VA's Central Office establishes rules and policies to ensure proper administration of its programs by VA claims processing offices and medical facilities. At the same time there is also a trend within VA towards decentralization of power and authority over program administration. This approach may have some merit. However, the SIU found that VA Central Office program managers do not have ultimate control over implementation of priorities in the programs for which they are responsible. Instead, they must compete with field managers who have their own priorities in program implementation. Consequently, Gulf War veteran programs, like many others at VA, operate in an environment that fosters competition instead of cooperation within the agency. In turn, the delivery of health care services and compensation benefits to Gulf War veterans is inconsistent across the country and the national focus on making all Gulf War veterans a priority has suffered. Examples of

inconsistent delivery of services described earlier in this chapter include Gulf War physicians' understanding of when to conduct Phase I and Phase II Persian Gulf Registry examinations and when to refer a Gulf War veteran with an undiagnosed illness to a VA Gulf War Referral Center. Additionally, as discussed below, the quality of decisions made by regional office decision-makers across the country represents inconsistent delivery of compensation benefits to Gulf War veterans. In reviewing completed decisions on compensation claims filed by Gulf War veterans, SIU investigators found an error rate ranging from no errors to as high as 90 percent of those claims. These noted deficiencies in delivering health care and deciding compensation claims for Gulf War veterans implies that VBA management has not exerted the level of oversight of program administration and implementation that it should in order to properly implement programs for Gulf War veterans.

Quality assessment reviews of decisions made in Gulf War veterans' claims for compensation reflect deficiencies in implementing program policy. In order to ensure compliance with Gulf War laws, regulations, and policies concerning Gulf War veterans, each regional office is required to conduct a monthly quality review of Gulf War claims and to file a report of the results with VBA management. However, the SIU's review of monthly quality review reports showed that these reports do not appear to be designed to provide the information that Central Office needs in order to ensure that the regional offices are complying with those laws, regulations, and policies. For example, at approximately 90 percent of the regional offices where SIU investigators reviewed completed claims decisions during their site visits, significant errors were found in a large number of those decisions even after they had been quality reviewed by regional office personnel.

Slightly more than half of the regional office personnel conducting the quality reviews stated they had not had training specifically given by VA for Gulf War claims processing. From SIU investigators' observations that quality reviewers are missing errors in the claims they review, the SIU believes it likely that the monthly quality review reports being forwarded to Central Office do not accurately portray the type or quantity of errors that are being made in these claims. In addition to the questionable validity of the information they contain, the quality review reports themselves vary greatly in their level of detail and usefulness. For example, SIU investigators were shown quality review reports at some regional offices that provide a narrative describing specific errors found in each case. Other offices' quality review reports merely indicate whether an error was found in a claim without expounding on the exact nature of the error. Thus, it appears that VBA management's reliance on the monthly quality review reports to ensure that the regional offices are complying with laws, regulations, and policies regarding Gulf War claims is unwise. Likewise ill-advised is VA's reliance on those reports when allocating resources to ensure that Gulf War veterans are provided with priority service.

GULF WAR VETERANS ARE DISSATISFIED WITH VHA'S SERVICE DELIVERY

During the course of this investigation, the SIU saw indications that many veterans may not be satisfied with the quality of health care they receive from VHA. In May 1995, the GAO, after reviewing the health concerns of Gulf War veterans from the 123d Army Reserve Command, reported that many of these veterans were dissatisfied with VHA's delivery of health care to them. Certain members of this Army Reserve Command first reported health concerns in February 1992, a year after the ground war in the Gulf.¹⁷¹ The GAO testified in June of 1997 before the House Subcommittee on Health of the Committee on Veterans Affairs that, based on new input from a limited set of Gulf War veterans, those veterans appreciated the efforts of individual VHA staff but are frustrated with the "system."¹⁷² The GAO noted that veterans continued to cite such problems with VHA as delays in getting service, unsympathetic attitudes of some health care providers, the cursory nature of registry examinations, poor feedback and communication with health care personnel, and a lack of post-examination treatment. This testimony also noted that veterans stated that they expected VHA personnel would (1) schedule the registry examination and tests in a timely manner, (2) listen to them describe their symptoms, take their concerns seriously, and perform all needed tests and evaluations, and (3) discuss test results with them as well as the need for further tests and treatment. However, the veterans complained that they experienced delays in getting the registry examinations and follow-up testing, received little personal counseling and, based on form letters received, felt that some of the VHA physicians they encountered believed nothing is wrong with them.

SIU investigators interviewed a number of Gulf War veterans during the course of this investigation about the health care they received from VHA.¹⁷³ In those interviews, veterans verified GAO's findings in their repeatedly-expressed dissatisfaction with VHA health care. These Gulf War veterans reported that VHA health care providers ignored them when they discussed the possible effect of various exposures they had experienced during their service in the Gulf War. Some Gulf War veterans report that health care providers at times have told them that their health problems are "all in their heads." Although some Gulf War veterans praised the VHA medical staff they have had contact with, more often these veterans reported that they often do not get timely or adequate feedback on their examinations and medical personnel often are unresponsive to their requests for information. Though the veterans' opinions expressed to GAO and to the SIU investigators reflect only those veterans' own experience, they strongly suggest that many Gulf War veterans being served by VHA are not satisfied with the care they receive.

VA DOES NOT MAINTAIN ADEQUATE INFORMATION SYSTEMS TO ACCURATELY TRACK IMPORTANT DATA REGARDING GULF WAR VETERANS

As previously mentioned in this chapter, the SIU found that information contained in VA data systems is inaccurate, inconsistent, and unreliable. VA utilizes various information sources to collect data concerning benefits and services for Gulf War veterans. Some of these sources contain

data specific to disability claims while others contain data relating to the Gulf War Health Registry. Other databases contain military service information, clinical care information and other miscellaneous data.

One example of VBA's generation of inaccurate data is the Gulf War Readjudication Weekly Report. This weekly report, compiled and distributed by VBA Central Office, contains information concerning Gulf War claims readjudicated due to the extended presumptive period for undiagnosed illnesses. The report indicates the number of readjudicated claims completed and still pending a decision for each regional office as well as the nationwide total. The number of readjudication claims pending decision is given twice, representing the number of claims pending a decision as reported by the regional office and the number of claims pending a decision in VBA's work-in-progress system. The numbers should theoretically match but do not. (An example of these Weekly Reports can be found at Appendix V.)

Another example of an inaccurate database at VA involves the Persian Gulf Registry program. Legislation mandated that VA establish a national data base to collect relevant personal and medical health care information on Gulf War veterans who participate in the Persian Gulf Registry program.¹⁷⁴ However, not only has VA failed to comply with the statutory requirement to develop a comprehensive national data base for Gulf War veterans, but record keeping at the medical facilities is in a state of disarray. In 1994, the VA Office of Inspector General (OIG) discovered that VHA was not accurately capturing in the Persian Gulf Registry the information that was mandated by law to be included.¹⁷⁵ VHA responded to that OIG report by stating that it believed itself in compliance with the statute.¹⁷⁶ However, VHA committed to working closely with VBA leaders to develop a reporting procedure to ensure that Gulf War veterans who have submitted applications for benefits are enrolled on the registry and that they would establish a task force to oversee the process and ensure compliance with the law.¹⁷⁷ Although the OIG responded that they considered the issue to be resolved, it expressed serious doubts as to the ability of a task force to provide consistent guidance and oversight to a program as complex and far reaching as the Gulf-War program.¹⁷⁸ As of the writing of this report, neither a reporting procedure to ensure that Gulf War veterans who have submitted applications for benefits are enrolled on the registry nor establishment of a task force to oversee the process and ensure compliance with the law had occurred.

Additional problems with VHA's data bases were noted by SIU investigators during an inspection tour of VA's Austin (Texas) Automation Center (AAC). SIU investigators were informed that the Persian Gulf Registry data was actually held at the AAC in three separate computer files. AAC personnel informed SIU investigators that they were unsure what relationship, if any, the three files had with one another. No effort has been made to combine the three files although AAC staff indicated that consolidation of the three files would help bring them VA into compliance with the mandates required by law to maintain a national data base.¹⁷⁹

Given these defects, VA needs to make it a top priority to remedy the defects in its information collection and management processes for Gulf War veteran data. In addition to complying with legislative requirements, it should commit to a goal of maintaining a level of data integrity consistent with that of data systems operating under generally accepted accounting principles. Data systems that support decisions involving adjudication performance, workload issues, and quality of decision making should be subjected to annual rigorous audit and certification procedures just as financial databases are regularly reviewed.

VBA DOES NOT ADEQUATELY UTILIZE ITS QUALITY ASSESSMENT TOOLS TO OVERCOME KNOWN DEFICIENCIES

Because of concerns about potential troop exposures to environmental hazards during the Gulf War and the growing numbers of Gulf War veterans who have undiagnosed illnesses, the VBA made efforts to develop specific expertise to decide compensation eligibility for these veterans. However, the area processing offices operated without adequate oversight of the accuracy of the decisions they made affecting Gulf War veterans until late 1995. VBA Central Office completed the first in a series of quality reviews of Gulf War veterans' compensation claims in November 1995 involving approximately 200 claims from the four area processing offices. Several more reviews followed within the next two years. (At the time this report was written, another review of 100 claims was in progress and the results were unknown.) The results of the first review were reported to the area processing offices for the purposes of correcting the claims that had errors and to use the information in future training.

After Gulf War veterans' claims were redistributed from the area processing offices to the regional offices, regional office personnel began conducting quality reviews of Gulf War veterans' claims that were processed by the regional office. SIU investigators chose the same claims to review on their visits to the regional offices that were previously subjected to the VA's quality review process. The intent in adopting this approach was to examine claims which were selected by the regional office personnel themselves so as to avoid any appearance of bias as to which claims were chosen. Moreover, since the claims had already been subject to a quality evaluation by the regional offices, they should have represented the best decisions at those regional offices. Of the 200 claims that SIU investigators reviewed, 75, or 38 percent, had errors. However, quality reviewers nationwide in 1997 found an average of almost 22 percent errors. Of the stations reporting the results of their quality reviews, 31 percent found no errors in the Gulf War veterans' claims they processed.¹⁸⁰

The most common errors found by the SIU's investigators were failure to obtain statements from lay persons and medical professionals identified by the veteran, failure to address inferred issues, and failure to note that no VA examination was conducted. All of the issues are required by law to be addressed.¹⁸¹ Of the 22 regional offices where SIU investigators conducted an assessment of quality reviewed claims, no errors were found at only two stations, less than ten percent of the offices visited.

Even in two regional offices that were formerly Gulf War claims area processing offices, SIU investigators discovered that of ten quality-reviewed claims, one office had three errors out of ten claims and the other office had six errors out of ten claims. Further, in conducting a random review of eleven claims involved in the Central Office quality review last September, investigators found two errors. In comparison, on average 31 percent of the regional offices are self-reporting to VA's Central Office each month that their internal quality reviews reveal no errors. Five regional offices reported no errors for the entire four months of reports that the investigators examined.

The error levels identified by SIU investigators have been communicated to VBA management, yet the SIU can find no evidence that steps have yet been taken to remedy this situation. The SIU is gravely concerned that error rates continue to occur regularly yet are not detected or corrected at the working level and on review are not addressed. VA's inability to respond to claims processing problems when they are discovered has been the subject of concern to other entities reviewing the agency as well. For example, last year the National Academy of Public Administration released a report on VA's adjudication processes which contained findings similar to those found in this investigation such as the lack of a cooperative working relationship between Veterans Benefits Administration and Board of Veterans Appeals, lack of accountability within VA's leadership, and a high error rate that is not addressed in VA.¹⁸² This failure to detect or correct errors does not inspire confidence in VA's ability to monitor itself in its implementation of Gulf War veteran programs or to make changes in that program when problems are evident.

VHA EFFORTS AT QUALITY ASSURANCE ARE NOT ALWAYS SUCCESSFUL

VHA has undertaken several efforts to assess the quality of the services provided to Gulf War veterans, but they are not always effective. In response to a VA Office of Inspector General's recommendation,¹⁸³ VHA developed the Persian Gulf Registry Examination Program—Quality Management/Self Assessment Monitor for use as a quality management tool for conducting reviews of Gulf War veterans' medical records. Its purpose is to assess and monitor the appropriateness of medical care being provided in accordance with the medical protocol developed by VA medical personnel to ensure consistency in medically diagnosing illnesses of Gulf War veterans.¹⁸⁴ Using this quality monitor, VHA conducted a pilot study at one of its medical facilities and found this quality assessment tool helpful in identifying areas of compliance and noncompliance with Gulf War program requirements. For example, for this study VA medical records were reviewed to determine if the medical personnel conducted the examinations required under the Persian Gulf program and if the records were accurately documented. The study showed that the medical facility was in 90 percent compliance with the requirement to record in the Gulf War veterans' VA health records the results of laboratory blood work-ups but was in 100 percent noncompliance for completion of a breast/gynecology examinations for female Gulf War veterans. (See Appendix X of this report for results of the review of this pilot study.) Subsequent to this pilot study, VHA exported this quality

assessment tool to all medical facilities for the purpose of establishing a unified, nationwide quality assessment program. The analysis of VHA's quality assessment program has not been made available to the SIU for review to determine if the national program is meeting the compliance standards developed by VHA to meet the needs of Gulf War veterans.

Another quality assurance tool designed to help VHA assess the quality of health care services provided to Gulf War veterans is the Service Evaluation and Action Team (SEAT). The SEAT was established in each Veterans Integrated Service Networks (VISN) to enhance VHA's responsiveness to patient needs and service satisfaction. According to the VHA directive that established the program, the SEAT was also intended to provide a mechanism for each VISN office to continually assess opportunities to improve the effectiveness of the clinical programs and to respond to veterans' concerns. In addition, the SEAT was intended to enable VA managers at the medical centers and VA Central Office to identify trends in customer concerns and complaints.¹⁸⁵ This same directive noted that the SEAT is to obtain information on national and local customer satisfaction surveys, the patient representative tracking program, veterans, veteran service organizations, helpline inquiries, and quality improvement programs. Each VISN SEAT Chairperson is encouraged to process this aggregate information and submit a consolidated quarterly report to their VISN Director, with a copy to VHA Central Office.

The SIU's staff reviewed the most recent SEAT reports submitted to VHA Central Office. That review uncovered several problems ranging from VISN offices simply not filing the report to omission of any analysis of problems identified as required by the VHA directive. It is difficult to see how VHA can accomplish its stated goals, such as identifying and following trends, with the incomplete and inconsistent information it is currently receiving. To become an effective tool for measuring the quality of health care services delivered to Gulf War veterans, and eventually to other veterans, VHA Central Office needs better information to fully assess the concerns raised by Gulf War veterans. Furthermore, to meet the SEAT objectives, Central Office managers need information that is complete and consistently recorded and includes an analysis of problems and how to solve them. Without this information, VHA leaders cannot identify problems and make needed changes to the care delivered to Gulf War veterans.¹⁸⁶ Thus, although VHA and VBA Central Office have initiated several efforts to assess the quality of the services provided to Gulf War veterans, it does not appear that personnel in the field understand and utilize the tools available to accomplish this important goal.

CONCLUSION

Many individual VA employees, particularly those who deliver VA services and benefits, are clearly dedicated and deeply committed to serving Gulf War veterans as effectively and efficiently as possible. However, this investigation has identified serious problems as to how VA as a whole is implementing programs to make this happen.

It is not clear that VA is addressing the priorities it articulates. This is evident from how information is handled and generated in VA. It is especially true for information that forms the basis for policy decisions affecting the delivery of health care services and compensation benefits to Gulf War veterans. More can be done to understand the needs of Gulf War veterans which, if viewed as a whole, could lead to a fuller understanding of the scope, nature, and causes of their health problems. Unless VA addresses its fragmented approaches to health care service and benefits delivery, and acts as the "One-VA" that it claims to be, Gulf War veterans may never succeed at getting their questions answered and receive the health care treatment and compensation benefits they deserve.

The lack of coordination between VA's health care system and compensation claims process must be addressed forthwith, for Gulf War veterans with undiagnosed illness now are caught in a web created from VA's organizational shortcomings. Although there is but one definition of "undiagnosed illness" in VA's regulations, when it is applied in the context of Persian Gulf Registry and compensation examinations all too often veterans receive different outcomes. The frequent consequence is denial to ill Gulf War veterans of deserved compensation benefits and eligibility for health care. VA decision makers need to ensure that the laws and policies established to provide Gulf War veterans with health care and compensation are consistently applied to avoid this result.

Finally, VA's top leadership must be held accountable for the programs they are obliged by law to administer. They set priorities and develop the policies to achieve them. This investigation found repeatedly that policy makers and program managers at the highest level in VA do not know if personnel in the medical facilities and regional offices are implementing VA's own regulations and policies. When VA does learn of problems with implementing policies and regulations through quality assessment efforts or through legislative oversight, effective long term corrective programs are not established. These shortcomings must be corrected if VA is to fulfill its commitment to Gulf War veterans. Gulf War veterans deserve no less from the department that exists solely for them and for other veterans who have served their country.

RECOMMENDATIONS

1. A new Assistant Secretary at the Department of Veterans Affairs should be created with responsibility for overseeing programs for addressing battlefield illnesses and other health issues that arise in connection with past and future deployments. Among this official's responsibilities would be oversight and coordination of research, treatment, and compensation efforts in this area.
2. The Secretary of Veterans Affairs should create in each of VA's Veterans Integrated Service Networks a working group on Gulf War illnesses that should meet at least quarterly to provide input on implementation of VA health care and compensation programs for Gulf War veterans. Members should include Gulf War veterans, veterans advocates and representatives

from veterans service organizations, VA Persian Gulf physicians and coordinators, and senior Veterans Health Administration and Veterans Benefits Administration officials whose responsibilities include implementation of these programs.

3. The Secretary of Veterans Affairs should direct development of a consolidated examination protocol for Gulf War veterans that can be used both to determine eligibility for service-connected disability compensation and provide necessary data for participation in the VA's Persian Gulf War Registry program.
4. The Secretary of Veterans Affairs should utilize team and case management approaches to serving Gulf War veterans with undiagnosed illnesses so that claims processors and health care providers jointly participate in and provide input to service-connected benefits eligibility decisions.
5. The Secretary of Veterans Affairs should require all Veterans Health Administration medical facilities to provide information to Gulf War veterans on how to apply for compensation benefits when they communicate to those veterans the results of their Persian Gulf Registry examination. All Veterans Benefits Administration regional offices should be required to provide Gulf War veterans with information on how to participate in the VA's Persian Gulf Registry program when they communicate with those veterans on compensation claims they have filed.
6. The Secretary of Veterans Affairs should expand the current Persian Gulf Registry to fully comply with the requirements for a Gulf War veteran national data base that was mandated by Congress in the Veterans Health Care Act of 1992.
7. The Secretary of Veterans Affairs should develop and implement joint training programs for compensation claims decision makers, examining physicians, Board of Veterans' Appeals decision makers, and others who coordinate or administer Gulf War veterans programs to ensure a common awareness and understanding of programs and activities involving unexplained illnesses.
8. Quality assessment of Gulf War veterans' compensation claims at the Department of Veterans Affairs should be conducted and validated by expert teams drawn from the Compensation and Pension Service, the Board of Veterans Appeals, and the Office of General Counsel. The Secretary of Veterans Affairs should implement and monitor corrective action.
9. The VA Office of the Inspector General should undertake a comprehensive assessment of VA medical facilities' compliance with Veterans Health Administration Central Office health care policies and programs on Gulf War veterans and monitor corrective action taken.

10. The Secretary of Veterans Affairs should contract with an independent scientific body, such as the National Academy of Sciences, to provide an ongoing review of the scientific literature to assess the nature of associations between illnesses and exposure to toxic agents and environmental or other wartime exposures as a result of service in the Persian Gulf War for purposes of determining a service connection relating to such illnesses.

3

EVALUATION OF WARTIME EXPOSURES, GULF WAR VETERAN HEALTH CONCERNS AND RELATED RESEARCH, AND UNANSWERED QUESTIONS

INTRODUCTION

This chapter examines health and science aspects of the question: "Why are Gulf War veterans ill?" and highlights some of complexities around this issue. It begins with health-related decisions made before the 1990 deployment to Southwest Asia, continues with a review of health events of importance during the deployment, and concludes with a review of developments in the eight years since the Gulf War. This chronological perspective is an important one, as events during the time leading up to the deployment have ultimately affected the ability of scientists, researchers, and physicians to examine potential causes of illnesses among Gulf War veterans. Problems such as inadequate information about the range and extent of troop exposures, missing health records, and limited health screening seriously hinder the ability to conduct scientific research that can provide clear answers to why Gulf War veterans are ill. This chronology of events provided insights and observations into how DOD and VA fell short in their attempts to best protect the health and treat the illnesses of Gulf War veterans.

HEALTH ISSUES PRIOR TO THE GULF WAR DEPLOYMENT

BACKGROUND ON THE MILITARY HEALTH CARE SYSTEM'S ROLE IN MAINTAINING TROOP HEALTH

An understanding of the military health care system's role in monitoring and protecting troop health is important to identifying pre-deployment factors that may have affected the health of Gulf War veterans. Military medicine differs from medicine practiced in the civilian context in several ways. For example, military physicians often care for service members as a group and are responsible for that group's health as part of a military mission. They also are responsible for providing health information to commanders that is relevant to operational decisions. Such operational decisions can

have a specific health focus while advancing a military goal. For example, vaccinations or medicines may be administered on a mandatory basis to service members to protect them against an identified threat. Because a key aspect of such decisions is how they may affect these troops' health in the future, military physicians also need to ensure that detailed and accurate records are kept to document the implementation of these decisions.

The military's medical system also needs to ensure that all troops—whether on active duty or in the reserves—are healthy and ready to deploy rapidly to war or conflict situations by providing troops routine physical examinations, regular preventive care, and medical care when ill. The military medical system also employs aspects of preventive and occupational medicine to monitor troop health, reduce disease and, where possible, prevent injuries and deaths. Examples of these functions are educating troops on how to minimize potential health risks from exposure to toxic substances on the battlefield, conducting environmental sampling and using that information to minimize troop exposure to toxic compounds, and providing protective clothing and equipment. Although military medicine made efforts to monitor and protect troop health, the Gulf War experience shows that it could have done far more for that deployment. In the future, the efforts of the military medical system in this regard should be expanded and more rigorously implemented.

PRE-DEPLOYMENT MEDICAL EFFORTS TO PROTECT AGAINST BIOLOGICAL AND CHEMICAL WEAPONS THREATS

One way in which medical and operational decisions overlapped during Gulf War planning was in efforts to protect troops against likely chemical and biological weapons threats that could have resulted from battlefield encounters with Iraq. To help protect U.S. troops against this threat, the Secretary of Defense, in consultation with military physicians and health policy planners, decided to vaccinate some troops against the biological weapons agents anthrax and botulinum toxin, as well as to administer a medication, pyridostigmine bromide (or PB), to attempt to protect against some chemical warfare nerve agents. The anthrax vaccine that DOD used (and continues to use) on troops had been approved for this use by the U.S. Food and Drug Administration (FDA) and had been used for decades to protect individuals from contracting anthrax. However, the botulinum toxoid vaccine and PB were not FDA fully-approved products for use to protect against biological and chemical warfare agents.¹⁸⁷

BACKGROUND ON THE FDA AND INVESTIGATIONAL NEW DRUGS (INDs)

FDA regulates whether and how medicinal drugs and vaccines in the United States may be used.¹⁸⁸ A medical drug or vaccine that FDA has not approved for marketing or one used for a purpose other than that identified in FDA-approved labeling is considered to be "investigational." Moreover, an investigational new drug (IND) application must be filed with the FDA in order to test an unapproved product in a clinical setting on human subjects or to test approved products for unapproved uses.¹⁸⁹ Prior to the Gulf War, FDA and DOD had closely collaborated in the use and

development of medical products under IND status under a joint Memorandum of Understanding dated May 1, 1987.¹⁹⁰

DOD EFFORTS TO ADMINISTER TWO INDs, BOTULINUM TOXOID VACCINE AND PB, DURING THE GULF WAR

DOD wanted to administer botulinum toxoid vaccine and PB, investigational new drugs, to some troops deploying to the Gulf War. Approximately 10,000 doses of the vaccine had already been safely administered from 1970 through 1990 to "laboratory professionals and public health professionals at risk of infection" from botulinum.¹⁹¹ PB was FDA approved to treat myasthenia gravis, a chronic disease characterized by muscle weakness, but not to protect against chemical weapons agents.¹⁹² However, DOD believed that there was sound scientific evidence that taking PB tablets could protect troops against some, although not all, chemical weapons agents that Iraq was believed to possess.¹⁹³

Although other NATO countries had used PB to protect their troops against some chemical warfare agents for years,¹⁹⁴ PB's ability to protect humans against exposure to nerve agents is not fully understood. In lieu of studies of human exposure to nerve agents (which would present serious ethical questions), animal studies have been conducted. These studies demonstrate PB's protective effect against animal (although not necessarily human) exposure to the nerve agents soman and tabun.¹⁹⁵ However, animal studies indicate that PB appears to be ineffective against the nerve agents sarin and VX.¹⁹⁶ At the time of the Gulf War, DOD made no distinction between the types of nerve agents that PB was considered to be effective against. Indeed, only in 1998 did DOD publicly acknowledge that PB should only be used as a pretreatment if the nerve agents soman or tabun were likely to be used against our troops, but not if other agents, such as sarin, were likely threats.¹⁹⁷

In addition to the limits on PB's likely effectiveness to protect against chemical warfare agents, it was unclear how healthy individuals would react to taking PB during the Gulf War deployment. There are instances where a drug administered to healthy people can cause more problems than when administered to those who are ill (for example, insulin injections help diabetics but can harm healthy people). However, FDA reviewed DOD's proposed use of PB and had few concerns about PB's potential toxicity because of its longstanding use to treat myasthenia gravis. FDA also expected that a healthy military population would experience even fewer side effects from PB than persons with that illness. In reaching this conclusion, FDA also reviewed data from DOD studies that evaluated PB's usefulness and safety, although the number of persons in each study was small (usually less than ten), less than 100 persons were studied in all, and the studies excluded women and persons with certain diseases, such as asthmatics.¹⁹⁸

DOD APPLIED TO FDA TO USE INVESTIGATIONAL NEW DRUGS WITHOUT INFORMED CONSENT DURING THE GULF WAR

In planning for the Gulf War, DOD applied to FDA to use the botulinum toxoid vaccine and PB as INDs without obtaining informed consent from troops. DOD did this although "under the [sic] DOD directive the Secretary of the Military Departments can dictate the use of unapproved FDA regulated products."¹⁹⁹ This application also was made despite the fact that IND products exported from the U.S. and used overseas do not need to meet investigational new drug regulations, and in particular "informed consent and investigational labeling are not required" in such circumstances.²⁰⁰ The FDA requires that the use of INDs be closely monitored, that accurate health records regarding their use be maintained, and that persons who receive these products give their informed consent before it is administered to them.²⁰¹

FDA and DOD both believed that the products discussed represented the best preventive or therapeutic treatment to provide protection against possible chemical and biological weapons.²⁰² FDA also gave "considerable deference to the Department of Defense's judgement and expertise regarding the feasibility of obtaining informed consent under battlefield conditions."²⁰³ However, major issues triggered by DOD's request to use INDs without informed consent were the feasibility of requiring informed consent in a wartime context, product labeling, and interpretation of the 1987 memorandum of understanding on INDs.²⁰⁴ In particular, DOD did not want individuals to have an option of refusing to receive an IND product because that choice could result in the individual's unnecessary death and could also jeopardize the lives of other soldiers who relied on that individual in a combat situation.

Prior to the Gulf War, FDA did not have a regulation that allowed INDs to be administered without informed consent to mentally competent individuals. DOD requested that FDA develop a new regulation that would allow this to occur. DOD stated in an October 30, 1990, letter to FDA, that:

"[f]or products that will be in the best interests of the patients, military combat exigencies may justify deeming it not feasible to obtain informed consent. FDA's regulation should provide the mechanism, subject to appropriate limitations, for DOD to request on a drug-by-drug basis, and the Commissioner [of FDA] to decide, that a waiver be granted in cases in which it is established that military combat exigencies make that necessary." ²⁰⁵

FDA ISSUES AN INTERIM FINAL RULE THAT ALLOWS DOD TO USE PB AND BOTULINUM TOXOID VACCINE UNDER CERTAIN CONDITIONS WITHOUT INFORMED CONSENT

On December 21, 1990, FDA published an interim final rule that allowed FDA to waive informed consent on a case-by-case basis if three conditions were met. These conditions were:

- "1) the use was required to facilitate the accomplishment of the military mission;
- 2) the use would preserve the health of the individuals and the safety of other personnel, without regard for any individual's preference for alternative treatment or no treatment; and
- 3) the application contained documentation to indicate that the protocol had been reviewed and approved by a duly constituted institutional review board for the use of the investigational new drug without informed consent."²⁰⁶

FDA published this regulation within two months of DOD's written request to FDA. However, by the time this interim final rule was published, troops had already been in theater for some months. On December 31, 1990, DOD asked that FDA allow the use of PB without informed consent and FDA approved this request on January 8, 1991.²⁰⁷ However, for the botulinum toxoid vaccine, the SIU could not find a record of a similar request by DOD to waive informed consent requirements for its use. FDA has also questioned whether DOD fully met those requirements.²⁰⁸

Although FDA agreed to waive informed consent requirements, FDA imposed other conditions on DOD's use of IND products during the Gulf War. For the botulinum toxoid vaccine, FDA required that DOD record each vaccination on the individual's permanent immunization record and maintain a roster with detailed information to identify all individuals receiving each vaccine dose. Adverse reactions were to be reported and a post-vaccination survey of a sample of individuals was to be done.²⁰⁹ DOD did not fulfill these requirements. For PB, DOD agreed to "collect, and summarize, adverse reaction data from medical personnel caring for casualties by the use of a form designed for this purpose, which the Agency found to be acceptable."²¹⁰ In addition, DOD was to "provide and disseminate additional information to all military personnel concerning the risks and benefits of pyridostigmine,"²¹¹ and to label the packets that contained PB as "FOR MILITARY USE AND EVALUATION ONLY."²¹² However, because packets containing PB tablets had been in the Gulf War theater since August 1990,²¹³ it appears that DOD's agreement to label PB packages was made with the knowledge that it probably could not fully comply with this requirement.

HEALTH ISSUES DURING DEPLOYMENT

BACKGROUND ON DEPLOYED TROOPS

In evaluating the health status of those deployed during the Gulf War, that group's characteristics are relevant in identifying whether particular health issues are of the type that normally would be expected to occur. From August 2, 1990, through July 31, 1991, 696,530 service personnel were deployed to the Gulf War theater of operations.²¹⁴ As shown in Table 1, the vast majority of deployed troops were enlisted males. Their median age was 24 years, although 28 percent were older than 30 years of age. Seven percent of deployed troops were women and the number of women who served in forward combat support positions was proportionately higher in comparison with previous

military deployments.²¹⁵ Almost one-fifth of those deployed were reservists, representing the largest mobilization and deployment of reserve component forces since the Korean War.²¹⁶ However, reserve troops reportedly received little or no health screening prior to deployment, unlike active duty troops who had access to the routine physical examination procedures that are part of the military's health care system.²¹⁷

Table 1. Characteristics of United States Military Servicemembers in the Gulf War (GW) Theater of Operations, August 2, 1990–July 31, 1991.²¹⁸

Characteristics	% GW Servicemembers (n=696,530)
Male gender	93
Race	
White	70
Black	23
Hispanic	5
Other/Unknown	2
Median age	24 years
Age categories (years)	
17-20	11
21-25	38
26-30	22
31-35	13
36-65	15
Rank	
Enlisted	89
Officer	10
Other/unknown	1
Branch	
Air Force	12
Army	50
Marines	15
Navy	23
Status	
Active	83
Reserve component	17

MEDICAL FORCE BUILD-UP AND DEPLOYMENT FOR OPERATIONS DESERT SHIELD/STORM

In testimony before the Senate Committee on Veterans' Affairs, CENTCOM Commander General Norman Schwarzkopf (Ret.) described Operations Desert Shield/Storm as requiring "the largest medical mobilization that has taken place since World War II."²¹⁹ A key aspect of the medical mobilization was ensuring that an adequate number of in-theater hospital beds would be available to handle potential casualties, in addition to the hospital beds needed for possible medical evacuation to Europe and the United States. During Operation Desert Shield, the CENTCOM Surgeon General established an initial requirement for 7,350 hospital beds in-theater, which was later more than doubled to 18,530 beds. However, as of the beginning of the air campaign in January of 1991 this requirement had not been met. In the theater of operations, only about one-third (6,160) of the required beds were "operational"—meaning all personnel and equipment were in place and ready. Another 7,680 beds were "fully staffed", meaning that support personnel but not all required equipment was available for use. Overall, the in-theater health care system included 41,000 medical personnel and 65 hospitals, which consisted of two Navy ships, three Navy fleet hospitals, 44 Army hospitals, and 16 Air Force hospitals.²²⁰

OTHER IN-THEATER MILITARY MEDICAL PREPARATIONS

In addition to ensuring that basic medical support like hospital beds were available in theater, medical planning was also underway to prepare for and protect against a variety of health threats that troops were likely to encounter, such as chemical and biological weapons, and local environmental conditions or diseases. In his January 1997 testimony before the Senate Committee on Veterans' Affairs, General Schwarzkopf stated that DOD had predicted that U.S. forces would lose as many as 20,000 people if biological or chemical weapons were used by Iraq.²²¹ However, it has been suggested that the focus on the potential for Iraq's use of chemical and biological weapons may have resulted in a neglect of other fundamental preventive health practices such as comprehensive techniques for tracking potential toxic exposures and troop health status. Nevertheless, DOD health officials did develop and implement policies and plans to provide preventive medicine appropriate to the desert environment and to counter the threat of conventional and chemical or biological warfare. These included "preventive and environmental medicine, veterinary medicine, food inspection, medical and dental care, medical maintenance, supply and logistical support, and the movement and evacuation of patients."²²²

MEDICAL FORCE CAPABILITIES AND SHORTCOMINGS

Despite these preparations and plans, there were serious shortcomings in the medical force aspects of the Gulf War deployment. These shortcomings were such that, had the war lasted longer or had chemical or biological weapons been used by Iraq, the level of medical support available would have been unable to adequately respond to the casualties that would almost certainly have occurred. Despite the pre-conflict estimate of 20,000 in casualties if chemical or biological weapons was used

that General Schwarzkopf cited in his Senate testimony, DOD acknowledged in 1992 that it was not adequately prepared to deal with such casualties. For example, DOD admitted to only limited availability of important treatment resources such as drugs and antibiotics as well as "protection, detection, decontamination" and other therapies designed especially for BW and CW injuries.²²³ Moreover, of the three service branches, only the Army had protective shelter systems to be used for decontamination and medical treatment of chemical weapon casualties, and not all health-care staff had received comprehensive pre-deployment training for handling such casualties.²²⁴ Other problems arose due to inadequate training of active duty and reserve medical personnel as well as ground transportation problems that limited mobility of medical support to the front lines of battle.²²⁵ Even more troubling are the more detailed assessments in three studies performed by GAO of the medical readiness and capabilities of each branch of the military. GAO's evaluations, summarized below for each service, demonstrate the degree to which the medical aspects of the Gulf War deployment fell far short of the level that would have been required to provide adequate care to injured troops had U.S. forces suffered the number of casualties that initially had been predicted.²²⁶

Shortcomings in Army Medical Capabilities

In reviewing the Army's medical capabilities, GAO identified numerous significant problems before and during the ground war. For example, the system used to identify active duty medical personnel was incomplete and outdated, hindering efforts to deploy an adequate number of medical units. Moreover, many health professionals in reserve or National Guard units could not be deployed. Some did not meet physical fitness requirements; some had not kept current in their medical specialty or did not have complete medical training; some had not taken basic training. Many units had not trained adequately to familiarize medical personnel with unit missions and equipment.²²⁷ Many medical personnel also were unfamiliar with management and treatment of chemical warfare casualties, so initial training had to be done in-theater. Medical supply shortages occurred throughout the war and some hospitals were never fully equipped. Transportation and communication difficulties limited the ability to rapidly evacuate casualties from the battlefield or to communicate essential data on casualty status. Based on these shortfalls, GAO recommended that "the Secretary of the Army ensure that the doctrine involving the employment and configuration of battlefield hospital units is consistent with the battlefield of the future and that these units are sufficiently resourced with transportation and support assets to accomplish their missions"²²⁸

Shortcomings in Navy Medical Capabilities

Although the Navy rapidly deployed significant medical capabilities to the Gulf, GAO found that it was given missions by CENTCOM that it was not designed, staffed, or equipped to perform.²²⁹ Plans for transporting casualties to hospital ships did not take into account limited helicopter capabilities and travel times necessary to reach hospital ships. Crucial equipment and supplies would have been rapidly exhausted if casualty rates had approached estimated levels. The Navy's medical capabilities for dealing with chemical warfare agents were severely limited. Fleet hospitals built

makeshift decontamination stations and improvised wash-down systems for airborne contaminants like chemical agents. With no reliable systems to remove contamination from those systems, the spread of contamination through that water or through decontamination exhaust vents located near air intake vents were also significant risks. Finally, as was true in the Army, only a small percentage of the Navy physicians deployed were trained to treat chemically contaminated casualties.²³⁰ GAO recommended that "the Secretary of the Navy set and enforce time frames to correct the shortcomings identified from lessons learned about medical operations during Operations Desert Shield and Desert Storm."²³¹

Shortcomings in Air Force Medical Capabilities

Many of the same problems and shortcomings found in the Navy and Army medical capabilities were also true of the Air Force. Mission assignments to the Air Force far exceeded unit capabilities, resources, and expertise. Air Force medical units had supply and equipment problems and many of the medical personnel were inadequately trained. An Air Force after-action report stated that the estimated flow of casualties would have overwhelmed the system because not enough aircraft were allocated to evacuate patients. Even with adequate equipment, the report noted that it is very likely that there still would have been problems as there were shortfalls in the crews and in-flight evacuation equipment.²³²

THE LINK BETWEEN POTENTIAL EXPOSURES TO HARMFUL AGENTS AND ADVERSE HEALTH EFFECTS

Background

During the Gulf War, troops were exposed to many toxic agents that may have adversely affected their health either at the time of or after that deployment. In understanding the roles that these agents may have played in the illnesses that some Gulf War veterans now experience, some basic scientific concepts about the link between exposure and health effects are relevant. First, the simple fact an individual has been exposed to agents known to cause disease (whether infectious organisms or toxic chemicals) does not automatically result in that individual becoming ill. Illness occurs only after exposure to an amount of a harmful agent sufficient to trigger that illness. In addition, the amount of agent to which an individual is exposed does not stay static. For example, the human body frequently rids itself of harmful agents to which it has been exposed through normal bodily functions, including attacks by the body's immune system.

Duration of exposure also can be an important factor in determining whether an agent has caused illness, so that a one-time exposure to a certain amount of an agent may cause adverse health effects but exposure to that same amount spread over a long period may not. Moreover, illness in an individual may not occur until long after an exposure. For example, exposure to large doses of radiation can rapidly cause death but exposure to low levels of radiation may cause cancer only many

years later.²³³ Also, some agents may interact in the body to jointly create a harmful effect. Therefore, in tracing the source of an illness it may be important to know if there were simultaneous exposures.²³⁴ Finally, everyone is exposed to multiple agents during the course of daily life that at certain levels can cause adverse health effects. Thus, in attempting to draw a causal link between known exposures to particular agents and illnesses that have occurred after those exposures, it is necessary to have reliable data to characterize exposures that normally occur as a part of daily life.

Measuring Exposure

The various ways in which exposure to certain substances or agents can, but may not always, cause illness in part demonstrates why it has been so difficult to determine why Gulf War veterans are ill. A link between exposure to an agent and illness is easier to draw if the agent is found still present in the body. Determining exposure to infectious agents like bacteria or viruses usually is based on identifying either the agent itself or antibodies against it. Determining exposure to chemical agents is usually done by measuring the amount of chemical in a person's body. Unfortunately, for many chemicals—including chemical weapons agents—this measurement cannot be done because effective laboratory tests do not yet exist.²³⁵ When actual measurement of exposure levels is not possible, scientists try to estimate the type and amount of a chemical that entered a person's body and determine if it was sufficient to cause health problems. Such after-the-fact exposure inquiries are only as good as the data on which they are based and do not account for differences in individual vulnerability to illness among those exposed.

Summary of Potential Troop Exposures to Harmful Agents During the Gulf War

During the years since the Gulf War, many agents have been suggested as possible sources of troop exposure and, in turn, as potential causes of the unexplained illnesses among Gulf War veterans. To review these potential causes in light of current available data, the SIU worked with the Department of Defense's United States Army Center for Health Promotion and Preventive Medicine (USACHPPM), which has overseen environmental monitoring for the Gulf War and Bosnia deployments. Using data provided by USACHPPM, which is set out in Figures 4 and 5, described below are the possible exposures to potentially harmful agents that some Gulf War veterans may have experienced. These figures are only guidelines for possible exposure. For example, individual service personnel may have been in-theater when an exposure was present and not have been exposed. Also described are some health effects due to these agents that could have occurred shortly following exposure. The SIU also asked several scientific experts to independently evaluate aspects of the possible long-term health consequences associated with these exposures. Chapter Four contains the full text or a summary of their reports, and the full text of the summarized reports is reproduced in the Appendix.

Biological Warfare Agents

Biological warfare (BW) agents are either live entities, such as bacteria and viruses, or they can be toxins or proteins produced by these entities.²³⁶ To be effective on the battlefield most BW agents must be dispersed in the air via mechanisms such as bombs, missiles, or spray tanks. Exposure to these agents would most likely occur by breathing them into the lungs. Following exposure to BW agents, persons develop diseases very similar to those that would occur following naturally acquired infection from such organisms.²³⁷ During the Gulf War, BW agent field detectors were relatively primitive and could not be relied upon to accurately detect exposure in a timely fashion.²³⁸ However, BW agents were likely not used because there is no intelligence evidence to date that indicates their use. In addition, the use of BW agents would have caused specific patterns of unique diseases that would have been noted by military physicians.

Finding: Any exposure of Gulf War veterans to BW weapons appears to be unlikely based on the information available at this time.

Figure 4. Total PGW Deployed Military Population and Potential Exposures

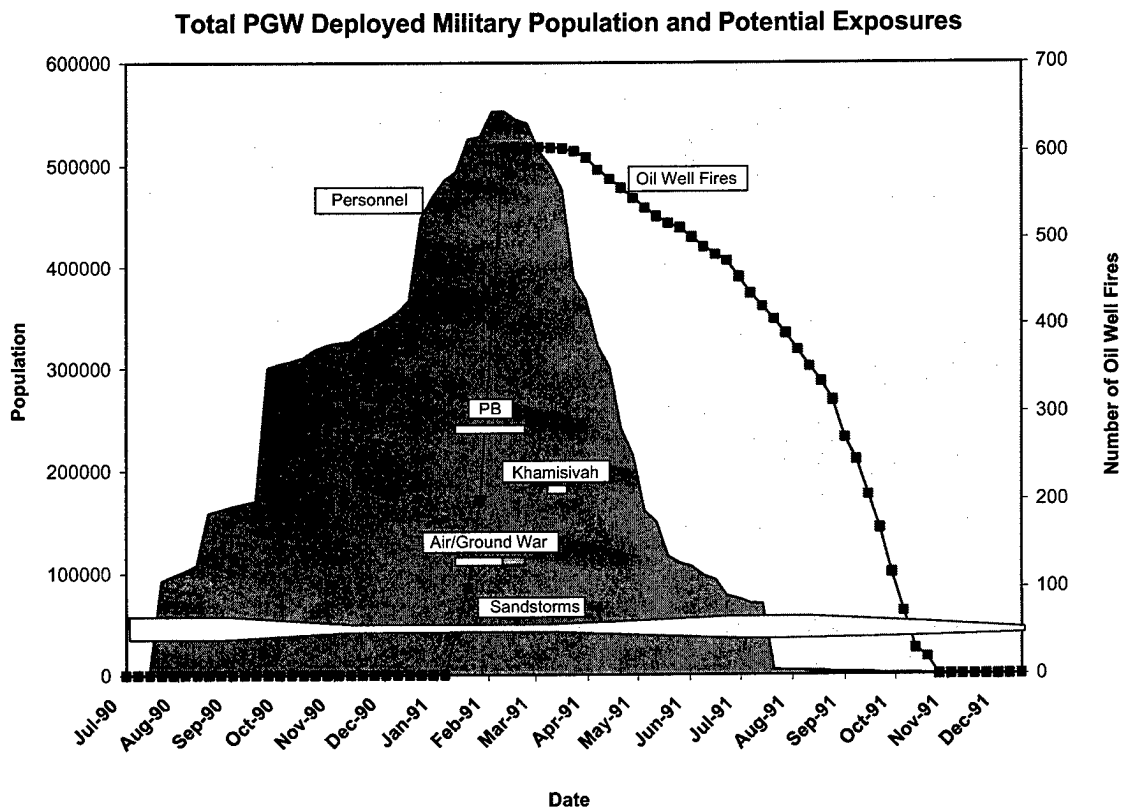
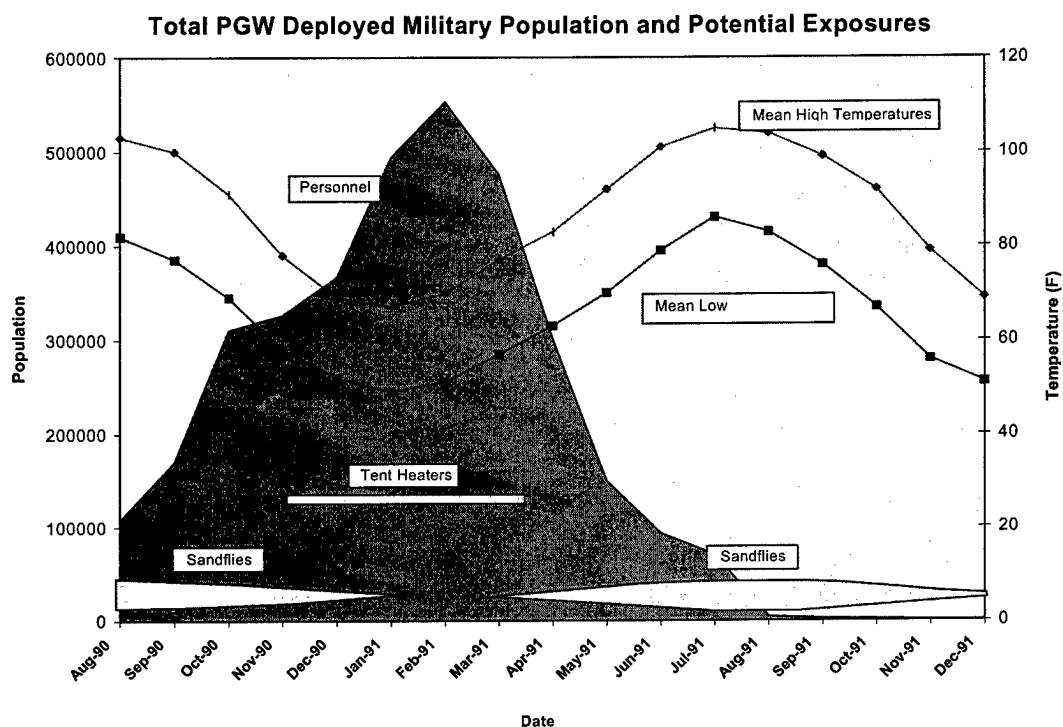


Figure 5: Total PGW Deployed Military Population and Potential Exposures—Continued



theater were from U.S. Air Force Environmental Technical Center data and the oil well fire data is from the National Oceanic and Atmospheric Administrations' Arabian Gulf Program Office. The sandstorm graphic was based on historical data and meteorological conditions and is not specific to the 1991 period. The sandfly data was provided to USACHPPM by Dr. William Reeves of the U.S. Centers for Disease Control and Prevention (CDC).

War

Chemical Warfare (CW) Agents

In the Gulf War, Iraq was assumed to have available included a variety of chemical warfare agents. Chemical warfare agents include mustard liquid (a blister agent), and nerve agents such as sarin (GB), soman (GD), tabun (GA), and VX. Mustard agent affects the skin and mucous membranes that it touches by forming blisters within twelve to 24 hours. Mustard can remain potent in its liquid form up to one hundred hours after release,²³⁹ but in a desert environment it can also evaporate quickly, producing a vapor affecting the lungs of those who breathe it in.²⁴⁰ Nerve agents inhibit an enzyme—acetylcholinesterase—in the nervous system. Exposure to nerve agents can cause nausea, vomiting, increased respiratory secretions, pinpoint size pupils in the eyes (miosis), convulsions, and respiratory failure resulting in death.²⁴¹ Some nerve agents can last for long periods of time in the environment (e.g., VX), while others dissipate rapidly (e.g., sarin and soman).²⁴²

There are no medical reports of symptoms or injuries to Gulf War troops consistent with acute exposure to CW agent. Although many medical records are incomplete or absent, exposure to CW agents in sufficient quantities to cause acute effects would likely have been noted, at least in medical reports to unit commanders. One report of exposure to a weaponized mustard agent during the Gulf War has been confirmed by DOD, most comprehensively in a case narrative issued by DOD/OASGWI. As discussed in Chapter One, that case narrative states that while performing reconnaissance in an Iraqi bunker on March 1, 1991, PFC David Fisher was likely exposed to mustard liquid. Eight hours after exploring the bunker, he developed burn signs and symptoms medically consistent with blister agent. FOX vehicle testing of liquid on Fisher's jacket was positive for a mustard agent on two separate readings. An initial urinalysis also indicated the presence of mustard agent. Although PFC Fisher received a Purple Heart for his injuries, later analysis of physical evidence was deemed inconclusive by DOD.²⁴³

Potential troop exposure to low levels of chemical agent that did not result in immediate symptoms or death cannot be assessed. As discussed in Chapter One regarding DOD/CIA attempts to produce computer models of the Khamisiyah incident (the only CW release during the Gulf War according to currently available information), there is no contemporaneous data to verify the presence or absence of such agents in-theater nor to determine the extent of possible troop exposure.

Finding: With the exception of PFC Fisher's injuries, there are currently no other reports of injuries consistent with exposure to chemical weapons agents sufficient to cause immediate significant or life-threatening symptoms. However, exposures to low levels of chemical agents could not be assessed as DOD lacked reliable detection methods for low level exposures.

Depleted Uranium

DOD uses depleted uranium (DU), a very dense metal, to increase the penetration capability of certain munitions and as a protective shield on tanks against enemy fire. DU is a byproduct in uranium refinement and its radioactivity is about half that of natural uranium.²⁴⁴ DU was first used in combat during the Gulf War, during which U.S. troops collectively fired approximately 285 tons of DU munitions.²⁴⁵ Many U.S. troops handled munitions containing DU, but because the DU is encased in a protective shell, that type of contact alone is unlikely to have resulted in exposure. However, during the Gulf War, troop exposure to DU occurred in other ways. Thirty-six persons were wounded with DU shrapnel in friendly-fire incidents.²⁴⁶ Of these, 33 currently are being followed medically and 15 still have detectable shrapnel fragments in their bodies.²⁴⁷ Additionally, unknown numbers of troops may have inhaled particles containing DU while working near a fire at the Doha, Kuwait, armored vehicle depot, or while climbing onto allied or enemy vehicles that had been hit by munitions containing DU.²⁴⁸ Gulf War veterans told SIU investigators that DOD provided little or no information and training that described potential health risks from contact with exploded DU munitions or how to minimize exposure to DU in such situations. This is consistent

with GAO findings and has been acknowledged by DOD as an area in which improvement is needed.²⁴⁹

Acute and long-term health effects from DU exposure mostly likely stem from the toxicity of its heavy metal properties rather than radioactivity.²⁵⁰ Symptoms of acute exposure are irritated eyes or upper respiratory tract problems.²⁵¹ These health complaints were reported nearly three times as often by troops in the Gulf War theater than by a comparable military group stationed in the U.S. (19 percent versus 7 percent of those troops).²⁵² However, it is unclear whether these complaints stemmed from exposure to DU or exposure to other factors such as sand or respiratory viruses. Although DU's radiation cannot penetrate the skin,²⁵³ inhaled or ingested DU may cause lung or kidney damage.²⁵⁴ However, there are no reports of acute, symptomatic lung or kidney damage during the Gulf War deployment that required unique intensive medical care for such symptoms, such as dialysis.

Finding: In addition to troops who were wounded by DU shrapnel, an unknown number of troops were exposed to low levels of DU, probably by inhaling DU particles.

Heat

Because the Gulf War deployment occurred in a desert setting, U.S. service members experienced certain health exposures characteristic of that environment. In the initial months of the deployment, troops were exposed to summer daytime temperatures that reached as high as 130 degrees Fahrenheit (F).²⁵⁵ In August and September, mean high temperatures were approximately 100 degrees F, with very intense solar heat and low humidity (see Figure 4). During the Gulf War, the U.S. military was well aware that the desert environment could contribute to heat stress and provided information to troops on fluid management and prevention of heat-related illnesses.²⁵⁶ There is insufficient data to determine how many troops had heat-related health problems. However, based on health surveillance data collected on approximately 40,000 Marines (about six percent of all deployed U.S. troops), less than three cases of heat injury requiring aid station treatment occurred weekly per 1,000 personnel under surveillance.²⁵⁷

Preliminary research by Israeli scientists suggests that heat stress can cause cerebral deficiency even in temperatures slightly above 100 degrees Fahrenheit.²⁵⁸ The Israeli military has reported that a few Israeli soldiers have developed undiagnosed illness-type symptoms (e.g., fatigue and memory problems) after symptomatic heat stress. More than 95 percent of those soldiers recovered fully and most did so in a matter of weeks, although some took up to a year.²⁵⁹

Finding: Based on available data as shown in Figure 5, many troops were exposed to conditions of extreme heat during part of the deployment.

Infectious Diseases

Many infectious diseases are prevalent in the Middle East including, but not limited to, agents causing diarrheal diseases, leishmania, sandfly fever, and malaria.²⁶⁰ The Navy's health surveillance system during the Gulf War that collected data on about six percent of all deployed troops found that, based on that group's data, the incidence of reported infectious diseases during the Gulf War was lower than during previous wars. Diarrhea was the most commonly reported condition, and up to four percent of those troops were ill per week. Cases of diarrhea decreased once troops no longer received locally obtained fresh produce with their meals, but outbreaks continued during deployment and were likely connected to living in crowded tents without indoor plumbing, eating in local restaurants, and food preparation by local hires.²⁶¹ As noted above, upper respiratory complaints were also common among Gulf War troops but it is unclear whether these problems were due to infectious organisms. (See the consultant report of Dr. Michael Lebowitz in Chapter Four and at Appendix KK.) Although unknown numbers of persons likely were infected with organisms that cause gastrointestinal and respiratory diseases, no troops are known to have developed sandfly fever. Seven persons developed malaria; one contracted West Nile fever; and one died from meningococcal meningitis.²⁶²

Leishmania—Leishmania is a parasitic disease transmitted by the bite of the adult sandfly, which also transmits sandfly fever.²⁶³ In the Middle East, Leishmania organisms typically cause either a skin disease (cutaneous disease) or disease of internal body organs such as the liver or spleen (visceral disease). There are neither blood nor skin tests for leishmania, thus, diagnosis is difficult and requires identification of the parasite in bone marrow samples.²⁶⁴ The adult sandfly that spreads the leishmania organism is inactive during the cooler, winter months (see figure 2).²⁶⁵ Thus, during the Gulf War most troops probably were at low risk of exposure to Leishmania organisms because they were in the area during the winter months when the sandfly is less likely to spread the disease. In addition, the widespread use of pesticides²⁶⁶ by DOD may have diminished the sandfly population in areas where troops lived. Since the end of the Gulf War, 32 persons have been diagnosed with leishmaniasis,²⁶⁷ with the last case diagnosed in 1993.²⁶⁸

A study conducted by the CDC has attempted to better understand exposure to the sandfly and illnesses among Gulf War veterans. CDC examined the blood of 154 Gulf War veterans who were in four units, and looked for evidence of exposure to sandfly fever, which is evidence of exposure to the sandfly. CDC found that about six percent of the veterans did show evidence of that exposure. However, there was no association between sandfly exposure and an individual's health status at the time of the study. In addition, among ill persons there was no association between exposure and the type or severity of reported symptoms such as fatigue, abdominal cramps, or skin rash. CDC concluded that among Gulf War veterans in those units exposure to the sandfly was not associated with illness.²⁶⁹

Mycoplasma—Mycoplasma organisms are bacteria that are found on healthy humans, animals and birds.²⁷⁰ Mycoplasma are also common contaminants of animal cell cultures, and some types of mycoplasma can cause disease in humans, such as pneumonia caused by *Mycoplasma pneumonia*.²⁷¹ Some researchers have postulated that mycoplasma infection is a possible factor affecting the health of Gulf War veterans with undiagnosed illnesses, although the source of such exposure, if any, is not clear. In particular, the strain *Mycoplasma fermentans* has been proposed as contributing to these illnesses by affecting certain human immune responses. To assist this investigation, a national expert in the field of mycoplasma, Dr. Kevin Dybvig, prepared and submitted at the SIU's request a report providing an overview of mycoplasma in the context of Gulf War illnesses and a review of related scientific literature. That report can be found in Chapter Four.

At least one research effort into a potential link between *Mycoplasma fermentans* and Gulf War illnesses is currently underway. As of the writing of this report, the Department of Defense was in the process of providing approximately \$150,000 to molecular biologist Dr. Garth Nicolson of the Institute for Molecular Medicine. Dr. Nicolson and his colleagues claim that they have detected *Mycoplasma fermentans* in some ill Gulf War veterans using a particular laboratory technique that they developed. This DOD funding has been provided to enable Dr. Nicolson and his colleagues to teach their technique to laboratory teams from three facilities—one government laboratory and two universities. These laboratories are the Armed Forces Institute of Pathology; the University of Texas Health Science Center (San Antonio); and the University of California (Irvine). Once scientists are trained at the three laboratories, double blind testing of specimens will occur by all laboratory teams and Dr. Nicolson's laboratory to verify the validity and reproducibility of the new testing procedure. Research into a possible link between *Mycoplasma fermentans* and Gulf War illnesses is in preliminary stages, and the SIU is not in a position to reach any conclusions on this matter.

Finding: Many troops were likely infected with organisms that caused diarrhea and respiratory diseases during the Gulf War deployment. Thirty-two persons developed leishmania, and few service personnel developed malaria, West Nile fever, and meningococcal meningitis.

Oil Well Fires

Towards the end of the Gulf War in February 1991, more than six hundred Kuwaiti oil wells and refineries were set on fire by the Iraqi troops (see Figure 1).²⁷² Air monitoring for pollutants from these fires was done by several U.S. and international agencies. Environmental Protection Agency (EPA) personnel were in Kuwait beginning in March 1991 and the U.S. Army's Environmental Hygiene Agency collected samples from May through December 1991.²⁷³ However, there was limited data collected earlier when most of the troops were in the area. The fires released numerous air pollutants, including particulate matter, volatile organic compounds (VOCs), sulfur oxides, nitrogen oxides, vanadium, and nickel. CDC measured the amount of VOCs in some individuals shortly after the Gulf War and found high levels among firefighters, however, persons in Kuwait City had levels comparable to the general U.S. population.²⁷⁴

Acute health effects associated with exposure to oil well fires would include irritation of the respiratory system and the eyes, which as mentioned previously appeared to be more common among some Gulf War troops than some troops in the U.S. However, this increase may be attributed to other exposures such as sand or infectious agents. (See the consultant report of Dr. Lebowitz in Chapter Four and at Appendix KK.) Pulmonary function tests were completed on a limited number of persons and their results did not differ significantly from troops stationed in Germany.²⁷⁵ The Armed Forces Institute of Pathology also compared autopsy results of 149 Gulf War veterans who died before the fires started with autopsy results of 202 persons who died after the fires began and found no significant differences between them.²⁷⁶

Finding: Based on available data, unknown numbers of troops were likely exposed to high concentrations of particulate matter, metals, sulfur and nitrogen oxides in the air as a result of oil well fires.

Pesticides

The military used many types of pesticides, insecticides, and rodenticides during the Gulf War deployment to which many troops were exposed. These chemicals fell into five major categories: carbamate, organophosphorus, chlorinated hydrocarbon (lindane), pyrethroid pesticides, and others such as N,N-Diethyl-*m*-toluamide (DEET).²⁷⁷ (See the consultant reports of Drs. Frederic Gerr and Matthew Keifer in Chapter Four and at Appendix II and JJ.) Organophosphate and carbamate pesticides act similarly to chemical warfare agents by inhibiting the enzyme acetylcholinesterase in the nervous system and acute health effects from exposure to them also include muscle twitching, vomiting, diarrhea, and possible respiratory suppression and death. Exposure to pyrethroid pesticides can result in nausea, incoordination, and eye and skin irritation.²⁷⁸ Most pesticides and similar substances used during the Gulf War were obtained from the United States. At least one pesticide, "SNIP,"²⁷⁹ was purchased locally,²⁸⁰ and it is unclear whether other pesticides were also locally obtained. DOD officials advised SIU investigators that DOD may have used local contractors early in the deployment to spray the dormitory facilities of several military units with unknown pesticides. DOD could not confirm this.

Although DOD kept records describing the type and amount of pesticides shipped from the United States, no records documented how individual service personnel used these chemicals. For example, DOD has reported that troops each received an average of about 2.0 tubes of DEET (33% concentration) intended for use directly on the body and 2.2 spray-cans of premethrin for use on uniforms; however, no records reflect how these agents were actually used.²⁸¹ Most other pesticides such as those used to control insects in camps were used by troops who reportedly were trained to follow strict guidelines in their use. However, it is unknown how many troops understood and followed safe occupational health practices when using these agents.²⁸² In addition, some service personnel chose to wear animal flea collars to ward off insects although DOD discouraged this practice because the health effects of human use is unknown. Some troops reportedly developed

rashes as a consequence of their use.²⁸³ However, no other acute health effects have been linked to the use of pesticides during the Gulf War.²⁸⁴

Finding: Most troops were likely exposed to some level of a variety of these chemicals although the amount or level of exposure is not known.

Pyridostigmine Bromide

As discussed earlier in this chapter, DOD obtained approval from FDA to administer pyridostigmine bromide (PB) as a pretreatment to guard against ill effects from exposure to some types of chemical weapons agents. FDA's conditions for its approval were that DOD inform troops as to why they were receiving PB, and that DOD keep records of who took PB as well as any adverse health effects that occurred.²⁸⁵ During the Gulf War, PB was to be used at the commanding officer's judgement and was to be self-administered by individuals in 30 mg doses three times daily. DOD kept no records to document who took PB and how much was taken despite the FDA's requirement to do so. DOD believes that about 250,000 personnel took at least some PB during the deployment.²⁸⁶ However, in many instances some troops did not take PB despite their commanders' orders to do so and some troops took several doses all at once when they heard CW alarms sound, reasoning that if one tablet would protect them against CW agents several tablets would work even better.²⁸⁷

Excessive doses of PB will cause many of the same toxic effects that nerve agents do and the recommended dosage in the Gulf did in fact lead to "annoying side effects" in about half the troops in theater.²⁸⁸ For example, information collected from medical officers of the XVII Airborne Corps regarding the symptoms and disposition of 41,650 members of the Air Force who received PB beginning in January 1991 showed that over half the troops experienced gastrointestinal symptoms and up to one-third complained of urinary urgency. Other side effects included hypertension in two individuals, headaches in five, and breathing difficulties in one with a history of asthma. At least one soldier experienced an overdose after inadvertently taking two tablets. The researchers concluded that approximately one percent of the individuals reported side effects that were severe enough to warrant medical attention and fewer than one-tenth of a percent had side effects severe enough to discontinue the drug.²⁸⁹

For many years, scientists thought that PB did not enter the brain because the brain's protective layers (also known as the blood-brain barrier) prevented that. However, recent DOD-funded research has shown that when a rodent is placed in a stressful situation, the protective layers of their brain become permeable and PB does enter the brain.²⁹⁰ It is unknown whether the human blood-brain barrier reacts similarly in stressful situations (including combat) and, if so, for how long the permeability may last. It is reasonable to conclude that if the human blood-brain barrier does become permeable in stressful situations, the brains of some soldiers may have been exposed to PB. The health consequences of such exposure are unknown.²⁹¹ In addition, as is discussed later in this chapter regarding the health effects of multiple exposures, PB may also interact with pesticides and

potentially create adverse health effects at lower doses of these agents, although the health consequences of such multiple exposures are also unknown. (See the consultant reports of Dr. Keifer, found in Chapter Four and at Appendix JJ, and Dr. James Moss in Chapter Four.)

Finding: Pyridostigmine bromide tablets were taken by about 250,000 troops; PB was likely more commonly taken during the air and ground wars in 1991 (January 16-27 and February 24-28, respectively).

Sand

Air monitoring during the Gulf War deployment revealed very high concentrations of particles that could enter and irritate the respiratory system and possibly cause low-grade lung inflammation.²⁹² Some particles were the result of oil-well fires but much was likely due to sand.²⁹³ Respiratory system irritation by airborne particles may compromise that system's ability to ward off other agents, including viruses. Of one group of U.S. troops under medical surveillance, a high rate of respiratory illnesses occurred at the beginning of the deployment, which later declined and increased again during the winter months.²⁹⁴ Long-term health consequences of inhaled exposure to fine sand particles, if any, are unknown. Some researchers have suggested that fine sand dust in combination with pigeon droppings in Saudi Arabian cities could have triggered an immune reaction that caused low-grade lung inflammation, and found that ill individuals in their study suffered a variety of complaints during the Gulf War that included nasal congestion, fever, sore throat, and generalized malaise.²⁹⁵ However, abnormal lung findings in this group were rare and most persons recovered from their symptoms after about three weeks.²⁹⁶ The long term health effects, if any, are unknown.

Finding: Most troops in theater were probably exposed to sand of a size that could be inhaled (see Figure 4).

Solvents: Petroleum Products, Diesel Heaters, and Others

Solvents are liquids that usually become vapors at room temperature, dissolve many organic compounds, and commonly are used as fuels, carriers for paints, and thinners. (See the consultant report of Dr. Gerr found in Chapter Four and at Appendix JJ.) Throughout the Gulf War theater, a variety of petroleum products were used. About 145,000 gallons of gasoline were used per day for the eight months starting in August 1990.²⁹⁷ Besides use in vehicles and machine engines, petroleum products were also used to burn human waste as well as trash, and as fuel in stoves.²⁹⁸ Diesel fuel was used in large amounts to suppress dust, with one reported case involving 30,000 gallons used on roads daily.²⁹⁹ In addition, the Navy and Marine Corps (and perhaps the Army) used unvented heaters in tents that were fueled with gasoline and diesel fuels.³⁰⁰ In all of these uses, these solvents likely released benzene, xylene, carbon monoxide, particulates, lead, and sulfur, as well as nitrogen oxides into air that troops breathed.³⁰¹ In addition, Chemical Agent Resistant Coating (CARC) paint, which releases a compound (toluene diisocyanate) that can adversely affect the lungs, was applied

to vehicles and equipment before shipment to the Gulf area or at port in Dhahran. Some persons who applied CARC paint may have done so without appropriate protective measures, although reports indicate that only a limited number of Gulf War veterans were exposed to CARC.³⁰²

During the deployment, some individuals experienced acute adverse health effects attributable to solvents. Persons who applied diesel fuels for sand suppression developed nausea, as did those who lived in tents near those roads.³⁰³ Accidental exposure to a chemical decontaminant agent (DS2) reportedly caused rashes in a group of soldiers.³⁰⁴ However, CDC obtained blood samples from some troops and did not find higher levels of volatile organic compounds, a marker for exposure to some of these compounds, than the background U.S. levels.³⁰⁵

Finding: No records were kept, but many troops were exposed to solvents, including diesel fuel and by-products from kerosene space heaters in unvented tents (see Figure 5). Exposure levels in these circumstances intermittently could have been very high.

Stress

Much has already been written about stress and the Gulf War, but often with poor specificity as to how the term 'stress' is defined. (See the consultant report of Dr. Richard Letz in Chapter Four for additional discussion of this problem.) In this report, troop exposure to "stress" means a collection of extremely adverse or potentially traumatic conditions that U.S. military personnel faced during deployment to the Gulf War, rather than their adjustment to or reactions following these events. While the war consisted of less than 100 hours of open, direct combat, the brief nature of the actual conflict does not negate the stressfulness of the deployment and the conflict that followed.

Moreover in defining stressful exposures, it is important to avoid labeling events as "physically" versus "psychologically" stressful. Researchers examining the effects of trauma on health note that these distinctions are "neither useful nor realistic . . . because each may interact with the other and both undoubtedly contribute to the suffering and despair associated with traumatic exposure."³⁰⁶ In the last decade, health scientists have only recently begun to understand and measure biological responses to stress, as reflected in changes in hormonal, physiological, and immunological functioning. (For a more complete discussion of this issue, see the consultant report of Dr. Letz in Chapter Four.)

The Ft. Devens Operation Desert Shield/Storm Reunion study examined reported stressful wartime exposures in a group of over 2,000 Gulf War veterans as they returned home.³⁰⁷ In addition to listing traditional combat experiences as stressful, this group reported nearly 300 other events that they identified as stressful, although it was not possible to identify individual levels of exposure to particular events.³⁰⁸ Categories of reported stress-related events included: (a) combat/mission stressors (e.g., actual threat to life from missiles or direct exposure to another's death or injury as part of a combat mission); (b) noncombat, war-zone stressor (e.g., a unit member seriously injured or

killed in a non-mission accident); (c) domestic stressor (e.g., long separation from or illness of family members and loved ones; divorce); (d) anticipation of war/combat activities (e.g., from missile attack alerts or fear of BW/CW attack); (e) physical/situational attributes of the war zone (e.g., severe climate or environmental conditions; long tours of duty; uncertainty about the war's duration); and (f) intraunit personal 'hassles' (e.g., personal conflicts in a unit; leadership problems or failure; harassment).³⁰⁹

Some of these stressful events are of particular significance in the context of the Gulf War. For example, troop exposure to "friendly fire" incidents (the inadvertent firing by U.S. forces on other U.S. forces) were and are likely to continue be a source of uniquely traumatic combat exposure. DOD reported to Congress in 1992 that the same factors that made for coalition success during the Gulf War—its rapid pace, a less structured battlefield, and more lethal and sophisticated weapons systems—also increased the risk of friendly fire casualties.³¹⁰ There were 28 incidents of fire from friendly forces resulting in the deaths of 35 service personnel and the wounding of 72 others.³¹¹ As these same factors will likely continue to characterize modern military conflict, service members who experience such events should be monitored over time and the information from that monitoring used to design and implement effective military health interventions and debriefings in future deployments.

Also, the additional physical and psychological burdens on troops stemming from possible offensive use of BW or CW during the Gulf War have been identified by military health researchers as a potential future source of stress exposure greater than that of more traditional military conflicts.³¹² Aspects of this include physical limitations and dangers from wearing chemical protective gear in a desert environment³¹³ and moderate to severe reactions of anxiety, panic, and claustrophobia estimated to occur in 10 to 20 percent of troops in one study.³¹⁴ Finally, stress from personal and family concerns likely played a more prominent role in the Gulf War deployment because it involved a greater number of married personnel and parents. For example, only 16 percent of those deployed in the Vietnam War were married with children. In contrast, in the Gulf War 60 percent—almost two-thirds—of U.S. service members and reservists were married with dependents, including approximately 32,000 single parents who had to make arrangements for their children during the deployment.³¹⁵

Finding: It is highly likely that troops in-theater were exposed to a wide array of very stressful and traumatic events and conditions.

Vaccines

DOD routinely administers vaccines to troops. Each service branch has different vaccine requirements upon entry into service, when individuals are assigned to groups likely to be deployed overseas, when troops are deployed, and for others engaged in certain high-risk occupations in the military.³¹⁶ Vaccinations generally administered include cholera, hepatitis A and B, influenza,

Japanese B encephalitis, measles, polio, plague, rabies, rubella, tetanus-diphtheria, typhoid fever (*Salmonella typhi*), varicella, and yellow fever.³¹⁷ During the Gulf War, approximately 150,000 doses of anthrax and 8,000 doses of botulinum toxoid vaccine were administered by DOD to protect against potential Iraqi use of biological warfare agents.

Anthrax Vaccine—The anthrax vaccine has been licensed by FDA since 1970. It consists of a series of injections: three injections over six weeks followed by three more injections over 18 months and an annual booster thereafter. Mild reactions at the injection site, such as pain or swelling, occur in about 30 percent of vaccinated persons. Flu-like symptoms occur in fewer than 0.2 percent of those vaccinated.³¹⁸ DOD uses the vaccine to protect individuals from anthrax exposure of the skin, lungs, and digestive tract. The vaccine is judged approximately 93 percent effective against the development of anthrax of the skin,³¹⁹ but there is limited data as to its effectiveness in protecting against inhaled anthrax, which can occur if anthrax is used as a BW agent and released into the air. Animal studies have demonstrated the protective effect of the vaccine against inhaled anthrax,³²⁰ but animal models do not necessarily apply to humans and studies in which humans are deliberately exposed to anthrax are unethical to perform. One study conducted in the 1960s followed 1,200 persons who were at risk of developing anthrax at their jobs (in this case, using imported goat hair to manufacture fabric).³²¹ The anthrax vaccine, not yet licensed at the time, was provided to some of these workers and all were followed to determine if the vaccine appeared to provide protection from anthrax. Five cases of anthrax through inhalation, four of which were fatal, occurred among the unvaccinated group; none occurred among those who were vaccinated.³²² CDC data on occupational anthrax cases in the United States from 1961 through 1974 identified 27 inhalation cases; none occurred among fully vaccinated persons but three cases occurred among persons not completing the full inoculation series.³²³ This data suggests that the vaccine can protect humans against inhaled anthrax but to date there is inadequate information to judge how well it works, particularly against weaponized anthrax, which could cause exposure to greater concentrations of anthrax than has occurred among workers exposed on the job.

Botulinum Toxoid Vaccine—The botulinum toxoid vaccine is not a fully FDA licensed product but, as discussed earlier in this chapter, as an IND it is administered to humans provided they give informed consent. Used for nearly thirty years to immunize laboratory workers and other persons at risk of the disease, 10,414 doses were administered from 1970 through 1990. Three doses are administered over a three month period and a booster is required one year after the first dose.³²⁴ Side effects included pain, redness, and swelling at the injection site.³²⁵ These symptoms occur in less than six percent of those receiving the initial three doses and about ten percent of persons receiving the booster. A few individuals (about 0.4 percent) have general flu-like symptoms and are unable to perform their duties for one to two days. The vaccine's ability to protect against respiratory exposure, such as might occur if botulinum toxoid was used as a biological warfare agent and released into the air, is unknown.³²⁶

Inadequate Record Keeping of Vaccine Administration During the Gulf War—During the Gulf War, DOD failed to keep adequate records to document which troops received the anthrax and botulinum toxoid vaccines. Nor did DOD comply with its agreement with FDA to keep detailed records on those receiving the botulinum toxoid vaccine as a condition for its use without obtaining informed consent from Gulf War troops. This lack of record keeping occurred despite FDA's modification of its initial record keeping requirements to accommodate DOD's explanation of limits to its ability to collect data during wartime. For example, FDA continued to require that DOD report unexpected life-threatening events connected with the use of the vaccine but permitted DOD to report these events "in as timely a manner as conditions permit" in lieu of requiring reports by phone within three days.³²⁷ DOD has defended its failure to note vaccine information on service members' permanent immunization records by claiming that information on which units received the vaccine was classified.³²⁸ In a July 1997 letter to DOD on this matter, FDA also noted that the number of botulinum toxoid vaccine doses DOD indicated it administered (8,000) and the number it returned "does not total the number of doses shipped." According to FDA's letter, DOD justified this discrepancy by stating that its "records of vaccine destruction were not maintained because its use occurred in a war zone."³²⁹

Squalene—A recent theory has emerged that some of the vaccines administered during the Gulf War contained squalene and that this may have been associated with the chronic, debilitating illnesses that have occurred among some veterans. Squalene is a natural, organic compound that is found in some oils, such as olive oil, and in the human body as a compound used in making cholesterol.³³⁰ According to FDA, squalene can be contained in a vaccine due to two different processes. It can occur as an adjuvant, which is an agent to enhance the immune response. FDA has stated to SIU investigators that none of the vaccines used during the Gulf War contained squalene as an adjuvant and the SIU has seen no credible evidence to the contrary. Additionally, extremely minute quantities of squalene could be found in vaccines manufactured using eggs, since eggs are rich in squalene and cholesterol. This type of manufacturing would affect vaccines in general, and not just vaccines administered to Gulf War veterans. As of the writing of this report, there is no peer reviewed literature that comments on the health effects of such exposure to squalene.³³¹

Potential Health Effects of Simultaneous Administration of Multiple Vaccines—Some have suggested that Gulf War veterans who received more than one vaccine at the same time are at increased risk of developing illnesses because their immune systems were somehow adversely affected by this vaccination process. This interesting theory would not only possibly affect veterans but also many children and adults who receive multiple vaccines simultaneously as part of routine, preventive health care. Additionally, in the course of life, the human body is exposed to many foreign agents simultaneously, as for example when numerous agents enter the body through a cut or scrape on the skin. Although it appears unlikely that simultaneous receipt of multiple vaccines contributed to Gulf War illnesses, there is insufficient data to appropriately evaluate this issue.

Finding: About 150,000 persons may have received at least one dose of anthrax vaccine and about 8,000 may have received one dose of the botulinum toxoid vaccine.

EFFECT OF MULTIPLE EXPOSURES ON GULF WAR VETERANS' HEALTH

Detailed records do not exist to describe the type and level of exposures that individual Gulf War veterans experienced that may have resulted in adverse health effects. However, it is clear that at least some troops deployed to the Gulf War were simultaneously exposed to many of these substances or agents. Science is only beginning to develop methods to better understand the interactive effects of many agents, and researchers are devoting time and effort to better clarify the health effects of such interactions. Recent research has demonstrated that some of the exposures that Gulf War veterans likely experienced can work together to cause adverse health effects at lower doses than would individual exposures to those agents. One example is recent research on the interaction between PB and some pesticides,³³² which is discussed in more detail in consultant reports found in Chapter Four and in the Appendix. Another potential interaction of possible concern is that of PB and exposure to heat. DOD documentation notes that because PB decreases the heart rate and increases sweating, it may interfere with troop ability to perform heavy workloads at high temperatures.³³³ Because so little is now known about the health effects of multiple environmental exposures, this area is one especially ripe for ongoing research.

POOR DATA COLLECTION ON GULF WAR EXPOSURES HINDERS CURRENT TREATMENT AND RESEARCH EFFORTS

Whether conducting research on Gulf War veterans as a whole or treating individual veterans, it is not enough simply to know that at least some of those troops likely were exposed to many potentially harmful agents during deployment. Especially when treating individual Gulf War veterans with unexplained symptoms, it is critical to know with some degree of certainty the type and level of that veteran's exposures to determine whether they contributed to his or her illness. Individual service personnel exposure levels could be identified in two basic ways. One method would ask the ill veteran to describe his or her exposures. However, gathering exposure data through a self-reporting method has several flaws, including that not every veteran would know or recognize many pertinent details related to certain exposures nor is it likely that accurate details would be remembered after the fact, especially some years later.³³⁴ Another method is to ensure that accurate written records of exposure are kept during a deployment so that they are available if needed in the future. For example, records could either document an exposure, such as the receipt of a vaccine, or troop physical location near certain exposures, such as being near oil-well fires.

During the Gulf War, however, almost no written records were kept describing exposure to any agent.³³⁵ DOD did compile several lists of toxic compounds such as pesticides that were used during the deployment,³³⁶ but there is no accurate data on how they were used or who came in contact with them and at what levels. Although much data exists quantifying air pollutant exposure from burning

oil fires, it was primarily collected after most troops had returned to the United States. Moreover, the morning reports kept during previous wars were not produced during the Gulf War. These reports could have helped provide data on the daily location of individual service members that cannot be recreated. DOD now attempts to keep such exposure-related records in the current Bosnia deployment as part of a comprehensive process that also attempts to quantify exposure by collecting environmental measurements and samples of blood and urine.³³⁷ These efforts should be evaluated to judge their completeness and effectiveness. During future deployments, troop exposure to chemical toxicants could be better evaluated if laboratory methods were developed to rapidly screen people for the presence of toxic chemicals. CDC has indicated it could develop the laboratory diagnostic capabilities to rapidly detect 150 toxic substances (including chemical warfare agents) in people. The SIU encourages DOD to provide CDC with sufficient funds to develop this capability.

POOR TRACKING OF GULF WAR HEALTH STATUS HINDERS CURRENT TREATMENT AND RESEARCH EFFORTS

In addition to exposure-related data that could have been but was not collected during the Gulf War, another tool that would be useful in treating and researching Gulf War veterans would be data on the health status of deployed troops before, during, and after their deployment. Standardized pre- and post-deployment physical examinations, including blood work, could provide baseline information to determine exactly how the health of veterans changed during or subsequent to the conflict. However, physical examinations were "not routinely provided to all members of the military, nor were they provided to many Guard and Reserve members called up for the Persian Gulf War."³³⁸ Most health-related data that would be a rich source of information on adverse health effects during deployment was either not collected or lost. Such information could have helped determine the extent and frequency of particular symptoms or diseases and might have provided clues as to exposures that may have contributed to them. Many in-theater hospitalization records do not exist, and according to DOD were lost or possibly burned.³³⁹ However, DOD recently revealed that some in-theater hospitalization records long thought to be lost have been found at the National Personnel Records Center located in St. Louis.³⁴⁰ These records could be useful in providing information about the types of health problems that resulted in hospitalizations during the deployment. DOD is currently planning to inventory these records, produce an index, and notify veterans whose records are identified.

Improved Medical Surveillance during the Gulf War Could Have Collected Important Health Information

In a medical context, surveillance is the ongoing and systematic collection, analysis, and interpretation of health data used in describing and monitoring a health event in order to plan, implement, and evaluate health interventions and programs.³⁴¹ As previously mentioned in this Chapter, during the Gulf War the only comprehensive medical surveillance performed on deployed troops was done by the Navy on a group of about 40,000 Marines and sailors stationed in northeastern Saudi Arabia. This surveillance process routinely collected information on heat injuries,

diarrhea, skin conditions, respiratory conditions, injuries/musculoskeletal conditions, eye problems, unexplained fevers, psychiatric conditions, and other problems.³⁴² These reports were used to calculate weekly disease and non-battle injury rates and allowed medical personnel "to respond immediately to problems and apply appropriate countermeasures."³⁴³ For example, detection through medical surveillance of high diarrhea rates in several units allowed medical personnel to avoid more cases by quickly identifying and removing certain local fresh foods which were found to be the cause. Other services did keep limited records on troop health, with Army records showing that approximately 200,000 soldiers were on sick call and 22,743 were hospitalized during the Gulf War deployment.³⁴⁴ However, this data cannot replace the kind of comprehensive ongoing medical surveillance performed by the Navy, which DOD has acknowledged "was a critical tool in immediately defining the major patterns of illness and injury in each Marine unit for most of the deployment."³⁴⁵ Based on the effectiveness of this surveillance system to effectively respond to conditions affecting troop health as they occurred, it is likely that a similar theater-wide surveillance system could have provided a mechanism to track other health events during this deployment about which little reliable data now exists.

HEALTH ISSUES FOLLOWING DEPLOYMENT

VA AND DOD ESTABLISH REGISTRIES TO EVALUATE GULF WAR VETERANS' HEALTH COMPLAINTS

After returning from the Gulf War, veterans began to report numerous health complaints, including memory loss, muscle and joint pain, fatigue, skin rashes, and gastrointestinal problems. In response to this, VA, and later DOD, established registries to collect health-related information about these veterans. While registries can serve multiple purposes, these were established with the primary purpose of gathering standardized information from questionnaires to describe veterans' exposure and health histories and to conduct comprehensive physical and laboratory examinations. The registries also record identifying information so that individuals with certain illnesses or diseases could be followed over time to determine how their health status has changed, although neither VA nor DOD have used the registries for this purpose. Registry information that has been collected has been entered into a combined VA and DOD computerized database that was established under a July 1997 memorandum of understanding between the two departments.³⁴⁶ However, these registries cannot be used by themselves to determine how many Gulf War veterans are ill, because there is no way to know whether all ill Gulf War veterans have participated in these programs. These registries do provide useful information to describe the health status of the Gulf War veterans who have voluntarily chosen to participate. Indeed, this is currently the only data source to describe the health status of a large group of Gulf War veterans who have undergone a standardized examination process to document their health complaints. Nevertheless, as discussed below, there are shortcomings in the registry programs that should be addressed in order to maximize the usefulness of these registries in helping ill Gulf War veterans.

VA's Persian Gulf Registry and Uniform Case Assessment Protocol and DOD's Comprehensive Clinical Evaluation Program for Persian Gulf War Veterans

The VA Persian Gulf Registry was mandated in 1992 by Public Law 102-585 and modified in late 1995.³⁴⁷ Any Gulf War veteran may participate in the registry, even if that person has no current health complaints. The examination consists of two phases. During Phase I, the veteran completes a standardized questionnaire on exposures during the Gulf War and health complaints and undergoes a physical examination with laboratory testing.³⁴⁸ According to the VA registry protocol, veterans with health problems that are undiagnosed after a Phase I examination should be referred to more extensive Phase II evaluations. VA modified the original registry in 1995 in response to comments from veterans, the General Accounting Office, physicians, Congress, and others. The revised registry collects information on ten symptoms and diagnoses (the original registry format only allowed for recording three symptoms and diagnoses, even if the veteran had more than that number of health problems). It also collects more information on exposures and birth defects and specifically allows for recording whether the veteran has an undiagnosed illness. VA facilities are reportedly updating information obtained from veterans who participated in the first registry with the revised registry forms.

DOD established a Gulf War veteran health registry—the Comprehensive Clinical Evaluation Program for Persian Gulf War Veterans (CCEP)—in June, 1994. The CCEP is available for “DOD beneficiaries (Persian Gulf War veterans not on active duty or retired; members of the full-time National Guard who are Persian Gulf veterans; Persian Gulf War veterans who are members of the Ready Reserve/Individual Ready Reserve/Standby Reserve/Reserve who are placed on orders by their units; and eligible family members of such personnel) who are experiencing illnesses that may be related to their service in the Persian Gulf.”³⁴⁹ DOD's CCEP is similar, but not identical to VA's registry, and functions to collect information on Gulf War veteran exposures and current health complaints and to refer ill Gulf War veterans for further treatment.

Differences Between VA and DOD Gulf War Registries

Although the VA and DOD Gulf War registries have similar goals, they differ in important ways. The two registries use different questionnaires. For example, unlike the VA registry, the CCEP does not ask about undiagnosed illnesses. In addition, almost every person who participates in the CCEP receives a diagnosis, however, that diagnosis may be a sign, symptom, or ill-defined condition (such as headache or abdominal pain due to gas)³⁵⁰ Thus, while VA may state that a Gulf War veteran with a headache has an “undiagnosed illness,” DOD may state that person has been diagnosed with a headache. These points should be kept in mind when comparing the participants in the two registries, particularly because the frequency of diagnosed diseases and reported symptoms will vary because of these differences in collecting information.

External Reviews of the Registries

The DOD registry has been reviewed by nationally prominent scientists who served on IOM Committees and the PAC.³⁵¹ In 1994, the Department of Defense asked the Institute of Medicine to review the adequacy of the CCEP regarding "1) difficult-to-diagnose individuals and those with ill-defined conditions; (2) the diagnosis and treatment of patients with stress and psychiatric conditions; and (3) assessment of the health problems of those who may have been exposed to low levels of nerve agents."³⁵² The IOM made specific suggestions to improve the CCEP. It suggested that undiagnosed illness patients be treated as early in the disease process as possible based on their symptoms and that DOD should evaluate treatment and examination referral patterns of ill Gulf War veterans overall. It recommended that DOD improve its screening for depression and substance abuse and that it provide special training and debriefing for troops who are deployed. The IOM also suggested that DOD and VA coordinate their activities better, especially with regard to ongoing treatment of ill Gulf War veterans.³⁵³ The SIU believes that, to date, DOD and VA have not adequately addressed these IOM recommendations.

In September 1996, VA asked the IOM to review the VA registry with "specific emphasis on (1) the protocol, (2) its implementation and administration, (3) outreach efforts to inform veterans of available services, and (4) education of providers."³⁵⁴ In a report issued in 1998 based on that review, the IOM provided a detailed and comprehensive set of recommendations for substantial changes to VA's registry program. The IOM found that physicians did not always follow the written standard registry protocol. It also found that many primary care physicians ordered tests during the "Phase I" process that were technically part of the "Phase II" process of the written protocol, an approach that the IOM believed may be more clinically appropriate and indicated that the terms "Phase I" and "Phase II" should be dropped. The IOM developed a recommended pathway for diagnosing health problems of Gulf War veterans and encouraged its adoption in order to increase the role of primary care physicians, decrease spending of unnecessary resources, and establish a standard approach to patients with undiagnosed illnesses. The IOM also recommended that the initial registry evaluation be expanded. To accomplish this, it suggested that a national group of experts be brought together to determine how to revise the questionnaire, expand the laboratory examinations, and conduct periodic reevaluations of each portion of the initial examination. It also recommended that VA develop clinical practice guidelines for the most common "symptoms, and the difficult-to-diagnose, ill-defined, or medically unexplained conditions"³⁵⁵ of Gulf War veterans and for "the evaluation and management of women's health issues,"³⁵⁶ and that VA should "plan for and include periodic reevaluations of the clinical needs of . . . undiagnosed patients."³⁵⁷

The IOM further recommended that the VA develop a "formal mechanism that enables practitioners to provide feedback on the practice guidelines and the diagnostic process used in the VA clinical program for Persian Gulf Veterans."³⁵⁸ In addition, the IOM suggested that the referral process be modified and that VA "establish an evaluation feedback mechanism that includes the elements of a performance improvement system."³⁵⁹ It proposed better monitoring of quality of care

and patient satisfaction, more consistent data reporting across VA facilities, and systematic updating and incorporation into databases of individual patient information. The IOM also recommended improved outreach and education of primary health care providers.³⁶⁰ All of these recommendations would substantially improve VA's Persian Gulf Registry in its ability to provide quality care to Gulf War veterans, and the SIU believes that VA should implement these changes as rapidly as possible.

Demographic and Health Status Profiles of Registry Participants

Although both Gulf War veteran health registries have limitations and should be improved, the information they have collected to date does provide useful insight into the health complaints of a large group of those veterans. The most recent report describing registry participants provides information through December 1997 for the CCEP and November 1997 for the VA registry.³⁶¹ In all, 83,197 persons, or 12 percent, of the 696,530 potential Gulf War veterans, had participated in the registry programs. Table 2 sets out data describing demographic and other pertinent characteristics of those veterans.

The five figures that follow represent time lines of numbers of registry program participants on a monthly basis. As the figures demonstrate, participation in the VA registry gradually increased until the fall of 1994, then tapered off. A slight increase in participation followed the July 1996 announcement of the U.S. troop demobilization of Khamisiyah with potential release of chemical agent into the atmosphere. Relatively large numbers of Gulf War veterans participated in the DOD CCEP from late 1994 through mid-1995. As was true for the VA registry, these numbers tapered off but then increased following the Khamisiyah announcement. Each month a larger number of male service members participated than female service members, but there was no other apparent difference in monthly participation on the basis of gender. Larger numbers of active duty personnel participated in the DOD CCEP than reservists, and reservists were more likely to participate in the VA registry than in DOD's. The VA registry has also had more equal participation of active duty and reservists as compared with the DOD CCEP. Larger numbers of Gulf War Army veterans participated each month than any other branch of the services, however, as shown by Table 2, the Army composed 50 percent of troops in the Gulf War deployment.

The registries also provide information about the most common diagnoses for participants. Unfortunately, the two sets of VA registry data (from the original registry and from the registry as revised in 1995) and the CCEP differ in how they have collected data, as described earlier, and thus are difficult to compare. However, Table 3 presents the most frequent diagnoses, and Table 4 presents the most common symptoms reported by participants. Although the registries differ, this information is still useful to develop a sense of the most common diagnosis and symptoms of the veterans who have participated. As can be seen from these tables, the diagnosis and symptoms of Gulf War veterans vary greatly and encompass multiple body systems. These diagnoses and symptoms should not be viewed as representative of all Gulf War veterans, but only reflecting the health problems of veterans who participated in the registries.

In testimony before the House Veterans' Affairs Committee, the VA Under Secretary for Health stated that from ten to twenty-five percent of registry participants have unexplained illnesses, depending on how that term is defined, and that he believes this is about the same percentage that would be expected in a general medical practice outside of VA.³⁶² Another VA official testified at that hearing that about twelve to fifteen percent of participants have no health problems but have voluntarily chosen to take part in the registry.³⁶³ These statements, however, should be reevaluated based on the limitations of the registry that were pointed out by the IOM.

Table 2. Characteristics of United States Military Service members Who Participated in the Gulf War (GW) Theater of Operations and the Department of Defense (DOD) or Department of Veterans' Affairs' (VA) Gulf War Registries, 1997.

Characteristic	Gulf War Service members (n=696,530)	DOD and VA Gulf War Registry Participants (n=83,197) %
Male gender	89	90
Race		
White	65	62
Black	22	26
Hispanic	5	6
Other/Unknown	8	6
Age group (1991)		
<25	42	33
25-34	40	39
35-44	16	22
45-54	3	5
55-64	<1	<1
≥ 65	0	0
Service branch		
Army	50	77
Marine	15	11
Navy	23	6
Air Force	12	7
Unit Status		
Active	84	71
Reserve/Guard	16	29
Rank		
Enlisted	89	92
Officer	10	6
Other/Unknown	1	2

Note: Percentages may not total to 100 due to rounding.

Figure 6. Monthly Numbers of Participants in a Gulf War Exam by Registry Type, August 1992 through November 1997.

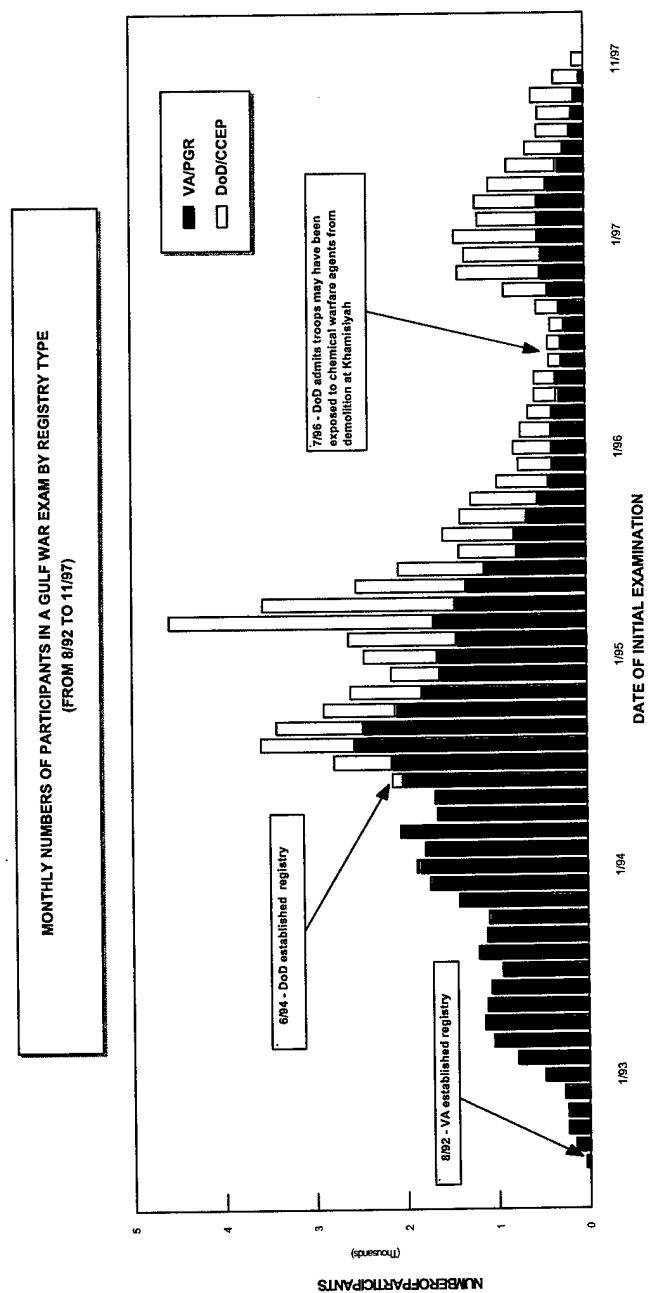


Figure 7. Monthly Numbers of Participants in a Gulf War Exam by Gender, August 1992 through November 1997.

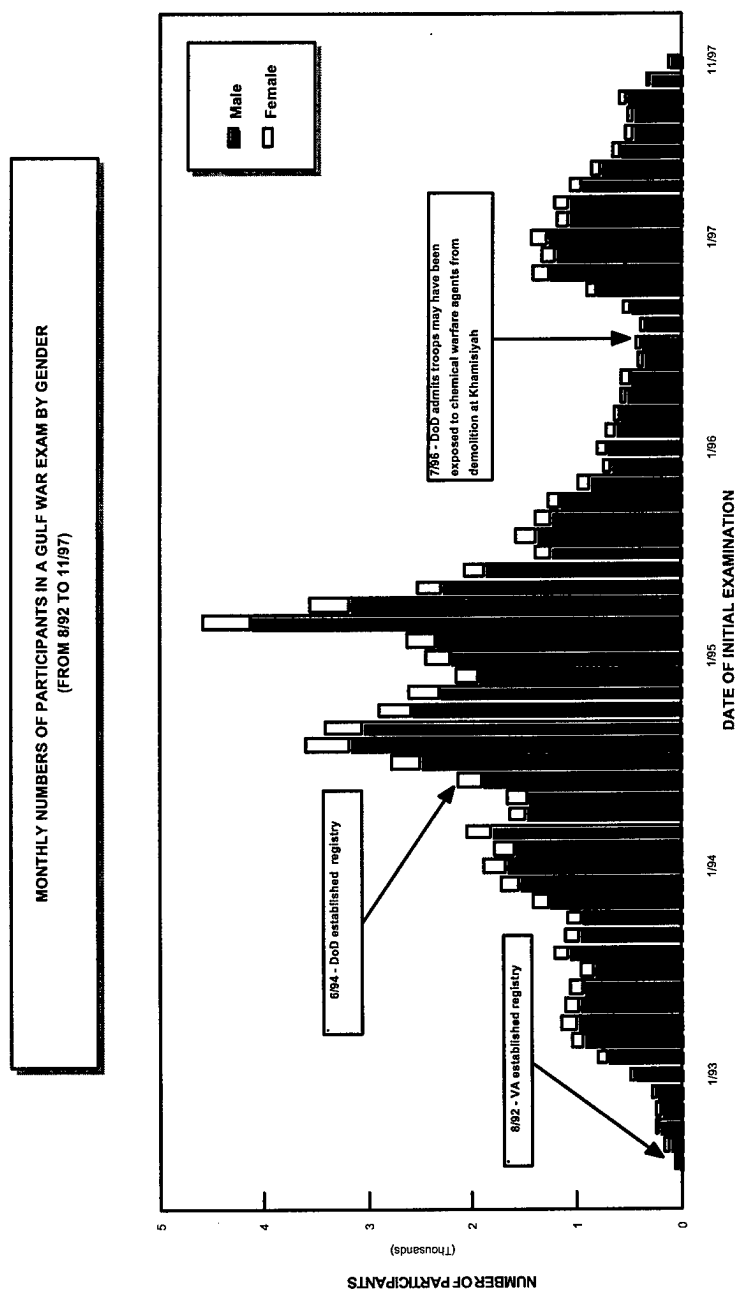


Figure 8. Monthly Numbers of Participants in a Gulf War Exam by Registry Type and Unit Component During the Gulf War, August 1992 through November 1997.

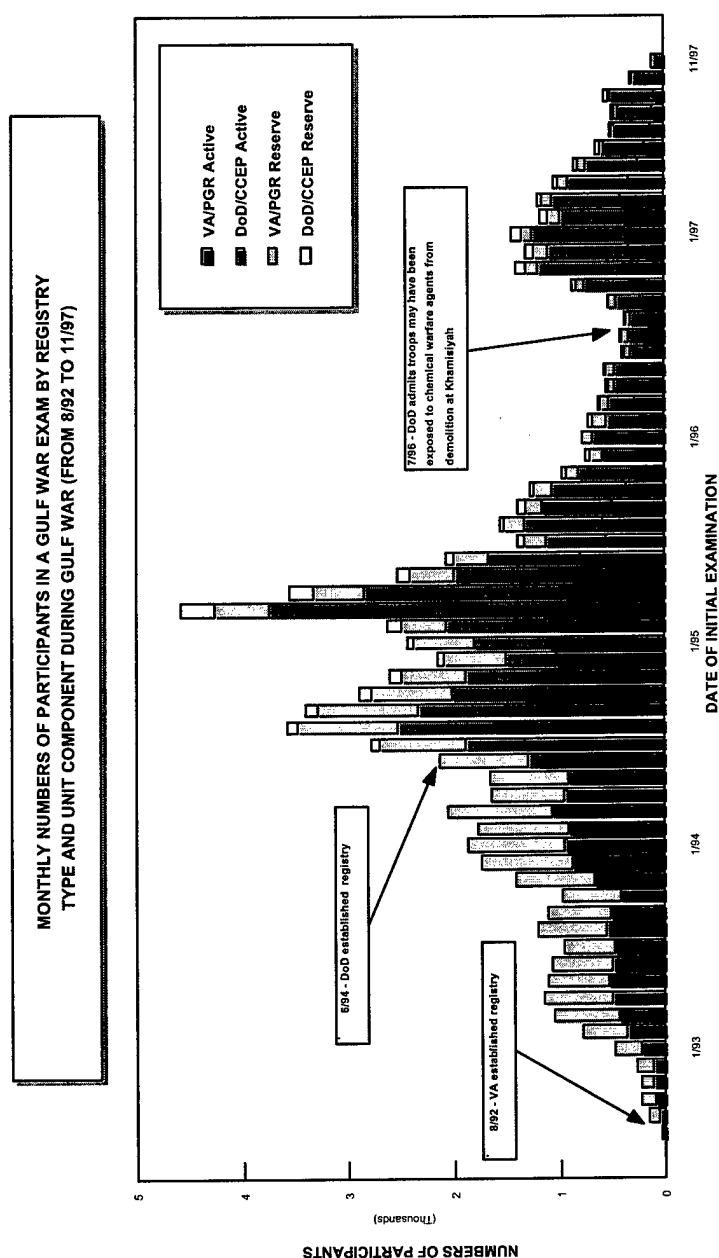


Figure 9. Monthly Numbers of Participants in the Department of Veterans' Affairs Persian Gulf Registry Program (VA/PGR) by Branch of Service, August 1992 through October 1997.

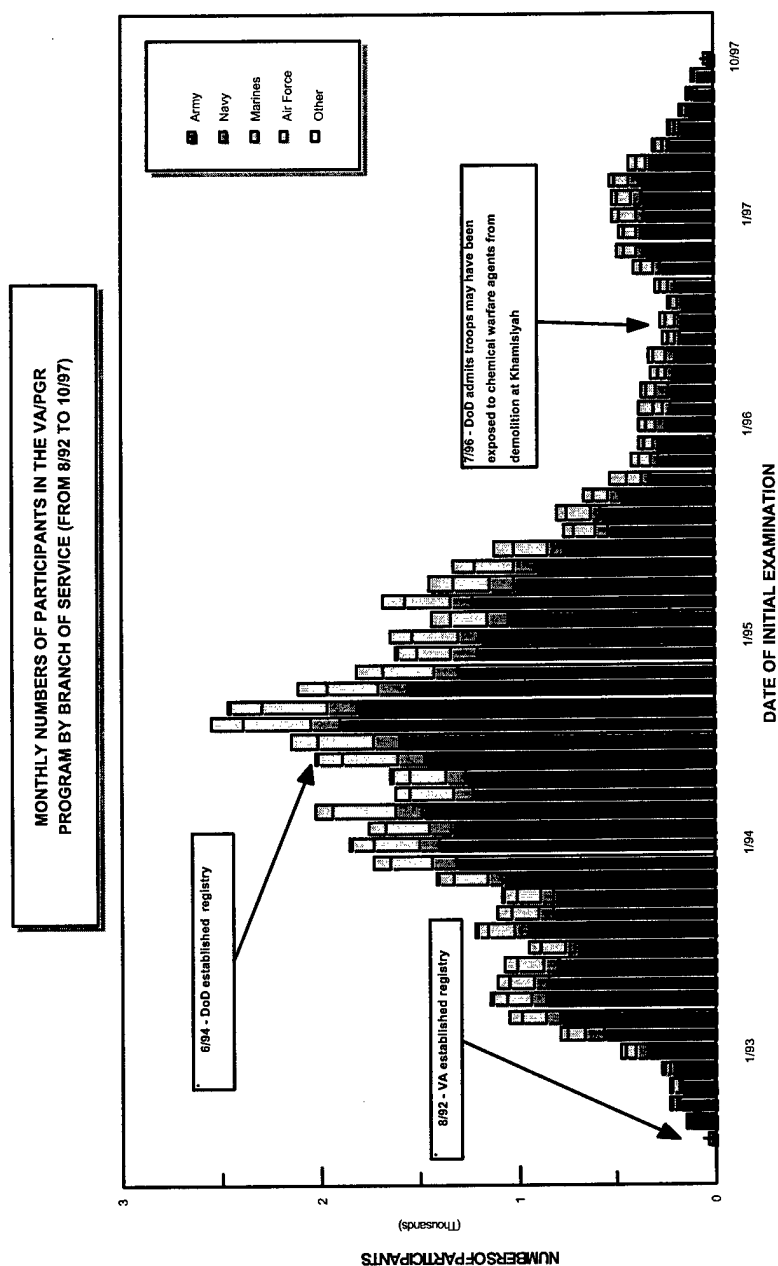


Figure 10. Monthly Numbers of Participants in the Department of Defense's Comprehensive Clinical Evaluation Program (DOD/CCEP) by Branch of Service, January 1994 through November 1997.

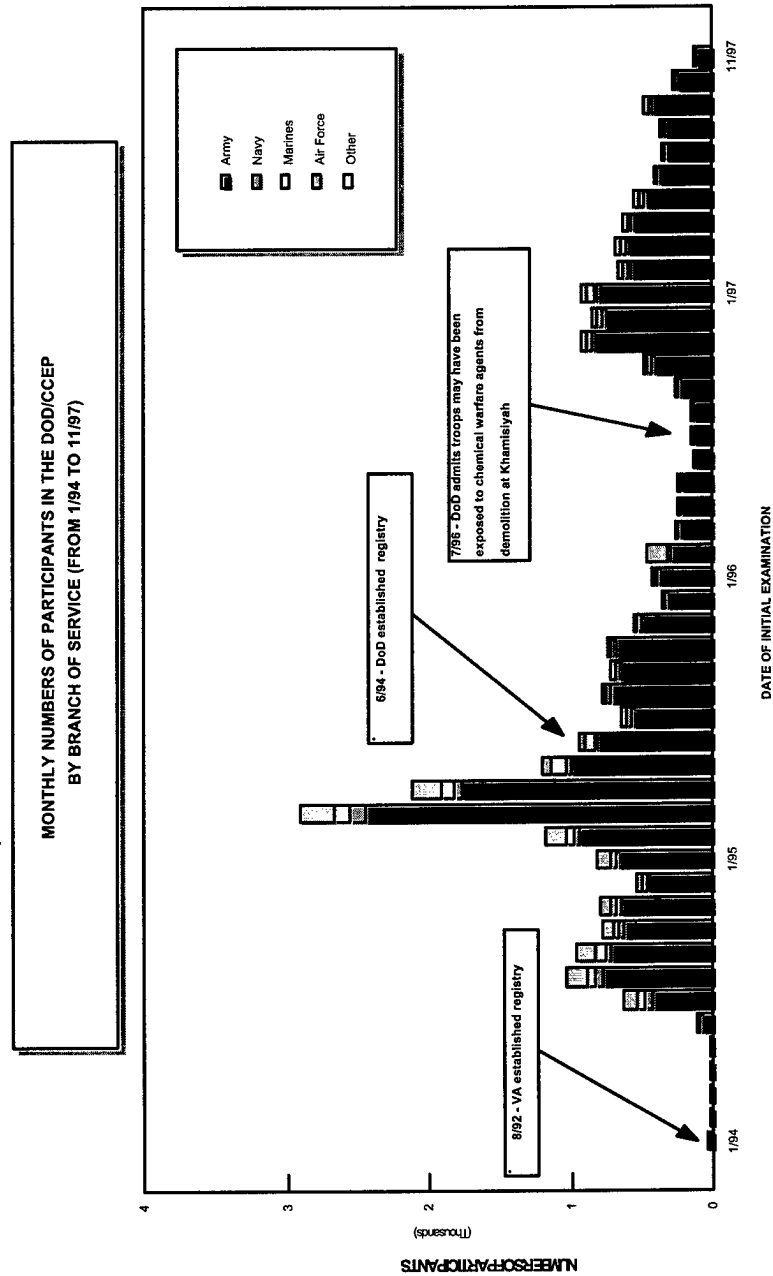


Table 3. Distribution of Diagnoses of United States Military Personnel Who Participated in the Gulf War (GW) Theater of Operations and the Department of Veterans' Affairs (VA) Gulf War Registry (PGR) or the Department of Defense's Comprehensive Clinical Evaluation Program (CCEP), 1998.³⁶⁴

Diagnosis	Old GWR (n=48,251) %	New GWR (n=9,002) %	CCEP (n=27,747) %
Musculoskeletal and Connective Tissue	25	36	48
Mental Disorders	15	33	35
None Given	32	26	21
Skin and Subcutaneous Tissue	13	19	19
Respiratory System	14	18	16
Nervous System	8	16	17
Digestive System	11	16	20
Injury and Poisoning	5	11	3
Circulatory System	7	10	8
Infectious Disease	7	9	9
Genitourinary System	3	6	5
Neoplasm (Malignant)	<1	1	<1

Table 4. Distribution of Common Complaints of United States Military Personnel in the Gulf War (GW) Theater of Operations Who Participated in the Department of Veterans Affairs (VA) Gulf War Registry (PGR) and the Department of Defense's Comprehensive Clinical Evaluation Program (CCEP), 1998.³⁶⁵

Complaints	Old PGR (n=48,251) %	New PGR (n=9,002) %	CCEP (n=27,747) %
Muscle, Joint Pain	16	51	58
Fatigue	21	25	52
Headache	18	27	45
Loss of Memory/Other General Symptoms	14	30	40
Shortness of Breath	8	11	40
Diarrhea/Other	5	14	27
Gastrointestinal			
Skin Rash	19	26	25
Sleep Disturbances	6	13	18
No Complaint	12	10	7

GULF WAR VETERANS AND THE DILEMMA OF UNEXPLAINED ILLNESSES

Data from the VA and DOD registries demonstrate that many Gulf War veterans are ill with health complaints that involve a variety of body organ systems (e.g., musculoskeletal, gastrointestinal, and nervous systems). As the registry data indicates, Gulf War veterans do not share a single medical diagnosis or "disease" characterized by a single set of symptoms (complaints) and signs (objective evidence of disease, such as temperature or abnormal laboratory results).³⁶⁶ Thus, there is no single "Gulf War syndrome." Rather, these veterans are best described as suffering from unexplained "illnesses," some of which very debilitating but are nevertheless not easily identified by medical professionals as part of a known clinical syndrome.

This distinction between "diseases" and "illnesses" is not unique to Gulf War veterans but is one that hinders any research investigation of new, unexplained, or previously unrecognized conditions

or diseases.³⁶⁷ One way to understand this distinction is to view "illness" as the health changes experienced and reported by the patient while "physicians diagnose and treat 'diseases' . . . abnormalities in the structure and function of body organs and systems."³⁶⁸ Thus, Gulf War veterans who were physically and mentally healthy enough to be deployed but after the war developed symptoms and decreases in physical functioning after the war have experienced "illness." However, as many Gulf War veterans have reported, their initial complaints that they were ill as a result of their Gulf War service were countered by physicians' responses that they could find nothing wrong and that there was no "disease."³⁶⁹ As a result, many Gulf War veterans are frustrated and left with many unanswered questions about why they are ill and whether their health will improve. Similarly, health care providers also report frustration in being unable to provide treatment that effectively improves the health of Gulf War veterans with unexplained illnesses.

Understanding the Link Between War Experiences and Health

The unexplained illnesses of Gulf War veterans do not represent the first time that concerns about veterans' health have arisen after a war. Unexplained or poorly understood illnesses among veterans were identified during the Civil War and both World Wars. Post-traumatic stress disorder among Vietnam veterans was first referred to as "post-Vietnam syndrome."³⁷⁰ However, historical medical data—especially clinical descriptions dating back to the 1800s and early part of this century—are difficult to compare with modern medical data, especially because "the psychological aspects of illnesses were not as well appreciated and reported in the past."³⁷¹ Moreover, modern improvements in overall health and nutrition make it difficult to compare the health of military populations of different eras.³⁷²

However, unanswered questions about Gulf War veterans' health can be better understood by reviewing past attempts to examine the relationship between veteran health and exposure to combat and war trauma. One of the few studies that examined chronic long-term health problems associated with war trauma and post-traumatic stress disorder (PTSD) in Vietnam veterans found that those with a history of PTSD were at higher risk for a number of physical diseases than those without PTSD. The study found those with PTSD to have a higher lifetime prevalence of a range of physical diseases as many as 20 years after military service.³⁷³ This study suggests there may be a strong link between exposure to trauma and a broad spectrum of physical diseases, such that the medical implications of exposures to severe environmental stress like combat should be considered when examining illnesses among combat veterans.³⁷⁴ Moreover, the literature on physical health outcomes associated with exposure to a variety of traumatic events has been described as "impressive for the consistency of results showing that exposure to catastrophic stress is associated with adverse health reports, medical utilization, morbidity, and mortality among survivors."³⁷⁵ This strong evidence of a link between the fact of wartime service and subsequent health problems should be drawn upon by VA and DOD in devising prevention and medical follow-up strategies for future military deployments.

ATTEMPTS TO DEVISE CASE DEFINITIONS FOR UNEXPLAINED ILLNESSES

Another problem presented by the “unexplained illnesses” of Gulf War veterans is that without an identifiable disease or diseases, research into possible causes of these illnesses is made much more difficult. In order to do epidemiological studies on Gulf War veterans—that is, conducting research on the illnesses affecting members of that group of veterans and what factors may have triggered them—researchers must first determine what constitutes an illness by developing a case definition. “Case definitions” describe what specific criteria must be met in order to classify a person as having a particular disease and ensures that those being studied have as “homogeneous a disease entity as possible”³⁷⁶ so that studies include only those with the same disease when searching for a possible cause for that disease. Although there have been attempts to develop a case definition for Gulf War veterans with undiagnosed illnesses, there is no accepted definition. Research funded by CDC is now underway to develop an accepted case definition for Gulf War undiagnosed illnesses.³⁷⁷ The purpose of the study, to be conducted by the Robert Wood Johnson Medical School, is to “characterize and compare alternative classifications for symptoms and functional disability which remain medically unexplained in Gulf War veterans.”³⁷⁸ Advantages to developing a case definition for undiagnosed illnesses in Gulf War veterans include aiding researchers in identifying groups at increased risk of illness and providing clues about possible causes of or what risk factors may be associated with the illness.

Diagnosable Conditions and Death Rates in Gulf War Veterans

In addition to undiagnosed illnesses, as the entries on Table 3 indicate, many Gulf War veterans have diagnosable health conditions. Researchers have examined the morbidity (meaning “prevalence or incidence of a disease or of all diseases in a population”³⁷⁹), mortality (rates of death), and reproductive outcomes for Gulf War veterans to detect any patterns or increases in specific diagnoses or deaths in this population. These studies have been summarized previously by the PAC and IOM³⁸⁰ and are addressed in several of the consultant reports in Chapter Four and the Appendix. In general, studies to date have not found Gulf War veterans to have an increased number of deaths, hospitalizations for disease, or birth defect rates among their offspring as compared with non-deployed veterans.³⁸¹ These findings must be viewed in light of limitations of these studies such as inability to accurately estimate exposures or to generalize results to the entire Gulf War veteran population because, for example, some groups at increased risk of health problems were excluded.

However, an increase in accidental death, particularly from motor vehicle accidents has been found among Gulf War veterans. This heightened death rate from accidents has been observed for Vietnam and Korean War veterans as well.³⁸² For example, a CDC study found a significantly higher postwar death rate from motor vehicle accidents among Army veterans who had served in the Vietnam War compared to Vietnam-era Army veterans who were stationed elsewhere. This increase did not appear to be related to elevated blood alcohol levels.³⁸³ Moreover, a study of Vietnam-era

female veterans found that women veterans who had served in Vietnam had a threefold risk of dying from injuries sustained in a motor vehicle accident than women veterans who did not serve there.³⁸⁴

CONCERNS ABOUT THE HEALTH OF GULF WAR VETERANS' FAMILY MEMBERS

As VA and DOD developed registry programs to address Gulf War veterans' health concerns, reports surfaced of developing health concerns in the family members of Gulf War veterans, including fears about a higher incidence of birth defects in children of Gulf War veterans. There were anecdotal reports of spouses and children of veterans developing similar symptoms, and concerns about the reproductive health of the spouses and partners of Gulf War veterans. In addition, some feared that the health problems experienced by Gulf War veterans may have been secondary to an infectious agent or transmittable illness, despite the lack to date of clinical findings or scientific evidence to support such a theory.

Persian Gulf Spouse and Children Examination Program

To address these concerns about family member health, the Persian Gulf Spouse and Children Examination Program was created by Congress under Section 107 of the Persian Gulf War Veterans' Benefits Act (P.L. 103-446). This legislation provided for VA to conduct a pilot study to contract with medical center affiliates to perform medical exams of spouses and dependents of Gulf War veterans. Congress authorized \$2 million for this pilot program and directed VA to enter information collected under the program into the Persian Gulf Registry for the purpose of evaluating for any potential association between health problems of the family members of veterans and the veterans' service in the Gulf.

There was significant resistance by VA to implementing this program, and debate over the intent of the legislation authorizing the spouses and dependents program continued for well over a year after the law was enacted. VA had been directed to start this program immediately after enactment in November 1994, but the program did not begin until 18 months later.³⁸⁵ VA sought to interpret the legislative intent in creating the program as providing for an already-planned epidemiological study of randomly selected spouses and children of Gulf War veterans. However, Congress and the White House both saw the statute as clearly providing a program for voluntary medical evaluations (but not treatment) of spouses and children with health concerns potentially related to the veterans' Gulf War service.³⁸⁶ The Persian Gulf Spouse and Children Examination Program was finally started by VHA on April 1, 1996, with 36 VA medical centers across the country designated to coordinate the program.

In reviewing VHA's implementation of this program, GAO found a number of significant problems. Some of these problems appear related to VHA's increasing decentralization of health care programs, with little oversight existing except at the level of the 22 Veteran Integrated Service Networks (VISNs). Because VA medical centers do not provide care for spouses or children of

veterans, they were to contract with an affiliate medical center to provide program examinations. However, a number of the designated medical centers failed to do so, with the result that evaluations for spouses and children of Gulf War veterans were in fact not being provided and VHA headquarters officials were largely unaware of this fact until GAO made inquiries about the program in January of 1998.³⁸⁷ Turnover in key VA medical center personnel and VA's failure to require monthly activity reports from coordinating centers until a year and a half after the start of the program were identified by GAO as reasons why VA had not fully monitored this program's status.

GAO also found uneven efforts to inform Gulf War veterans of the availability of the program and a number of potential barriers to participation in the Persian Gulf Spouse and Children Examination Program. For example, veterans' requests for examinations cannot be made through a local medical center; they must be coordinated through the Persian Gulf War Veterans' Helpline, with the average time from an initial request to the completion of the examination stretching to over 15 weeks. Geographic distance from a center providing exams was another major deterrent for many families, especially because VA does not reimburse for travel expenses. As of January 1998, 2,802 evaluations had been requested but only 872—less than one-third—had been completed. GAO reported that less than seven percent of the \$2 million appropriated for this program—only \$148,916—had been spent as of February 1998.³⁸⁸

In order to improve participation rates, GAO recommended that VA simplify the process for requesting and scheduling evaluations, offer the examinations in more locations, seek approval to reimburse participants for travel expenses, and increase the capacity of VA's Office of Public Health and Environmental Hazards to monitor the implementation of the program in the field. GAO noted that the program of clinical examinations offered through this program are not likely to resolve the issues related to whether illnesses among family members are related to the illnesses of Gulf War veterans.³⁸⁹ However, because the Persian Gulf Spouse and Children Examination program provides family members of veterans with an opportunity to visit a physician and receive a free medical examination, the greater value of the program may be that it is a way to address and perhaps resolve the fears and concerns of individual veterans as to whether exposures that they may have experienced during their service may have adversely affected the health of their families.

OVERVIEW OF INDEPENDENT SCIENTIFIC PANEL REPORTS ON GULF WAR HEALTH CONSEQUENCES

As part of the national response to concerns about the emergence of unexplained illnesses and health problems of Gulf War veterans, a number of independent, scientific panels were convened to examine these health issues and to make health policy recommendations to the federal agencies involved. This section provides a brief, chronological overview of the health findings of the major independent scientific review boards that examined these issues. Published reports are available on the complete findings and recommendations of each of these groups. The common goals of all these groups were to study reports of undiagnosed and diagnosed illnesses among Gulf War veterans, to

examine the environmental exposures that were present in the Gulf, to evaluate the biological plausibility of various illness etiologies, and to review the information available on the incidence and prevalence of these health problems.

Institute of Medicine: Health Consequences of Service During the Gulf War

In response to Public Law 102-585, the Committee to Review the Health Consequences of Service During the Persian Gulf War was assembled in December 1993 by the Medical Follow-Up Agency of the Institute of Medicine (IOM). The IOM issued an initial report in January 1995 and a final report in October 1996. It was tasked to assess the effectiveness of DOD and VA to collect and maintain data on the health of Gulf War veterans and make recommendations on improving the collection and maintenance of such data. It was also asked to determine whether there was a sound scientific basis for an epidemiological study of the health consequences of service in the Gulf, and if so, to make recommendations about the design of such studies. The complete set of findings and recommendations are contained in the Institute of Medicine's 1995 and 1996 reports, Health Consequences of Service during the Persian Gulf War.

The IOM committee found that problems with the collection and maintenance of health information of service-related personnel had adversely affected any subsequent efforts of researchers and medical caregivers to evaluate Gulf War veterans' health concerns. They identified the need for DOD and VA to work together to "develop, fund, and staff medical information systems that include a single, uniform, continuous, and retrievable medical record" for each service member.³⁹⁰ The IOM committee also recommended that VA and DOD work together to expand and expedite plans for a shared basic epidemiological data system, the Defense Medical Epidemiological Database.³⁹¹ Their report stressed the need to examine DOD capabilities to evaluate the health significance of geographically defined exposures of troops over time in areas of conflict, and they recommended that DOD support military medical preparedness through increased monitoring of natural and man-made environmental exposures and planning for rapid response and investigation of known or possible exposures in specific theaters of operation. The importance of accurate data collection and maintenance of such exposures was also emphasized.³⁹²

The final report of the IOM committee noted that a number of large epidemiological studies were already well underway and thus no new nationwide study of Gulf War veterans was advised. The committee recommended that death rates of Gulf War veterans should be monitored on a regular basis for up to 30 years and compared to rates for Gulf War-era veterans who were not deployed to the Gulf.³⁹³ Finally, the IOM committee recommended that the Congress, VA, and DOD should require that unless there are clear and justifiable reasons not to do so, requests for research proposals on Gulf War-related health issues should be publicly announced to the scientific community at large and peer reviewed by appropriately qualified scientific experts who would evaluate the scientific merit and rigor of such proposals and then make funding recommendations to the granting agencies.³⁹⁴

National Institutes of Health (NIH) Technology Assessment Workshop

The NIH Technology Assessment Workshop on the Persian Gulf Experience and Health convened on April 27-29, 1994 and was sponsored jointly by HHS, VA, DOD, EPA, and the Office of Medical Applications of Research of NIH. The panel was composed of scientific experts in fields including environmental and occupational health, international medicine, neurology, and toxicology, all of whom were drawn from outside the federal government. The panel noted problems with the lack of clear information about the types and levels of possible exposures in the Gulf and the need for a case definition. The panel suggested that there may be multiple illnesses with overlapping symptoms and causes and criticized the failure to develop a uniform protocol to examine Gulf War veterans across military service branches, VA facilities, and civilian physicians. Further, it suggested that the failure to do so contributed to the lack of a clear description of Gulf War veterans' health problems. The panel also recommended types of epidemiological studies that could help address these issues.³⁹⁵

Defense Science Board Task Force on Persian Gulf War Health Effects

The Defense Science Board Task Force on Persian Gulf War Health Effects was also established in 1994 by the Under Secretary of Defense for Acquisition and Technology.³⁹⁶ This Task Force was set up to review available intelligence information and reports regarding possible exposures to chemical and biological weapons, scientific and medical literature on health effects of low level exposures to nerve agents, and other potential health consequences resulting from potentially hazardous exposures in the Gulf. In its report, the Task Force concluded that there was "no persuasive evidence that any of the proposed etiologies caused chronic illness on a significant scale in the absence of acute injury at initial exposure."³⁹⁷ It described the overall health experience of this conflict as very favorable in comparison to other wars and suggested that the background of low non-combat and combat-related disease during the Gulf War had highlighted "residual health problems" in this population.³⁹⁸

The Task Force also concluded that there was no scientific evidence that chemical or biological weapons were used during the Gulf War nor was there evidence of exposures to BW or CW agents, with the exception of a single instance of mustard agent blister injury in the postwar period. It found no epidemiological evidence to support the existence of a single, well-defined syndrome, suggested that a number of cases resembled a chronic fatigue syndrome, and recommended that clinical treatment be directed toward symptom management. The panel recommended significant improvements in DOD's pre-and post-deployment medical evaluations and record keeping. Finally, the Task Force recommended that as "high-tech, low-casualty military campaigns in exotic places" continue, further research is needed to evaluate residual health effects of such deployments.³⁹⁹ However, following the 1996 disclosure of a low-level release of nerve agent during the U.S. demolition of the Khamisiyah munitions depot, the Task Force's chair, Dr. Joshua Lederberg, questioned some of the report's findings. He stated in an interview that the panel was unaware of the events at Khamisiyah when it wrote its report and suggested additional research into the potential for chronic health effects as a consequence of low-level exposures to nerve agents.⁴⁰⁰

The Presidential Advisory Committee on Gulf War Veterans' Illnesses

On May 26, 1995, President Clinton established the Presidential Advisory Committee on Gulf War Veterans' Illnesses (PAC). The PAC was tasked with conducting a full review of governmental activities related to Gulf War veterans' illnesses, including research, coordinating efforts, medical treatment, outreach, risk factors, and chemical and biological weapons. In addition, it was asked to examine the work of other governmental and nongovernmental scientific panels. The 12-member panel, made up of veterans, policy experts, scientists, and health care professionals, held a series of open meetings from August 1995 through November 1996. Following release of its final report in December of 1996, the President renewed the PAC's charter to continue oversight of DOD investigations of possible chemical and biological warfare exposures during the Gulf War. The PAC issued a supplemental special report in October of 1997.

In its final report, the PAC noted important parallels in the post-conflict health experience of Gulf War veterans' and those of Vietnam veterans, with several recommendations focused on the need to better understand, and hopefully prevent, veterans' post-conflict health concerns.⁴⁰¹ They recommended that a Presidential Review Directive be issued to develop "an interagency plan to address health preparedness for and readjustment of veterans and families after future conflicts and peacekeeping missions."⁴⁰² The 1997 supplemental report noted continued difficulties with DOD's medical record keeping, assessment of environmental health threats, and other health measures such as compliance with FDA agreements on the use of an investigational vaccine in the Bosnia deployment. In particular, it characterized DOD's performance in complying with the FDA agreement for the investigational new drug, a vaccine for tick-borne encephalitis, as an "abysmal failure" and concluded that DOD had shown itself incapable of evaluating such investigational products during deployments.⁴⁰³

The PAC concluded that in general the government had acted in good faith in responding to the health concerns of Gulf War veterans but found shortcomings in the availability of treatment for Gulf War veterans, especially in the areas of mental health and reproductive health. They described concerns about VA's lack of coordinated follow-up care of Gulf War veterans by knowledgeable health care providers. The PAC also found that additional research was needed in areas such as the long-term health effects of low-level exposures to chemical warfare agents and possible synergistic relationships between PB and other exposures in the Gulf, but cautioned that federal research funds should not be awarded outside a competitive peer review process to keep research funding a scientific process rather than a political one.⁴⁰⁴ The PAC also expanded upon previous evaluations of the potential effects of stressful wartime exposures on the subsequent health of veterans, noting the many physical manifestations of stress, including that it can "affect the brain, immune system, cardiovascular system, and various hormonal responses."⁴⁰⁵ A number of the PAC's comments on stress were imprecisely phrased and, taken out of context, were criticized for focusing on "stress" to the exclusion of other possible risk factors that may be causes of Gulf War veterans' unexplained illnesses.

LONG-TERM HEALTH CONSEQUENCES OF GULF WAR EXPOSURES

Because of the lack of exposure and health data from the Gulf War and the inherent complexity of the inquiry into why Gulf War veterans are ill, a complete answer may never be possible. However, the SIU engaged several nationally recognized scientific experts to provide some specialized insight into the difficult questions of potential short- and long-term health effects from a variety of exposures Gulf War veterans likely experienced. The SIU identified experts with the assistance of independent organizations, such as the American Association for the Advancement of Science, U.S. Centers for Disease Control and Prevention, National Institutes of Health, and Association of Occupational and Environmental Clinics. These experts looked at various types of exposures in their area of specialization and the potential health effects associated with those exposures. Experts included researchers who have examined short- and long-term health effects associated with pesticide use in populations who work with pesticides to provide observations on the use of pesticides in the Gulf and any expected adverse health effects. Others specialized in health effects of indoor and outdoor air pollution in the general population, and assessed air pollutants in the Gulf and their potential health effects. Still other experts reviewed available information about exposures to the wide range of chemicals present in the Gulf (e.g., solvents, depleted uranium, pyridostigmine bromide, organophosphates, etc.) to provide information about the potential risks for the development of central nervous system damage, reproductive problems, and cancers.

In reports submitted to the SIU, these experts provided information on what health effects could be expected in the general population, the veteran population who had been in the Gulf, or subgroups of that population who may be at increased risk. The consultants also reviewed existing scientific studies on Gulf War veterans, as well as other populations who have experienced similar exposures (e.g., individuals who work with those particular chemicals). In their reports, most of the consultants noted that the limited information to document exposures during the Gulf War hindered their capability to adequately address what types of health problems, if any, could occur from those exposures. The consultants also provided recommendations on additional studies that could be done, and what health practices the military should consider changing or implementing. Summaries or the full text of their work appear in the following chapter; the full text of the summarized reports appears in the Appendix. Because these reports necessarily are based on information now available, the SIU does not regard these expert reports as the final word on these subjects. However, the SIU believes that the work of these experts provides a broad picture of what is known about possible reasons for illnesses among Gulf War veterans and contains important recommendations for the future. These consultant reports should prove valuable in the ongoing national dialogue about why so many Gulf War veterans are ill.

CURRENT STATE OF TREATMENT OF GULF WAR VETERANS BY DOD AND VA

Department of Defense: Walter Reed Army Medical Center's Gulf War Health Center

To help coordinate implementation of its CCEP registry programs for Gulf War veterans and to provide primary and tertiary care CCEP evaluations, in 1994 DOD created a Gulf War Health Center at Walter Reed Army Medical Center.⁴⁰⁶ DOD then determined that a multidisciplinary treatment program also was needed for care of Gulf War veterans with persistent and unexplained physical symptoms and in March of 1995 also began a Specialized Care Program at Walter Reed.⁴⁰⁷ At DOD's request a panel of national experts reviewed the program and its recommendations were implemented in the program's design. To date, this is the only treatment program in DOD or VA providing a "multidisciplinary chronic pain treatment approach for those with persistent Gulf War related physical symptoms,"⁴⁰⁸ an approach which studies have shown is highly effective in treating and reducing pain and in improving both physical and emotional functions in individuals suffering chronic pain.⁴⁰⁹

The program provides intensive multidisciplinary outpatient treatment over a three week period for Gulf War veterans with chronic, unexplained symptoms. The program's goal is to reduce the severity and frequency of these veterans' physical symptoms and to improve their quality of life, physical functions, and ability to work.⁴¹⁰ Initial research indicates that Gulf War veterans who have enrolled in Walter Reed's Specialized Care Program had been utilizing health care services at a higher rate, yet they had continued to report large numbers of physical symptoms that seriously impaired their ability to function. Preliminary followup data from the SCP suggests that Gulf War veterans who have participated in the program have reported notable improvement in their physical and social functioning.⁴¹¹ As of February 1998, 130 active military personnel and veterans who served in the Gulf have been through this clinical program. Although the program typically takes only 8 to 10 Gulf War veterans at a time, the fact that only 130 veterans have been through it during a three year period reflects an unfortunately low use of this innovative and apparently effective health care program for Gulf War veterans.

This low rate of use may be the result of a number of potential barriers that this investigation has identified. First, some active duty personnel who are ill report that it is difficult to get unit commanders to agree to give them leave for the three weeks that is necessary to participate in the program.⁴¹² Reservists who are interested in the program have expressed concerns that they will lose wages for the time away from their job unless it is possible to officially activate them for reserve duty for the time spent in treatment.⁴¹³ Also, some servicemembers have expressed concerns about requesting a referral to the program because they are worried that admission of health problems related to their Gulf War service will adversely affect their promotion potential or their possible retention in a downsizing military because there continues to be a stigma associated with Gulf War illness or health problems in the military.⁴¹⁴ It is unclear how much outreach is being done to military servicemembers who served in the Gulf or to their military physicians to notify them that the program

exists. Finally, while this program would be equally beneficial in meeting VA's Gulf War veteran health care programs and goals, there has been little communication between VA and DOD to explore the program's potential as a joint VA and DOD clinical program. Resolving these problems would go far in making the unique aspects of this important program more widely available to many Gulf War veterans who could benefit from its approach.

VHA Treatment of Gulf War Veterans

Since the end of the Gulf War in 1991, many veterans have been treated at VA facilities. VHA testimony before Congress in February 1998 stated that 220,000 Gulf War veterans have made 2.5 million ambulatory health care visits to a VA health care facility, 80,000 have been counseled at veterans' centers, and 22,000 Gulf War veterans have been hospitalized for both service-connected and non-service connected reasons.⁴¹⁵ In addition to providing treatment through the existing VA health care programs, recent legislation⁴¹⁶ directs VA to establish ten demonstration projects by July 1, 1998, in order to test new treatment approaches, including multidisciplinary treatment to manage symptoms and to improve satisfaction with treatment of Gulf War veterans with undiagnosed illnesses. These treatment centers have the potential to provide important advances in determining how best to care for Gulf War veterans with undiagnosed illnesses.

SIU Survey of VA Hospitals on the Status of Gulf War Health Programs

As part of this investigation, SIU investigators conducted a telephone survey of 23 VA hospitals across the country to learn more about programs and treatment being provided to Gulf War veterans. The survey's goal was to assess what an average caller's experience would be when phoning a VA medical center to get basic information about Gulf War veteran health programs at that facility. SIU investigators reached individuals who could answer basic questions about Gulf War veterans' programs at 17, or three-fourths, of the 23 medical centers. In the other six cases, three times SIU investigators were connected to the wrong department and then told that someone would call back with the name of the correct VA employee. However, in none of those cases did anyone from that medical center return the call. In one instance, no one answered the medical center's main number despite repeated tries and long waits. In attempting to contact the other two medical centers, a recording stated that the number had been disconnected but provided no new number at one facility, and at the other the main number was busy each time when called despite seven separate tries over a four day period.

Of the 17 hospitals where information on Gulf War programs was available, seven (41 percent) knew that their facility could determine how many Gulf War veterans were being currently followed for treatment. At one hospital, registry examinations were given by a nurse practitioner rather than a physician. All 17 of the facilities surveyed reported that primary care physicians who treated Gulf War veterans had received some training about the problems of Gulf War veterans, including conference attendance as well as written materials. At two facilities, individuals reported that their

facility did no outreach or marketing to Gulf War veterans, and a third of the individuals contacted did not know if their hospital did so. Attempts were also made to interview physicians who were responsible for the Persian Gulf War Registries to learn their general impressions about the health care needs of Gulf War veterans. Six physicians were eventually contacted, and all also treated Gulf War veterans. They suggested ways to improve treatment that included ensuring that adequate amounts of time are provided for physicians to counsel as well as examine veterans and improving the information VA provides to Gulf War veterans. Although this limited survey involved only a small sample of all VA facilities, at a minimum the results suggest that barriers exist to obtaining good and timely information on VHA's programs for Gulf War veterans.

CURRENT STATE OF FEDERAL RESEARCH PROGRAMS ON GULF WAR HEALTH ISSUES

Persian Gulf Veterans Coordinating Board Research Working Group

On August 31, 1993, President Clinton designated VA as the lead agency for the coordination of the federal research program on Persian Gulf veterans' illnesses, and the Persian Gulf Veterans Coordinating Board was formed. The Board's Research Working Group (RWG) includes representatives of VA, DOD, HHS, and EPA. This group is charged with ongoing evaluation of the direction of federal research in this area. Tasks of the Research Working Group include: identifying testable research hypotheses; making recommendations for research in identified high priority areas; coordinating research among the agencies involved; reviewing developing research concepts; collection and dissemination of peer-reviewed scientific research; and "ensuring that all research collected under the umbrella of the RWG undergoes appropriate scientific peer-review, and that the results of peer-review lead to appropriate actions by the sponsoring agencies."⁴¹⁷

Federal Research Funding Levels and Priorities

Federal agencies had spent a total of \$77.4 million on research on Gulf War veterans' illness-related issues from fiscal year (FY) 1994 through FY 1997. Of that total, DOD spent approximately \$62.5 million, VA spent \$10.8 million, and HHS spent \$4.1 million.⁴¹⁸ During FY 1998, the RWG projects that an additional \$37.9 million will be spent on Gulf War research.⁴¹⁹

A summary and breakdown of research categories and levels through 1997 is provided in Figures 11-13.⁴²⁰

Figure 11. Persian Gulf Illness Research Type

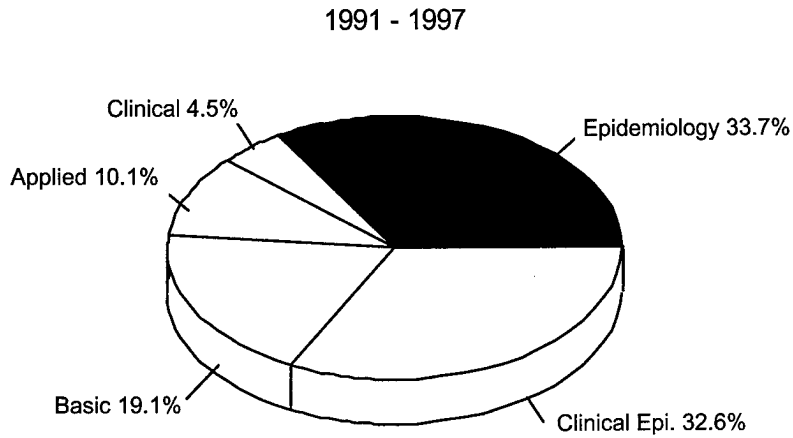
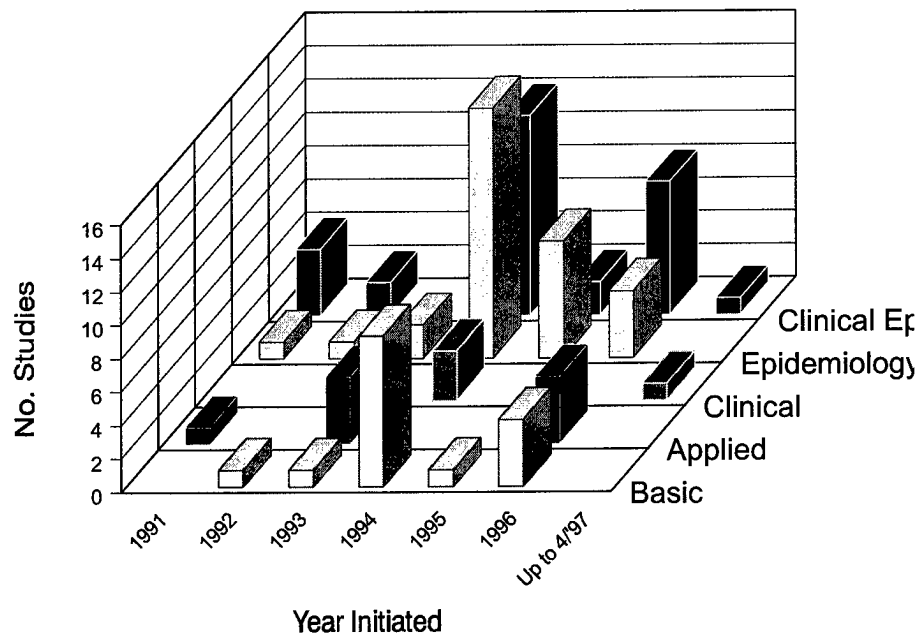
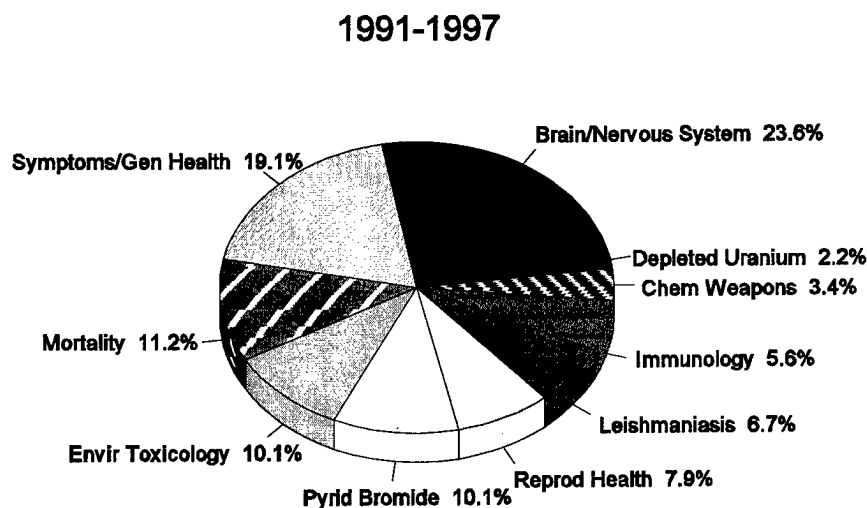


Figure 12. Persian Gulf Illness Research by Study Type and Year



Source: 1997 Annual Report to Congress by the Research Working Group of the Persian Gulf Veterans Coordinating Board

Figure 13. Persian Gulf Illness Research Focus



Source: Research Working Group of the Persian Gulf Veterans Coordinating Board, 1997 Annual Report to Congress

For FY 1997, the DOD allocated almost \$17 million for research on Gulf War veterans' illnesses-related research and solicited proposals in three specific areas: (1) the feasibility of epidemiological studies of troops potentially exposed to chemical warfare agents at the Khamisiyah depot demolition, and basic (animal model) research to assess the potential health effects of exposure to low-levels of chemical weapons; (2) the potential health consequences of exposures to combinations of multiple risk factors; and (3) studies of historical war syndromes and physiological manifestations of stress. DOD awarded \$12 million for new research projects, most of which involved basic science research into health effects of exposure to chemical warfare agents, either alone or in combination with pyridostigmine bromide. DOD also awarded \$1.7 million for studies of historical war syndromes and stress-related illness and \$3.1 million in research funds has been targeted for research into health effects of low-level chemical exposures. A competitive, peer-review grant process was used to fund all of these studies. The Department of Veterans Affairs spent approximately \$2.42 million in direct VA-appropriated funds for Gulf War illness-related research in FY 1997, and this figure is estimated to be \$10.4 million in FY 1998.⁴²¹

CDC is also funding three projects at \$2 million annually for a period of approximately 3 years. The first study will evaluate pulmonary function, occupational and exposure histories, functional status, and risk factors for asthma among a population-based group of Iowa Gulf War veterans and controls. The second will evaluate brain activation patterns, work toward development of a case

definition, and attempt to replicate these findings. A third study will examine the stability of symptoms over time, compare case definitions, and will examine existing definitions (such as for Chronic Fatigue Syndrome) for unexplained illnesses.⁴²²

Gulf War Illnesses Federal Research Funded Outside the Peer Review Process

Although most federal funding is done through a competitive peer review process, DOD has over the years awarded at least \$6.5 million in research grant funding for Gulf War illness projects without such review. An award of \$3.4 million was earmarked in the FY 1995 DOD appropriations bill to fund the research of Dr. Edward Hyman of the Louisiana Medical Foundation in New Orleans. DOD also is in the process of making a smaller grant of approximately \$150,000 to Dr. Garth Nicolson to test his new laboratory methodology to detect *Mycoplasma fermentans*.

In 1997, Dr. Robert Haley of the University of Texas Southwestern Medical Center in Dallas was awarded \$3 million to further investigate his hypothesis that some of the veterans' illnesses may reflect neurotoxicity syndromes resulting from low-level chemical exposures and interactions of exposures. (For a discussion of these studies, please see the consultant reports of Dr. Gerr in Chapter Four and at Appendix II and Dr. Letz in Chapter Four). His initial research had been supported by the Perot Foundation. Dr. Haley and his associates had submitted a grant proposal to DOD for a \$13.8 million three-year, multi-component study. The level of funding that Dr. Haley requested exceeded the \$10 million amount of funding available in the call for proposals in the PGVCB announcement, and the proposal was not recommended for funding by the peer-review panel that evaluated the study.⁴²³ However, in subsequently awarding Dr. Haley \$3 million, DOD stated that it was funding portions of the study that had received favorable ratings from the review panel.⁴²⁴ DOD's decision to fund Dr. Haley outside the competitive peer review process was criticized by the Presidential Advisory Committee on Gulf War Veterans' Illnesses⁴²⁵ and other members of the scientific community. The Institute of Medicine in 1995 and the PAC in its 1996 report both emphasized the importance of external competition in order to ensure the scientific merit, level of priority, and relevance of research proposals. The PAC noted in its 1997 special report that these issues "are especially crucial when spending involves the public's money during times of shrinking budgets; the interests of veterans are not well served by research that is not meritorious."⁴²⁶ The SIU concurs with the PAC and IOM that federal research programs should be guided by sound scientific principles, which is best assured when all research funding is subject to a rigorous and independent peer review process.

Additional Research

Many of the studies that have assessed health outcomes of Gulf War veterans to date are not generalizable to the population of Gulf War veterans and their results may be skewed because they did not use a population-based approach to select study participants. A population-based approach means that all veterans from a defined population of veterans (for example, all Gulf War veterans

from a state or all Gulf War veterans who served in the theater of operations) would be eligible to participate in the study and participants are randomly selected from that group. This approach minimizes biased results and is more likely to ensure results that can be applied to that population as a whole. Further, designing studies to include a similarly selected comparison group of non-deployed Gulf War-era veterans would allow for more reliable comparisons between those who served in the Gulf War and those who did not.⁴²⁷

Although VA is currently in the process of conducting such a population-based study, in doing so it should make every effort to obtain standardized and verified exposure and health outcome data. This study is being conducted through initial telephone interviews and followed up with medical evaluations of 1,000 deployed and 1,000 non-deployed veterans and their immediate family members. The VA study's primary hypothesis is that "Gulf War veterans will have an increased prevalence of the following medical and psychological conditions . . . compared to a control group of non-deployed veterans: chronic fatigue syndrome, fibromyalgia, PTSD, neurological abnormalities, including peripheral neuropathy and cognitive dysfunction, and measures of general health status."⁴²⁸ This study has been planned for several years and will provide important information, but as it is now eight years after the Gulf War all efforts should be made to ensure its timely completion. In addition, large scale population-based studies are underway in the United Kingdom which will examine the rate of health complaints and illnesses among UK servicemembers who served in the Gulf War,⁴²⁹ and to help determine whether there are an increased number of health (including reproductive) problems among the family members of Gulf War veterans. This latter study will examine the full range of reproductive problems and outcomes in random samples of deployed Gulf War veterans and non-deployed Gulf War-era veterans.⁴³⁰ (See the consultant report of Dr. Shanna Swan in Chapter Four and at Appendix LL.)

ALLIED COALITION HEALTH EXPERIENCES

Thirty-eight countries (in addition to the United States) participated in the Allied Coalition force that took part in Operations Desert Storm and Shield.⁴³¹ The SIU sought to learn about their veterans' experience and post-conflict health status because valuable clues might be found to explain why U.S. troops have developed illnesses following the Gulf War. Summaries of the experience of several countries are included at Appendix OO, however, information was not obtained from all 38 countries. Overall, at least three countries (Canada, the Czech Republic, and the United Kingdom) have examined some of their veterans and documented that they have developed health problems similar to U.S. veterans. Interestingly, Egypt, France, Kuwait, and Saudi Arabia state that their Gulf War veteran populations have not developed such health complaints. However, these countries have apparently not systematically examined their Gulf War veteran populations for health problems.

It is beyond the SIU's purview, at this point, to make definitive statements about whether Gulf War veterans from other countries are ill and the reasons why some may not be ill. However, troops

from different countries had have different exposures (e.g., receipt of vaccines or use of PB varied among troops of different countries, although North Atlantic Treaty Organization (NATO) countries gave PB to their troops). In considering health data from other countries, it should also be kept in mind that some countries have national health care systems that provide access to health care for all citizens. Veterans in those countries may be less likely to participate in Gulf War health programs because they already have access to health care. In addition, countries differ in their military pension and disability systems, and most countries do not have a separate veterans' health care system. The SIU believes that additional collaboration with Allied Coalition countries is warranted to further examine the health status of their veterans and to attempt to elucidate reasons why veterans from some countries may not have developed Gulf War undiagnosed-type illnesses.

CONCLUSION

Many veterans have become ill since their service in the Gulf War, and in some instances, they have been disabled by these health problems. The undiagnosed illnesses of many veterans remain poorly understood and as a result, veterans and their families have been appropriately frustrated as they seek answers. However, health problems in the absence of a diagnostic label are very real for the veterans who live with them every day. In addition to the burdens of coping with health problems, some veterans have also been frustrated in their attempts to find appropriate, responsive, and effective care at the Departments of Veterans Affairs and Defense. While these veterans bravely served our country during the Gulf War, our government has not always appropriately served their health care needs during and following that conflict. Many questions still remain about why Gulf War veterans are ill. Some of these questions may never be answered because of shortcomings such as poor data collection and record keeping during the war. However, the common factor in the illnesses among these veterans is their service in the Gulf. Since these illnesses appear to be associated with their service, the most important things that VA and DOD can now do is provide timely, accessible, and appropriate treatment to Gulf War veterans with these illnesses who seek it and attempt to prevent such illnesses in future deployments.

In considering the health problems of Gulf War veterans, inevitable comparisons have been made with post-conflict health problems following other military deployments such as Vietnam and the World Wars. If such adverse health events do indeed follow every conflict, why have DOD and VA not learned more from these events and more effectively intervened to keep history from repeating itself after each deployment? At some point, more comprehensive health policies and programs should be developed that build upon the lessons learned. The same mistakes should not be repeated when the veterans' health and the government's credibility are at stake. DOD and VA share responsibility in anticipating, planning, and preparing for post-deployment health concerns. This continuum of responsibility extends from the beginning of military service and continues with the transition to veteran status through the lifetime of the individual. DOD's responsibilities include the prevention of avoidable illness and injury on the battlefield and a rapid medical response in the field when illnesses or injuries do occur.

DOD and VA are both responsible for providing quality and responsive care for the health concerns that follow any deployment. Greater cooperation and more expedient planning on a regular basis between VA and DOD are needed to adequately address the health concerns that follow military deployments. We cannot afford to wait years after unexplained illnesses have emerged again before initiating a federally coordinated response. Smaller scaled efforts should be initiated as troops are returning home from future deployments to immediately begin assessment and treatment of their health concerns as part of routine DOD and VA health care. Because of the unanswered questions about the illnesses of Gulf War veterans, DOD's and VA's credibility has suffered. In order to restore public trust, it is the responsibility of DOD to demonstrate that it can adequately protect the health of troops and it is the responsibility of both DOD and VA to demonstrate that they can provide quality health care to veterans of any deployment.

RECOMMENDATIONS

1. The Secretary of Defense and Secretary of Veterans Affairs should undertake a major effort to monitor on an ongoing basis the treatment provided to ill Gulf War veterans, especially those with undiagnosed illnesses, to determine whether those veterans are getting better or worse over time. Both agencies should evaluate and revise existing health care programs to remove or minimize barriers to timely and effective veteran participation in them. The Secretary of Defense and Secretary of Veterans Affairs should jointly develop and implement methods to monitor the health status of Gulf War veterans over time to provide early detection of future illnesses which may emerge years later, such as higher rates of cancers.
2. The Assistant Secretary of Defense for Health Affairs, in collaboration with VA and the Department of Health and Human Services, should develop and implement integrated policies and programs that incorporate health lessons learned from the Gulf War, including data collection and retention, surveillance, and protection and monitoring of troop health during deployments.
3. The Secretary of Defense and Secretary of Veterans Affairs should maintain compatible information systems, collect registry information that can be meaningfully analyzed and compared, and implement methods for regular exchange of information on the health status of and effective treatments for Gulf War veterans.
4. The Secretary of Defense should establish a program to improve the capacity for rapid and early detection of exposures that may affect troop health during and after deployments, such as through funding the U.S. Centers for Disease Control and Prevention, to develop technology to rapidly screen persons exposed to a wide range of chemical toxicants, including chemical warfare agents.

5. The Department of Defense, in consultation with the Environmental Protection Agency and the Centers for Disease Control and Prevention, should make available to military commanders environmental intelligence about factors that could adversely affect troop health and thereby impede the successful achievement of military missions.
6. The Secretary of Veterans Affairs should direct that veterans be provided clear and candid information about pertinent environmental health risks they may have experienced during deployments that may have had an adverse impact on their health.
7. The Assistant Secretary of Defense for Health Affairs should develop awareness and treatment doctrine to identify possible troop exposures to depleted uranium (DU) on and off the battlefield and fund research into the health effects of DU exposure. The Departments of Defense and Veterans Affairs should also utilize the existing VA Depleted Uranium Medical Follow-Up Program to provide timely and in-depth medical evaluations to active duty service members and veterans with DU injuries.
8. The Secretary of Defense should direct that complete and accurate medical information is collected and maintained on all troops, from base-line physical examinations to all immunizations and administration of medical products occurring on and off the battlefield. This includes directing that reservists, as well as active duty military personnel, who are deployed receive health assessments before and after deployments.
9. The Secretary of Defense and Secretary of Veterans Affairs should, in collaboration with the national, state-based birth defects registry under development, establish a birth defects registry for all military service members to gather statistics on possible reproductive health effects stemming from battlefield exposures.
10. The Secretary of Defense and Secretary of Veterans Affairs should contract with an independent scientific body to evaluate treatment protocols that have been useful for persons in the general population who suffer from illnesses similar to Gulf War veterans' unexplained illnesses and to recommend funding of appropriate clinical programs and research in this area.
11. The Secretary of Defense and Secretary of Veterans Affairs should only fund Gulf War health research pursuant to an impartial, scientific peer review process, except in the case of the most serious and extreme circumstances.
12. Congress should direct an independent scientific body, such as the National Academy of Sciences, to evaluate the need for and feasibility of a new national center for the study of military health, with an emphasis on post-conflict health concerns and illnesses.

4

POSSIBLE LONG TERM HEALTH CONSEQUENCES OF GULF WAR EXPOSURES: AN INDEPENDENT EVALUATION

INTRODUCTION

This chapter provides an independent examination of the long-term health consequences of Gulf War exposures by nationally recognized scientific experts. Chapter Three reviewed many of the complexities associated with the question of "Why are Gulf War veterans ill?" as well as some of the reasons why this question may never be answered. In an effort to examine what is known regarding the health effects of some of the exposures experienced by troops during the Gulf War, the SIU contracted with the following scientists.

This chapter contains the brief reports prepared by the consultants listed below. (The consultants' affiliations are provided for identification purposes only.) They are, in the order their reports appear in this chapter:

Fredric Gerr, M.D., Peachtree Environmental Consultants Inc., Decatur, Georgia; and Associate Professor, Department of Environmental and Occupational Health, Rollins School of Public Health of Emory University, Atlanta, Georgia. Dr. Gerr examined the chemicals that were in the Gulf, such as solvents, pesticides, depleted uranium, and others, for their potential health effects particularly upon the brain and nervous system. (Dr. Gerr's detailed report is at Appendix II.)

Matthew Keifer, M.D., M.P.H., Assistant Professor, Occupational and Environmental Medicine Program, Departments of Medicine and Environmental Health, Harborview Medical Center, University of Seattle, Washington. Dr. Keifer examined the total range of health effects to exposures to pesticides and related chemicals such as pyridostigmine bromide and some chemical nerve agents that are similar to pesticides. (Dr. Keifer's detailed report is at Appendix JJ.)

James Moss, Ph.D., Gainesville, Florida. Dr. Moss looked at the use of PB as it acts with combinations of other agents such as certain pesticides.

Richard Letz, Ph.D., Peachtree Environmental Consultants Inc., Decatur, Georgia; and Associate Professor, Department of Behavioral Sciences and Health Education, Rollins School of Public Health

of Emory University, Atlanta, Georgia. Dr. Letz evaluated the health effects of stress as an occupational and or environmental exposure in the Gulf.

Michael Lebowitz, Ph.D., Professor of Medicine, Pulmonary and Critical Care Medicine; Professor and Director of Epidemiology, Arizona Prevention Center; Chair, Epidemiology Graduate Interdisciplinary Program, University of Arizona, Tucson. Dr. Lebowitz examined the long-term health effects of sources of indoor and outdoor air pollutants during the Gulf War including oil well fires, sand, space heaters used in unvented tents, and other sources. (Dr. Lebowitz's detailed report is at Appendix KK.)

Kevin Dybvig, Ph.D., Professor, Departments of Comparative Medicine and Microbiology, University of Alabama at Birmingham. Dr. Dybvig evaluated the potential role of infection with *Mycoplasma fermentans* in the health problems of Gulf War veterans.

Shanna Swan, Ph.D., Chief, Reproductive Epidemiology Section, California Department of Health Services. Dr. Swan evaluated reproductive health issues from an epidemiological perspective. (Dr. Swan's detailed report is at Appendix LL.)

Melissa McDiarmid, M.D., M.P.H., Associate Professor of Medicine, Occupational Health Project, University of Maryland; and Director, Depleted Uranium Follow-up Program, Baltimore Veterans' Affairs Medical Center. Dr. McDiarmid examined the chemicals that were in the Gulf, such as solvents, pesticides, and depleted uranium, for their potential to adversely affect reproductive health outcomes. Dr. McDiarmid also examined the chemicals associated with the Gulf War deployment for their potential to increase the risk of cancer among Gulf War veterans. (Dr. McDiarmid's detailed reports are at Appendix MM and NN.)

HEALTH EFFECTS OF EXPOSURES TO NEUROTOXIC AGENTS USED IN THE PERSIAN GULF WAR

Prepared by: Fredric Gerr, M.D., Peachtree Environmental Consultants, Inc., Decatur, Georgia; and Department of Environmental and Occupational Health, Rollins School of Public Health of Emory University, Atlanta, Georgia

SUMMARY

The purpose of this report is to review in detail the known health effects of chemical agents potentially hazardous to the nervous system to which military personnel may have been exposed during the Persian Gulf War. This review is made with special attention to possible relationships between these agents and symptoms and health complaints that have been reported by a large number of Persian Gulf War veterans.

On August 2, 1990, Iraq invaded Kuwait and set in motion the events that would eventually lead to US military intervention in the Persian Gulf. On August 8, 1990, the first US Air Force planes arrived in Saudi Arabia and, on the following day, the first US ground forces arrived. The ground war began and ended in February, 1991. The last of the US service members who served in the ground war were returned to the United States in June, 1991.

In all, the United States had approximately 697,000 troops stationed in the Persian Gulf. Following their return, mounting concern has focused on symptoms and unexplained illness experienced by some. In response to concern about unexplained illness, the VA Persian Gulf Health Registry was created. As of June, 1994, over 17,000 veterans, either ill or concerned about illness, had enrolled. The ten most frequent complaints among those in the Registry were fatigue (17.4%), rash (16.8%), headache (14.1%), muscle and or joint pain (13.9%), neuropsychologic complaints (10.5%), shortness of breath (7.5%), sleep disturbances (4.9%), gastrointestinal disturbance (4.1%), cough (3.8%), and other respiratory complaints (3.3%) (Persian Gulf Veterans Coordinating Board, 1995). The registry has not shed light on any distinctive demographic, exposure, or geographic risk factor, with the possible exception that nearly half of the veterans with symptoms were reservists/National Guard personnel, a group that accounted for only 17% of all troops deployed in the Persian Gulf (Persian Gulf Veterans Coordinating Board, 1995).

Numerous possible risks to health were present in the Persian Gulf at the time of the Gulf War. These included poor living conditions, characterized by heat and humidity, initially, and cold during the actual combat. Troops slept in temporary housing with little personal privacy. Food consisted

mainly of prepackaged meals. Flies and other insects were prevalent. Chemical warfare alarms sounded frequently, although virtually all were false. Such alarms, nevertheless, resulted in donning of air purifying masks and chemical protective clothing. Attention has been paid to possible chemical warfare agent exposure in the Gulf occurring as a result of destruction of a chemical warfare agent facility at Kamisiyah. Iraq was reported to have stockpiled biological warfare agents as well. Concern about health effects from exposure to these weapons as well as to indigenous infectious diseases lead to an extensive vaccination program. In addition, an estimated quarter of a million troops took the chemical warfare agent protective drug pyridostigmine bromide. Pesticides were used to control insect populations and insect repellents were provided to troops for personal use. Some troops were exposed to solvents from jet fuel, paint vapors, and other sources. Depleted uranium was used in special applications during the Gulf War and tetra-ethyl lead was formulated in gasoline used in motor vehicles. Finally, some troops were exposed to non-ionizing radiation from microwaves and radar installations (PAC, 1996).

In order to better characterize the health complaints of Gulf War veterans and to determine whether exposure to hazardous substances in the Gulf had caused them, health investigations of morbidity and mortality among Persian Gulf War veterans have been performed.

The largest and most methodologically sound study investigation included nearly five thousand subjects and involved inquiry about symptoms and exposure to known hazards in the Persian Gulf (Schwartz et al., 1997). Military personnel who served in the Persian Gulf War reported significantly more symptoms of depression, PTSD, chronic fatigue, cognitive dysfunction, bronchitis and asthma than non-Persian Gulf War personnel. Most of the self-reported exposures to hazards were statistically significantly related to virtually all of the health outcomes studied.

The results of the study indicate that subjective symptoms, including those consistent with nervous system impairment, occur more frequently among those who served in the Persian Gulf War than Persian Gulf War-era personnel who were not stationed in the Persian Gulf. The associations between multiple, unrelated exposures and multiple, unrelated symptoms, however, is more consistent with differential recall of exposure as a function of symptoms experience than a toxic response to a single or even several agents.

Several other studies intended to characterize with more objective measures the neurological health of Gulf War Veterans have been published. Authors of some suggest that the results show neither increased nervous system impairment nor a consistent pattern of illness suggestive of a common etiology (Amato et al., 1997; Jamal et al, 1996). Conversely, others conclude that their results show an increase in nervous system impairment and a pattern consistent with exposure to specific neurotoxicants (Haley et al., 1997). Unfortunately, nearly all of these studies were performed on "samples of convenience" and, as a result, cannot be used to draw conclusions about the larger but unstudied group of all Gulf War veterans. This body of literature has added little to the collective understanding of symptoms and health concerns among Persian Gulf War veterans.

Epidemiologic investigation of relationships between potentially toxic substances and ill health require accurate and unbiased assessment, on an individual basis, of both health status and the intensity and type of exposures experienced among a sample of persons representative of the entire group at risk. Of these requirements, the task that appears nearly impossible at this time is a person by person estimation of the intensity and type of exposures experienced by military personnel who served during the Persian Gulf War. Characterization of exposure to hazards was, apparently, not performed during the actual deployment of troops. As a result, estimation of the magnitude of past hazardous exposure at this time requires either direct questioning of veterans with resulting reporting bias or historical exposure reconstruction of unknown validity. As indicated above, reporting bias likely accounts for the associations observed in one study between symptoms and a very wide range of potential hazards.

As an alternative to epidemiologic investigation, another approach to investigating associations between health and hazardous exposure is to focus separately on 1) health problems among veterans and 2) exposures which they might have experienced. If a characteristic illness is observed among Gulf War veterans, then known causes for it can be explored. If particular hazards were encountered by veterans in the Gulf, the known health effects of exposure to them can be reviewed and compared to reported health problems among veterans. As neither approach attempts to relate exposure to illness on an individual basis, considerable caution must be exercised in their execution and interpretation. This report employs the latter of these two approaches and provides a systematic review of health effects of substances potentially toxic to the nervous system to which military personnel may have been exposed during the Persian Gulf War. A summary of the review is provided below.

Pyridostigmine bromide is an anticholinesterase drug given to tens of thousands of military personnel in the Persian Gulf war as a protective pre-treatment for exposure to "nerve gas" type chemical warfare agents (Dirnhuber et al, 1979). It is a member of the carbamate class of chemical agents and has been used for decades in humans as a treatment for the neurological disorder Myasthenia Gravis as well as a short acting accelerator of recovery from certain anesthetic agents. Pyridostigmine bromide acts by binding reversibly to, and consequently inhibiting, the enzyme acetylcholinesterase, which is necessary for normal function of the nervous system. This action is the basis for its ability to protect against the lethal effects of nerve agents which bind irreversibly to this enzyme. Pyridostigmine bromide is known to cause short-term discomfort and its use in the Gulf War was associated with abdominal distress, nausea, and diarrhea (Keeler et al., 1991; Sharabi et al., 1991). Little epidemiologic information is available about its long-term effects healthy young human populations, however, several factors suggest few or no long term effects on the nervous system. First, it has been used for decades for treatment of neurological illness with no systematic occurrence of symptoms resembling those experienced by Gulf War veterans. Second, the agent is not known to pass through the natural barrier that protect the brain from many drugs and chemicals (the "blood brain barrier"), thereby making effects on the brain unlikely. Third, the class of drugs and chemical

agents to which Pyridostigmine belongs, carbamates, have been used extensively in agriculture for decades and are not known to cause persistent adverse effects on the nervous system in that setting.

Chemical warfare agents, known as "nerve gas", are members of the organophosphate class of chemical compounds. The organophosphate nerve agents act to irreversibly bind the enzyme acetylcholinesterase (Grob and Harvey, 1957). Accumulation of the intended substrate of acetylcholinesterase, the neurotransmitter acetylcholine, results in a characteristic complex of symptoms. Unlike pyridostigmine, which also binds the enzyme acetylcholinesterase (reversibly, however), the organophosphate chemical warfare agents are capable of freely penetrating the brain and producing acute and chronic central nervous system toxicity.

Most of what is known about the effects of chemical warfare agents is a result of experimental studies of exposure to animals (Blick et al, 1994). However, several studies or case reports of acute human effects of exposure were identified in the literature (Grob and Harvey, 1957; Sidell, 1974). In addition, because of their chemical and toxicological similarity to organophosphate pesticides, some inferences about their toxicity can be made from the considerable literature about the organophosphate pesticides. Short term, acute exposure to chemical warfare agents produces a characteristic array of symptoms including sweating, diarrhea, urination, muscle twitching, pinpoint pupils, confusion, seizures, and, with sufficient exposure, death. Some credible medical evidence suggests that, upon recovery from toxic effects of acute exposure, chronic impairment of the central nervous system may occur (Sidell, 1974; Burchfiel and Duffy, 1982). Little evidence is available to suggest that exposures insufficient to produce acute toxicity are associated with long term neurological effects. Reportedly, no military personnel were treated for acute effects of nerve agent exposure, making unlikely that chronic effects of such exposure are the cause of symptoms experienced by Persian Gulf War veterans.

Organophosphate pesticides were used in the Persian Gulf for control of insects. Because of widespread use of organophosphate pesticides worldwide, a larger body of literature about the acute and chronic health effects of organophosphate pesticides on human populations, including chronic effects on the CNS, is available than is available for organophosphate chemical warfare agent agents.

In addition to the organophosphate class of pesticides, carbamate, pyrethroid, and organochlorine pesticides were also used. Only the organophosphate pesticides are known to cause, under certain exposure circumstances, long-term adverse effects on the nervous system. The carbamate pesticides, although similar in acute toxicity to organophosphates, are not known to result in long-term adverse neurological effects. Similarly, long-term adverse neurological effects of pyrethroid insecticides, and Lindane, the one organochlorine pesticide used in the Persian Gulf, have not been reported in the peer reviewed medical literature.

Exposure to organophosphate pesticides has been most convincingly associated with chronic adverse central nervous system health effects only when the exposure intensity is sufficient to

produce acute toxicity consistent with acetylcholinesterase inhibition (Steenland et al, 1994; Ames et al., 1995; Savage et al., 1988; Rosenstock et al., 1991). Only one report in the literature related exposures to levels of organophosphate pesticides insufficient to produce acute effects to long-term adverse effects on the central nervous system (Korsak and Sato, 1977). This finding has not been duplicated by other investigators. Given the apparent absence of documented signs and symptoms characteristic of acute organophosphate pesticide toxicity among soldiers deployed to the Persian Gulf, it is unlikely that long-term health effects of pesticide toxicity is responsible for symptoms described by Persian Gulf veterans.

Lead, in the form of tetra-ethyl lead, was an octane boosting additive in gasoline used to fuel motor vehicles used by US forces in the Persian Gulf. Tetra-ethyl lead had been used in gasoline in the United States for decades and was widely discontinued from such use, for protection of the public health, beginning in the 1970's. Exposure to lead in the Persian Gulf War was limited to that emitted from vehicles in which leaded gasoline was used.

Both organic and inorganic lead are known to be toxic to the nervous system. Clinically, symptoms of lead intoxication include abdominal pain, fatigue, joint pain, headache, irritability and other mood disturbances, and muscle and joint pain. On clinical examination, physical signs of peripheral neuropathy, including paresthesias and motor weakness may be present (Culen et al., 1983). Clinical examination is insensitive to central nervous system impairment; however, when subjected to formal clinical neurobehavioral evaluation, patients with lead intoxication often show impairment of multiple central nervous system functions (Bordo et al., 1982; Baloh et al., 1980; Valciukas et al., 1978a. Valciukas et al., 1978b. Stollery et al., 1989; Hanninen et al., 1979; Mantere et al., 1984; Baker et al., 1985; Ashby, 1980).

Although leaded fuels were used in the Persian Gulf, it is unlikely that exposures to tailpipe emissions were of sufficient duration or intensity to produce any kind of clinically apparent toxicity from lead exposure. While long-term exposure to lead does result in accumulation of lead in long-term storage pools in the human body, short-term exposures result in little long-term accumulation. Failure of symptoms to remit for years following exposure is inconsistent with lead as an etiology of unexplained symptoms experienced by some Gulf War veterans. Furthermore, leaded fuels were used in the United States for decades and are still in use in many other countries worldwide. No reports of symptoms identical to those experienced by Persian Gulf veterans have emerged despite such widespread and long-term use.

Depleted uranium is a by-product of the extraction of uranium-235 (U235) from naturally occurring uranium. Military applications for this material include munitions production (armor piercing bullets and artillery shells) and armor for tanks and personnel carriers. The PGW was the first US use, in actual military conflict, of depleted uranium tipped shells and depleted uranium armored tanks and other vehicles (United States General Accounting Office, 1993).

At the current time, estimates of the total number of military personnel who had any exposure to depleted uranium are not available. Exposure may have occurred to personnel in vehicles penetrated by depleted uranium rounds as well as personnel involved in recovery and repair of vehicles damaged by depleted uranium containing rounds. The Army has identified 35 soldiers who were injured in combat vehicles damaged by depleted uranium munitions, 22 of whom likely were wounded by DU containing shrapnel. In addition, 27 soldiers involved in damage assessment and preparation for shipment of damaged combat vehicles have reported exposure to DU during those activities (United States General Accounting Office, 1993).

Exposure to uranium, depleted or non-depleted, is not known to produce adverse effects on the nervous system (Thun et al., 1985; Leggett, 1989; Morris and Meinhold, 1995). Reports of exposure to depleted uranium to soldiers in the Persian Gulf, although uncertain, suggest limited numbers of involved personnel. These facts make extremely unlikely that exposure to depleted uranium during the Gulf War is responsible, wholly or in part, for the array of symptoms observed among Gulf War veterans.

DEET, the common name for N,N-Diethyl-m-toluamide, is widely regarded as the most effective topical insect repellent available and is the major active ingredient in virtually all products marketed for this purpose (Robbins and Cherniack, 1986; Osimitz and Murphy, 1997). It was registered for use by the general public in 1957 and has been in civilian and military use since then. DEET has been a remarkably successful commercial product and is currently estimated to be used, in some form, by approximately 80 million persons in the United States, annually (Stinecipher and Shah, 1997). Despite relatively long-term use by millions, only a few reports of toxicity were found in the medical literature. Most descriptions of human toxicity come from case reports of individual exposures or from small case series. Among the 20 individuals described in case reports, the group most frequently affected by DEET exposure were children and the most commonly reported effects involved the nervous system (Osimitz and Murphy, 1997).

Several factors suggest that DEET is not responsible for the symptoms reported by some veterans of the Persian Gulf War. First, the product appears to have adverse effects only on a very small proportion of those who use it (Veltri et al., 1994). Second, the main adverse neurological effect appears to be seizures, a condition not reported commonly among Gulf War veterans, although one study of occupationally exposed workers has associated DEET with neurological symptoms with some similarity to those experienced by Gulf War veterans (as reported by Osimitz and Murphy, 1997 and Robbins and Cherniack, 1986). The symptoms were experienced at the time of exposure to DEET, however; no long-term follow-up was reported. All clinical studies of adverse effects of DEET suggest full recovery occurs after withdrawal of exposure. No literature is available to suggest that topical use of DEET results in long-term health consequences.

Solvents are simple organic substances that are (1) liquid at room temperature, (2) relatively non-reactive, and (3) able to dissolve a wide range of organic compounds (i.e., lipophilic). Most

solvents are quite volatile. The primary uses of solvents in the PGW were as motor vehicle and jet fuel, carriers for paint and coatings, and as an agent for control of airborne dusts blown from sand.

Solvents can affect the central nervous system (CNS), the peripheral nervous system (PNS), or both. Short term exposure to organic solvents can cause reversible anesthesia-like depression of the CNS. Long-term, heavy exposure to solvents may cause persistent, potentially irreversible impairment in cognitive function and affect, which may be associated with structural changes in neural tissue (NIOSH, 1987). Solvents can also cause impairment of peripheral nerve function (Spencer and Schaumburg, 1985).

Peripheral nervous system effects are well-established for a few specific solvents, none of which appear to have been used in the Persian Gulf (Spencer and Schaumburg, 1985). Acute, reversible CNS effects (i.e., acute intoxication) are common with all solvents (Laine and Riihimäki, 1986). Chronic, apparently fixed, adverse effects of solvents on the CNS have been reported in the literature, with general agreement that long-term occupational exposure to solvents is associated with adverse effects on multiple CNS domains and that persons who suffer from such effects may report symptoms similar to those reported by some Persian Gulf War veterans, including depression, impaired concentration, and memory loss (Hanninen, 1986; Danish Ministry of the Environment, 1991; Hogstedt, 1994; Spurgeon et al., 1992; Rasmussen et al., 1993; White et al., 1995; Daniell et al., 1993; Hänninen et al., 1991). The duration and intensity of exposure required to cause such effects and the potential severity of such effects is somewhat controversial, although most authorities agree that at least ten years of occupational (daily or near daily) exposure is required before effects are seen (Mikkelsen et al., 1988). Exposures to organic solvents in the Persian Gulf appear to be of insufficient duration, and may also have been of insufficient intensity, to produce chronic adverse effects on the CNS.

In summary, multiple agents with potential toxicity to the nervous system were used by military personnel in the Persian Gulf War. Such agents include pyridostigmine bromide, chemical warfare agents ("nerve gas"), pesticides, heavy metals, DEET, and organic solvents. Each of these agents or class of agents has been associated, in the biomedical literature, with acute or chronic toxicity to the central or peripheral nervous systems.

Soldiers returning from the Persian Gulf have reported numerous symptoms compatible with nervous system dysfunction including fatigue, headache, sleep disturbance, depression and memory impairment.

The concurrence of exposures with potential toxicity to the nervous system and the reporting of symptoms compatible with nervous system toxicity has lead to considerable scrutiny of a possible causal association between them. Review of the biomedical literature suggests, at this time, that neurotoxicity from exposure to pyridostigmine bromide, chemical warfare agents ("nerve gas"), pesticides, heavy metals, DEET, and organic solvents is not a likely explanation for symptoms

experienced by Persian Gulf War veterans. Reasons for this conclusion vary for each individual agent or class of agents but include insufficient duration of exposure, evidence of insufficient intensity of exposure, incompatibility of effects of exposure with symptoms reported by military personnel, and the chronicity of illness following removal from exposure.

While currently available evidence does not support a neurotoxicological etiology for symptoms reported by many Persian Gulf War veterans, some key issues remain unclear. To close these gaps in knowledge, the following recommendations are made:

To better characterize the neurological health status of Persian Gulf War veterans, a large study of a randomly selected sample of Persian Gulf War veterans and Persian Gulf War era veterans who did not serve in the Gulf in which objective measures of neurological and neurobehavioral function are used to assess neurological health should be performed.

Because clinical experience among healthy adults is limited, additional investigation of the long-term human health effects of pyridostigmine bromide in among healthy adults should be performed. Should pyridostigmine bromide be used by the US military in future conflicts, accurate records should be kept to permit fruitful long-term assessment of dose-effect relationships.

To determine whether exposure to pyridostigmine bromide altered military personnel responses to stress, investigation of the effect of pyridostigmine on physical and psychological responses to perceived threat of physical harm should be performed.

Because exposure to hazards rarely occurs in isolation, investigation of the effects of combined exposure to potentially toxic agents used in the Persian Gulf War should be performed. While such investigations may necessarily be performed on animals, the exposures used should be similar in route of administration, intensity, and duration to those experienced by humans under actual exposure conditions.

In the future, better efforts should be made to characterize objectively both health and hazardous exposures among US military personnel facing hazardous duty. Standardized, objective neurological and neurobehavioral testing of military personnel before deployment would provide useful baseline information about health status to which results of repeat testing, following deployment, could be compared. Quantitative assessment of exposure to potential hazards would provide information to compare to changes in health status that might be detected. The feasibility of such an effort should be explored.

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PERSISTENT HEALTH EFFECTS OF PESTICIDES AND OTHER CHEMICALS USED IN DESERT STORM AND DESERT SHIELD

Prepared by: Matthew Keifer, M.D., M.P.H., Occupational and Environmental Medicine Program, Departments of Medicine and Environmental Health, Harborview Medical Center, University of Washington, Seattle, Washington.

This report reviews the classes of pesticides, nerve gas, and prophylactic medication (pyridostigmine bromide) to which the Gulf War (GW) personnel were exposed, or potentially exposed, for the possibility that such exposure might be responsible for the chronic health problems known collectively as the Gulf War Syndrome. Recommendations for future research are also included.

Several different types of pesticides were imported to the Persian Gulf and acquired locally by American forces during Desert Storm and Desert Shield. While use patterns of neither imported nor locally acquired pesticides are documented, the quantities of imported pesticides are documented. Most of the imported pesticides were insecticides or repellents. Pesticides are by nature poisons most of which affect the nervous system. The potential for long term health effects resulting from exposure to many of these chemicals has been demonstrated in numerous studies and case reports with the nervous system being the principal focus of the majority of these reports.

The *oganophosphates*, a potent class of pesticides, appear to have been imported in large quantities. These chemicals have been clearly identified in many studies as a cause of both central and peripheral chronic neurological effects in persons who have sustained a heavy exposure (Keifer 1997, Rosenstock 1991, Steenland 1994, Savage 1988, McConnell 1994, Lotti 1986). It is important to note that nearly all cases of chronic neurological effects attributed to organophosphates resulted from overexposure which caused acute severe clinical illness. Most studies of subjects who have sustained less severe exposures or only chronic low level exposure have not observed these chronic neurological outcomes (Ames 1995, Fiedler 1997, Engel 1998).

One organophosphate, *chlorpyrifos*, which was shipped in large quantities (1580 gallons pure active ingredient, 3841 gallons of formulated product) and has been identified as capable of causing peripheral neuropathy in human beings following heavy exposure (Lotti 1986, Kaplan 1993), has recently come under careful scrutiny in the US because of its extremely broad use by both private citizens and pesticide applicators. The Health Effects Division of the Environmental Protection Agency reviewed the published literature and unpublished case reports and concluded that chlorpyrifos "may be a significant cause of chronic neurobehavioral effects". Unfortunately the report provided no exposure context in which these "chronic effects" might be expected to occur

(Blondell 1997). A recent study of morbidity by investigators from the manufacturer of chlorpyrifos identified an elevated risk for five diagnostic categories among its employees exposed to chlorpyrifos: 1. diseases of the ear and mastoid process; 2. acute respiratory infections; 3. other diseases of the respiratory system; 4. general symptoms, signs, and ill defined conditions; and 5. symptoms, signs and ill defined conditions involving the digestive system. (Burns et al. 1998). The illness categories identified by these investigators as showing higher rates in exposed workers reflect a broad assortment of signs and symptoms but of particular interest is the inclusion of the general symptoms category (numbers 4, ICD9 780-799).

The medical conditions included in this category are generally those that do not permit strict disease diagnosis by clinicians but interestingly this symptom category is the same as the third most common diagnosis identified by the Comprehensive Clinical Evaluation Program (CCEP) in evaluating 20,000 Persian Gulf veterans (Joseph et al. 1997). This overlap of diagnosis between workers exposed in an industrial setting and personnel exposed during the Gulf War experience potentially to the same chemical is intriguing. However, it should be pointed out that the situations are not directly comparable. How this chemical was used by personnel in the Gulf is not clearly documented (IOM 1996) where as exposure to the chemical is estimated in the Burns study. Additionally the workers who were reporting these illnesses through the company medical program were presumably actively exposed at the time of their reported illnesses and the CCEP study group was examined and questioned at time when presumably exposure to chlorpyrifos had ceased. Before conclusions that an excess prevalence of this diagnostic category in the CCEP study population is reached an adequate control population would be needed. There was no association drawn in either the EPA report or the morbidity study between chlorpyrifos and peripheral neuropathy, a condition affecting 0.2% of 20,000 veterans examined by the CCEP (Joseph et al 1997).

The other organophosphate pesticides included in the list of imported pesticides include one, *dichlorvos*, which has been identified in animal models as an inducer of peripheral neuropathy. However this chemical as used in the Gulf was enclosed in pest strips making significant overexposure less likely. No reports were found in the literature that environmental exposure to these pest strips caused significant illness or peripheral neuropathy.

The *N-methyl-carbamates* were imported in large quantities and while sharing the acute toxicological characteristics of organophosphates, have only rarely been associated with persistent health effects, and then only after chronic heavy exposure (Ecobichon et al 1982). The carbamates are in the same family of chemicals as pyridostigmine, the chemical used to prophylax personnel against nerve gas in the gulf. The pyrethroids, another category of pesticides, were brought over in large quantities, but are of relatively low acute toxicity and appear to be relatively safe pesticides (Aldridge 1990, He 1994).

Aluminum phosphide, a fumigant, was also imported in substantial quantities (20,020 tablets). These chemical tablets produce phosphine gas when combined with water. Phosphine is a very toxic gas which can produce severe illness in the setting of sufficient exposure. The illness produced by phosphine exposure would not be easily overlooked (Morgan 1989). Furthermore, based on how aluminum phosphide is generally used it is highly unlikely that low dose exposure to phosphine occurred. There is no evidence in the literature that chronic illness results from low dose exposure to phosphine.

In the absence of massive overexposure, each of these pesticides by itself, organophosphates, n-methyl-carbamates and pyrethroids, or phosphine, is not likely to have resulted in chronic health effects among even a substantial minority of U.S. troops.

Diethyl-m-toluamide (DEET) was imported in large quantities and presumably used widely as an insect repellent during the conflict (DOD on Aug 27, 1997 to Senator A. Specter). It is also widely used by the U.S. population in general and given its broad use (30+ % of the US population), the chemical has a reasonably good safety record (Veltri 1994). Case reports indicate that this chemical can induce central nervous system effects when absorbed in sufficient quantity but cases usually involve excessive exposure and often involve young children or infants. No reports in the literature describe the long term toxicity of DEET among humans with low level chronic exposure though some permanent residual effects have been noted in at least one case following recovery from what appeared to be an acute intoxication (Knowles 1992). The possibility that even relatively heavy exposure to DEET alone could induce chronic health effects in the Gulf personnel is unlikely.

Pyridostigmine bromide (PB), used by the U.S. forces as a prophylactic agent against the toxicity of nerve gas has demonstrable toxicity for both animal models and humans when given in relatively high dosage. The standard 30 mg three time per day dosage provided to U.S. forces may have caused acute toxicity in particularly susceptible populations such as asthmatics or soldiers with a unique serum cholinesterase phenotype (Loewenstein-Lichtenstein 1995), or in soldiers who received high per weight dosage because of small body mass (Gouge 1994) but this dosage has been shown to be generally well tolerated by the majority of the population (Blick 1994, Borland 1985, Cook 1992, Glikson 1991).

Studies on animals suggests that under stressful situations the lack of central nervous system penetration which makes PB an attractive prophylactic may not be assured. This central nervous system penetration may lead to acute central nervous system symptoms. Symptom persistence resulting from this increased penetration has not been reported to date in human or animal models, although evidence from one study presented indicated that a central nervous system feedback mechanism may account for changes which may outlast the acute cholinergic effects of the drug (Freidman et al 1996).

No information was found as to whether the *bromide* in the preparation might have had deleterious effects given bromide's long half-life and the desert conditions of chronic high heat and salt depletion. Despite these caveats, the years of experience in treating patients for myasthenia gravis with PB at doses often much higher than those taken by Gulf War service personnel would suggest that the development of persistent health effects among Gulf War personnel from PB alone is unlikely. The pyridostigmine is rapidly metabolized and the bromide is excreted over several weeks once the drug administration is stopped. The penetration of the blood brain barrier by pyridostigmine under the stress of a combat situation may potentially result in acute effects given sufficient blood levels, but with metabolism of the drug and the reversal of the acute effects, it is unlikely that long term effects would ensue.

The health effects of exposure to *nerve gases* has been only periodically addressed in the mainstream literature. One excellent study which examined most of the important nerve gases for production of peripheral neuropathy showed that sarin was capable only at super-lethal doses of potentially inducing neuropathy (Gordon et al. 1983). Few cases of known human exposure to nerve gases are available to examine for long term effects, so predictions must be modeled mostly from animal experiments. The Center for Disease Control concluded in 1988 that there appeared to be little risk of adverse health effects from low level long-term exposure to GA, GB, VX, H, HD, HT or lewisite (CDC 1988). In a review of the literature on nerve agents, Gunderson et al. concluded that persistent effects such as psychological and behavioral problems, could result after acute exposure, but that no evidence supported persistent effects from low level exposure to these chemicals (Gunderson et al. 1992). A recently published study on survivors of the Japanese subway sarin gas incidents identifies possible delayed effects on balance among surviving female victims. These authors also cite an as yet unpublished manuscript identifying neurobehavioral abnormalities among other victims 6-8 months after the poisoning (Yokoyama et al. 1998). These findings are consistent with problems identified among persons previously poisoned with organophosphate pesticides (Keifer et al. 1997, Steenland et al. 1994, Rosenstock et al. 1991, McConnell et al. 1994, Savage et al. 1980, Lotti et al. 1986), which are related to the military nerve gases. The literature does not provide evidence to support persistent neurological or other health effects from low-level exposure to nerve gases.

From the information presently available, it does not appear that the DOD has a policy for *monitoring cholinesterase* or for assessing the physiological effects of the prescribed standard prophylactic dose of pyridostigmine bromide. The broad application of cholinesterase monitoring for all those taking PB doses would probably not be beneficial. Most people taking the drug would probably have a very predictable response to the dosage. The drug generally appears to be safe when taken by individuals of average size (70 kg), with normal uninhibited cholinesterase activity and with no illnesses which would make them particularly susceptible to ill effects from the PB. However, there is a substantial minority of individuals who may be smaller in stature, have illnesses such as asthma or, in rare cases, have congenitally low cholinesterase which makes them sensitive to PB even when taken in the prescribed dose. A mechanism should be in place to identify those who might

suffer ill effects and determine how their dosage should be adjusted in order to avoid complications while still providing protection from nerve gases.

Cholinesterase monitoring has long been used among pesticide applicators to identify overexposure to organophosphates. It also can potentially be used to identify personnel exposed to organophosphate nerve gas. Accurate interpretation requires a pre-exposure baseline on a subject against which to compare subsequent values. This limitation, and problems with the accuracy of commercially available test kits, makes cholinesterase testing complicated. Recently, a new approach to identifying overexposure to organophosphate nerve gas has been described. This method reactivates inhibited cholinesterase and reconstitutes the nerve gas molecule which can then be measured (Polhuijs et al. 1997). If this technique shows itself to be sound, it has potential application in determining whether personnel have sustained exposure to nerve gas even several weeks after exposure.

The potential for chronic health effects resulting from *mixtures of chemicals and from mixtures of pyridostigmine bromide and pesticides* is a subject of interest and recent investigation, though relatively little has been published to date. Studies on laboratory animals have demonstrated that in sufficient dosage, damage to the nerves of the body can occur with mixtures of some of the chemicals used by service personnel in the Gulf War conflict (Abou donia 1996a & b). An important caveat to these studies is that the dosages used to induce these damages were well above what would have been expected to occur by regular use of these chemicals. Studies of the effects of DEET on the absorption of pyrethroids and carbaryl (an n-methyl-carbamate) do not support the contention that more chemical is absorbed in the presence of DEET (Baynes et al 1997).

SUMMARY

A fair degree of uncertainty surrounds the exposures that may have occurred to personnel during Desert Shield and Desert Storm. Nevertheless, based on the information available in the literature regarding the pesticides and anti-personnel chemicals to which troops may have been exposed in the GW, chronic health effects would not be expected in any significant number due to low level exposure to these chemicals or to combinations of these chemicals. A small percentage of the population may have had reactions to these chemicals not predicted by animal research or human studies and given exposure sufficient to result in acute toxicity, chronic problems would not be surprising. Information cited in this report does raise questions about the possible non-specific symptoms reported by a substantial percentage of CCEP subjects and how this might relate to pesticide exposures which occurred in GW personnel. This relationship is uncertain but intriguing. The use of PB by the Gulf War personnel would probably not cause significant illness in most individuals but might cause problems in some with small stature, asthma or unique biochemistry. The two greatest limitations in identifying illness due to exposures in a theater of war are the virtual absence of exposure information and the difficulty of evaluating the health status of a self-selected group. In future conflicts, better collection of exposure information and prospective follow-up of a

statistically valid sample of the combatant population with an appropriate non-combatant control group would facilitate the identification and characterization of emerging illnesses.

RECOMMENDATIONS

A sincere and scientifically valid effort to explore and address health concerns of veterans from military conflicts is an extremely important responsibility that our government has toward its veterans. But communicating in an open, non-defensive manner with the concerned service personnel and the public about the state of knowledge and the progress of knowledge is potentially the greatest challenge facing the Department of Defense and the Veterans Administration with regard to issues of post conflict health of veterans. While the health problems from which Gulf War veterans suffer may never be completely ascribed with certainty to specific exposures that occurred during service in the Gulf, the challenge of identifying, and caring for the health of veteran's and responding to the health concerns of veterans will continue as long as there are veterans. Effective risk communication is essential to maintaining and optimized three way dialog between the veteran-active duty community, the citizenry and the responsible government branches.

SPECIFIC RECOMMENDATIONS

This author can not substantially improve on the scientific comprehensiveness of the recommendations made by the Institute of Medicine on improving the surveillance and monitoring capabilities of the DOD regarding health effects of combat service (Institute of Medicine, IOM, 1996). I do believe it is important to add that the IOM report fails to recommend a mechanism whereby the veterans, the U.S. public and active duty personnel might participate in the functioning of an ongoing system of health outcomes monitoring. Potentially the most important predictor of success of this program as judged by these constituencies is the degree to which they can claim ownership of the process. I strongly encourage that a mechanism be established to assure active participation by representatives of the U.S. public, veterans groups and active duty personnel of varied ranks and branches in the design and conduct of any program that is adopted. A mechanism should also be established to regularly communicate with all veterans providing them with ongoing information about new developments and knowledge regarding the effect of service and health.

RESEARCH IN BASIC AND APPLIED SCIENCE

Support for further research on technology for detecting environmental release and personal exposure to war gases should be a particular emphasis of the DOD. Monitors should be developed that are portable, collect and report real time information, and have data storage capabilities and are easily applied by combatants.

Research should be undertaken to develop profiles of individuals who may potentially suffer untoward effects from war gas antidotes (e.g. asthmatics, smaller individuals). Those individuals should have personal drug dosing profiles developed and confirmed by cholinesterase activity levels appropriate to the prophylactic medication taken. Routine cholinesterase testing of all personnel is probably not warranted, but the test should be available on a routine basis for evaluating ill combatants both for overdose of prophylactic medication and for evaluating war gas exposure.

A new technique described by Polhuijs (1997) potentially represents a very significant breakthrough in the detection of cholinesterase inhibited by the nerve gas sarin. Whether this technique is applicable to other nerve gases and pesticides has not been demonstrated to date. This technique should be explored and amplified if possible for application to exposure assessment of subjects potentially exposed to nerve gases and pesticides.

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POSSIBLE POTENTIATION OF PYRIDOSTIGMINE BROMIDE BY PESTICIDES

Prepared by: James Moss, Ph.D., Gainesville, Florida

SUMMARY

The Senate Committee on Veterans' Affairs requested a review and analysis of research on synergism or potentiation of pyridostigmine bromide (PB) toxicity by pesticides. This summary examines reports that indicate PB may become more toxic when an organism is simultaneously exposed to pesticides and other factors. This report suggests that PB has the potential to affect multiple organs and tissues, and that pesticides may synergise or potentiate the effects of PB on various organs and tissues. The author feels that knowledge of which pesticides and other chemicals potentiate PB toxicity will eventually lead to an understanding of the mechanism(s) underlying the observed interactions. When these mechanisms are understood, clearer scientific judgement, and hypothesis based models, can be used so that we may better understand whether PB may contribute to chronic illnesses. Knowledge of which biochemical systems are responsible for pesticide synergism of PB toxicity may allow avoidance of complications of PB use.

Introduction. Pyridostigmine bromide (PB) is a quaternary dimethyl carbamate that has been used to treat myasthenia gravis, a neuromuscular disorder characterized by skeletal muscle weakness (Breyer et al. 1990). Since 1986, PB has been recommended by the United States Army as a prophylactic agent for organophosphate (OP) nerve gas exposure (Dunn and Sidell 1989). Organophosphates bind irreversibly to the enzyme acetylcholinesterase (AChE) in the central (CNS) and peripheral (PNS) nervous systems and thereby prevent hydrolysis (breakdown) of the chemical neurotransmitter acetylcholine (ACh). As a result, ACh accumulates at nerve and muscle receptor sites. At muscles, this can produce excessive stimulation leading ultimately to muscle paralysis and death.

A prophylactic dose of PB (30 mg, every eight hours) binds to AChE, thereby protecting the enzyme from permanent damage by OP chemical warfare agents. Over time the PB is released and AChE activity is restored to a level needed to maintain life, providing that atropine and oxime treatments are also administered at the time of nerve gas exposure (Cook and Kolka 1992). This protocol has been shown to protect primates from the chemical warfare nerve agent Soman (von-Bredow et al. 1991, Wolfe et al. 1992).

Synergism (Potentiation). The possibility that PB could play a role in chronic illnesses increases if conditions potentiate (synergize) PB's toxicity. Such conditions might include simultaneous exposure to other chemicals/toxins such as pesticides. A simultaneous exposure to a toxin and another chemical can produce several different outcomes. These outcomes can range from no increased toxicity, an additive effect or a synergistic effect.

An additive effect is the sum of the independent effects of the chemicals. A dose of "A" may kill 5% of a population and a dose of "B" may kill 5% of a population. The effects would be additive if the same doses of "A" and "B" killed 10% of the population when given together.

Synergism, or potentiation, is an interaction that gives a more than additive effect. In a synergistic interaction, a dose of "A" that killed 5% of a population plus a dose of "B" that killed 5% of a population would kill over 10% and up to 100% of the population, when given together.

When used for nerve gas protection, PB was designed to be taken at doses that would inhibit about 30% AChE activity (Cook and Kolka 1992). Studies have shown that some pesticides increase PB's toxicity from about two-fold to ten-fold (Moss 1996) (Abou-Donia et al. 1996a) (McCain et al. 1997). Even low level potentiation of this specific PB action (AChE inhibition) might inhibit a large proportion of AChE activity, which could be fatal. Any degree of synergism of the effects of PB is therefore relevant.

PB's Effects Outside of Acetylcholinesterase Inhibition (Side Effects). It is possible to have substantial AChE inhibition by some chemicals without a resulting chronic illness. Several hundred humans were exposed to the AChE inhibitor sarin (nerve gas) at doses which caused cholinergic symptoms and substantial AChE inhibition (Sadayoshi et al. 1997), yet the authors reported that chronic delayed effects associated with poisoning by some other OPs were not present.

As mentioned above, PB's main action is acetylcholinesterase (AChE) inhibition. If PB's only action is AChE inhibition, and AChE inhibition is found unlikely to contribute to chronic symptoms, then the likelihood that PB can contribute to chronic illnesses is diminished. However, a different outcome is possible if, in addition to AChE inhibition, PB has some other specific action (side effect). If such a side effect were able to produce chronic outcomes, synergism of the side effect would increase the chronic outcomes. In this review, "side effect" means those effects which are the result of a chemical's action on a molecular target other than the presumed or known primary target for that chemical. For PB, this means effects that are the result of PB actions on a molecular target other than acetylcholinesterase. Possible side effects of PB, may be important if the side effects are potentiated by the actions of pesticides or other factors. Such a potentiation would cause the side effects to increase relative to the known cholinergic effects of PB, and might produce unexpected outcomes.

PB'S Muscarinic Side Effects. ACh causes two major types of response: nicotinic (nicotine sensitive) and muscarinic (muscarine sensitive) (Bowman and Rand 1980). PB produces more of one type of ACh induced response (muscarinic) over the other (nicotinic) (Arce et al. 1991, De-Novellis et al 1994, Muller et al. 1991). This predominantly muscarinic effect would not occur if PB's only action was acetylcholinesterase (AChE) inhibition, because blocking of AChE should elevate ACh at both nicotinic and muscarinic receptors equally. One would not expect to see one or the other effect to predominate. PB is known to directly affect cellular ACh receptors in addition to AChE inhibition (Pascuzzo et al. 1984), and PB binds to ACh muscarinic receptors (Yamamoto et al. 1996). PB therefore has one side effect of activating muscarinic receptors, in addition to its ability to inhibit AChE.

PB's Calcium Side Effects. LoPachin and Lehning (1997) stated that "Studies conducted over the past two decades indicate that calcium accumulation in injured axons has significant neuropathic implications and is a potentially unifying mechanistic event." PB induced muscle damage is probably caused by calcium leakage into cells through calcium channels, because a calcium channel blocker was able to reduce PB induced muscle damage (Meshul 1989).

PB'S Neurotoxic Esterase Side Effects. Another potential side effect target of PB is on an enzyme called neurotoxic esterase (NTE). NTE inhibition is believed to be associated with organophosphate induced delayed neuropathy (OPIDN). Some OP acetylcholinesterase inhibitors (in addition to their AChE inhibition), also inhibit NTE, and such exposure can lead to OPIDN (delayed neuropathy) in experimental animals (Lotti et al. 1993).

Many OPs inhibit both AChE and NTE (Ehrich et al. 1995). The type of toxic effect can range from purely AChE inhibition (rapid death from respiratory failure), to mostly delayed neuropathy (caused by NTE inhibition) (Lotti et al. 1993). Mixed effects can be exhibited by a single compound. Selective synergism of the NTE effect would result in selection for OPIDN symptoms over cholinergic symptoms. An example of this type of chemical manipulation was the production of OPIDN in cats by chlorpyrifos which normally causes only cholinergic symptoms (Fikes et al. 1992).

PB is a carbamate, and an AChE inhibitor. Some carbamates (in addition to AChE) inhibit NTE and therefore have the potential to cause delayed neuropathy if given chronically, or at high doses. A carbamate (PMBC) has been shown to cause delayed neuropathy in hens with repeated doses (Lotti et al. 1993). A series of other carbamates have been synthesized that also inhibit NTE (Randall et al. 1997). Carbaryl, a carbamate pesticide, has been reported to cause delayed neuropathy in a human (Dickoff et al. 1987). PB therefore has the potential to inhibit NTE and synergism of that side effect is a possible route to PB induced delayed neuropathy.

Target Organs. PB has predominately muscarinic side effects and many organs and tissues are affected by muscarinic, cholinergic chemicals such as PB (Bowman and Rand 1980). Many organs and tissues are therefore potential targets of synergised, muscarinic, side effects of PB. Examples are

the human central nervous system (CNS) which has PB sensitive, muscarinic receptors (Valcavi et al, 1991, Mazza et al. 1994, O'Keane et al. 1992). PB does not easily cross the blood-brain barrier (BBB) under "normal" conditions, however, the BBB may be more permeable under some conditions such as stress (Friedman et al. 1996). The BBB is not completely impermeable to PB, under any circumstances. PB causes CNS mediated behavioral changes in rats (Wolthuis and Vanwersch 1984), rhesus monkeys (Blick et al. 1994) and humans (Borland et al. 1985). Chronic dosing of PB resulting in a constant exposure of the BBB could result in significant amounts of PB in the CNS.

Other examples of organs and tissues that have muscarinic receptors which are potential targets of PB effects are peripheral neural tissue such as the guinea pig myenteric plexus (Mike 1994) and the rat superior cervical sympathetic ganglion (Ramcharan and Matthews 1996). There are also muscarinic receptors in the hearts of humans (Bowman and Rand 1980) and in blood vessels in the human brain (Tsukahara et al. 1989a), human skin (Stephenson and Kolka 1990), rat mesenteric vascular bed (Pinardi et al. 1992), the rabbit thoracic aorta (Tsukahara et al. 1989b) and the rat liver (Pfaffendorf and Van-Zwieten 1993). Other organs or tissues that are sensitive to muscarinic effects are the retina (Hutchins 1994) the eye's ciliary body (Farahbakhsh and Cilluffo 1994), salivary gland (Iwabuchi and Masuhara 1992), pancreas (Kato et al. 1992), tracheal smooth muscle (Thomas and Ehlert 1996), adrenal cells (Aguilar et al. 1992), gut smooth muscles (Reddy et al. 1995), the spleen (Sandberg, 1994), kidney cells (Mohuczy and Garg 1992), the bladder (Kumamoto et al. 1990), gallbladder smooth muscle (von-Schrenck et al. 1993) and lung (Mak et al. 1992). Immune system cells (thymocytes and lymphocytes) are also sensitive to muscarinic chemicals (Kubera et al. 1992).

Potential Pesticide Synergists of PB Toxicity. This table is a partial list of pesticides ordered through the federal supply system for operations Desert Shield and Desert Storm (U.S. Senate 1995b). The insecticides with question marks (?) have not yet been evaluated for the ability to potentiate the toxicity of PB.

Pesticide	Insecticide Class	Synergizes PB?
permethrin	pyrethroid	yes
chlorpyrifos	organophosphate	yes
lindane	organochlorine	yes
DEET	repellant	yes
propoxur	carbamate	?
carbaryl	carbamate	?
diazinon	organophosphate	?

dichlorvos	organophosphate	?
methomyl (Fly bait)	carbamate	?
malathion	organophosphate	?
pyrethrins	pyrethroid-like	?

Of these insect control chemicals, DEET, permethrin and lindane are designed to be used in a manner that was likely to involve close personal human contact. Interest in the synergism of PB by DEET and permethrin arose as a result of disclosures to the U.S. Senate Veterans' Affairs Committee (U.S. Senate 1995a) that DEET and permethrin caused increased PB toxicity in cockroaches. Abou-Donia et al. (1996b) recently reported that the organophosphate insecticide chlorpyrifos, PB, and DEET interact synergistically.

The pesticides discussed below potentiate PB toxicity in various animals. Little is known about the specific mechanisms of these synergistic mechanisms. It will be difficult to predict whether these interactions would cause chronic health consequences until the specific mechanisms of synergistic interactions are understood.

Permethrin. Permethrin is a pyrethroid insecticide. Pyrethroids are generally thought to kill by modifying sodium channel function in nerve fibers. This leads to excessive leakage of sodium ions in nerve fibers which leads to excessive depolarization and excitation of the neurons (Matusmura 1985). Pyrethroid insecticides can also directly inhibit an enzyme that removes (pumps) calcium from inside cells of the rat brain (Alrajhi1990). Combined effects of PB (increased calcium leakage into the cells) plus permethrin (blocked calcium removal by pumps) could lead to a co-synergistic increase by these chemicals on cellular calcium. The outcome would be potentiation, by permethrin, of PB induced damage. Calcium loading, and subsequent damage, would be possible in tissues that had muscarinic (PB) receptors and permethrin sensitive calcium pumps.

PB toxicity is potentiated by permethrin in cockroaches (Moss 1996), chickens (Abou-Donia et al. 1996a), and rats (McCain et al. 1997). It is not clear whether this potentiation was caused by permethrin's actions on sodium channels, calcium pumps, or another action of permethrin. Abou-Donia et al. (1996a) suggested that, in chickens, PB prevented the breakdown of permethrin, that the permethrin action was responsible for the toxicity, and that PB was simply increasing the permethrin concentration (and therefore its effect). However, the damage and clinical signs reported in this study (Abou-Donia et al. 1996a) were similar to the results of organophosphate induced delayed neuropathy (OPIDN) and not pyrethroid poisoning. In addition to this, Buchholz et al. (1997) found that when rats were simultaneously dosed with PB and permethrin, PB caused the central nervous system tissue levels of permethrin to be lowered by 30%.

Either pyrethroid mechanism (sodium or calcium disruption) can lead to an ion imbalance within nerve cells which can lead to over-excitation and eventual direct damage to the nerves (LoPachin and Lehning (1997)). This over-excitation also leads to an inappropriate release of neurochemicals from nerves that leads to secondary physiological effects (Bowman and Rand 1980). Any of these permethrin effects have the potential to synergise the primary action of PB, or PB's known and potential side effects. The long term consequences of a simultaneous exposure to PB and permethrin cannot be predicted without knowledge of which biochemical effects are responsible for the synergism of PB toxicity.

Chlorpyrifos. Chlorpyrifos is an organophosphate (OP) insecticide which inhibits acetylcholinesterase. It can also cause organophosphate-induced delayed neuropathy (OPIDN) (Fikes et al. 1992). Because OPIDN may be related in some way to the disruption of calcium levels in cells (Abou-Donia 1993), the possibility also exists that some interaction between PB and chlorpyrifos is from the effects of both compounds on calcium maintenance in nerve cells.

PB and chlorpyrifos potentiate the toxicity of each other in chickens. A suggested reason for this was that both compounds block a detoxifying esterase enzyme that breaks down both chemicals. The neuropathy was attributed to the action of chlorpyrifos which was synergized because its breakdown was prevented by PB (Abou-Donia et al. (1996b)). The authors suggested that these combined chemicals may be responsible for some manifestations of chronic illnesses in Persian Gulf War veterans. It was also suggested that the neuropathy seen was not from the effects of neurotoxic esterase (NTE) inhibition, but the symptoms reported were consistent with the effects of neurotoxic esterase (NTE) inhibition (Lotti et al. 1993, Johnson 1990).

Other Pesticides. Other pesticides may have been locally obtained. Those from the OP, carbamate and pyrethroid classes of pesticides have the potential to synergize PB toxicity because of similar modes of action. No information was found that ruled out or confirmed synergism of PB toxicity by those pesticides.

DDT is available outside of the U.S. and may have been present in the Persian Gulf. DDT does not strictly fit into the above classes, however, the mode of action of DDT is close to that of the pyrethroids in insects and vertebrates (Matusmura 1985). PB potentiates the toxicity of DDT in cockroaches and DDT may potentiate PB toxicity (Moss, unpublished data). It is therefore possible that DDT would also be a PB synergist in mammals.

Lindane. Lindane is a common organochlorine de-lousing agent. Lindane toxicity is potentiated fourteen fold in cockroaches by a sub-lethal dose of PB (Moss, unpublished data). No published research was found that dealt with synergism between PB and lindane on vertebrates. Lindane blocks inhibitory actions in the nervous system which results in over-excitation (Matusmura 1985). One of the side effects of lindane is the inhibition of a calcium ATPase, a pump that removes calcium from cells (Basavarajappa and Salimath 1990). Combined effects of PB (increased calcium leakage)

plus lindane (blocked calcium removal by pumps) would probably lead to a co-synergistic increase by these chemicals on cellular calcium. The outcome would be potentiation, by lindane, of PB induced damage. Calcium loading, and subsequent damage, would be possible in tissues that had muscarinic (PB) receptors and lindane sensitive calcium pumps. Synergistic interactions between PB and lindane in vertebrates should be investigated.

DEET (N,N-Diethyl-m-toluamide). The insect repellant DEET was developed by the U.S. Department of Agriculture in the 1950's (McCabe et al. 1954). The mechanism(s) of the repellant and toxic action(s) of DEET are still unknown. Some reports indicate that excessive doses of DEET may be toxic to humans (Clem et al. 1993, Lipscomb et al. 1992, Schaefer and Peters 1992) and non-human vertebrates (Mount et al. 1991, Schoenig et al. 1993, Verschoyle et al. 1992).

DEET and PB synergize each other's toxicity in cockroaches (Moss 1996), rats (McCain et al. 1997), chickens (Abou-Donia et al. 1996a), and mice (Chaney et al. 1997a). In chickens, the synergism of DEET has been attributed to blocking of degrading enzymes (esterases) by PB so that more DEET could cross the blood-brain barrier (BBB) (Abou-Donia et al. 1996a).

We cannot understand the sub-lethal, possible long term consequences of this chemical mixture of PB and DEET without knowing DEET's mode of action. One cannot tell from current experiments which of the two (DEET or PB), is the primary toxicant, the synergist, or if both contribute to synergism and toxicity.

Moss (1996) hypothesized that DEET might have actions similar to the insect neurochemical octopamine, or the human neurochemical adrenaline. Based on that speculation, Chaney et al. (1997a,b) tested the ability of both DEET, adrenaline, and adrenergic drugs to potentiate the toxicity of PB. Chaney et al. (1997a) found that both DEET and beta-adrenergic drugs (including the native neurochemical adrenaline) synergised the toxicity of PB in mice. The synergistic interactions between PB and DEET, and PB and adrenergic drugs, were probably caused by the muscarinic side effects of PB because atropine (a muscarinic receptor blocker) eliminated the synergistic interactions (Chaney et al. 1997a). DEET's synergism of PB toxicity may be the result of adrenergic effects of DEET.

The possibility that PB will synergise the effects of adrenergic stimulation should also be investigated. In preliminary experiments (J. Moss and J. Schiffenbauer, unpublished data) it was found that PB and salbutamol (a beta-adrenergic PB synergist in mice [Chaney et al. 1997a,b]) interacted synergistically in mouse T-lymphocytes. Combined, PB and salbutamol inhibited mouse T-cell proliferation while the same drugs alone had no effect. Adrenergic drugs were originally investigated because DEET mode of action research raised the possibility that DEET had adrenergic effects. The effects on lymphocytes might range from subtle short-term effects which could be stimulation or suppression, depending on the particular type and stage of development of the cells or the effect could be outright mortality of the cells.

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A DISCUSSION OF ISSUES CONCERNING THE ROLE OF STRESS IN VETERANS' REPORTING OF SYMPTOMS FOLLOWING DEPLOYMENT TO THE GULF WAR

**Prepared by: Richard Letz, Ph.D., Department of Behavioral Sciences and Health Education,
Rollins School of Public Health of Emory University, Atlanta, Georgia; and Peachtree
Environmental Consultants, Inc.**

THE PAC FINDING THAT STRESS IS LIKELY RELATED TO ILLNESSES IN SOME GULF WAR VETERANS

The Presidential Advisory Committee on Gulf War Veterans' Illnesses (PAC) found that (1) many Gulf War veterans have illnesses that are likely to be connected to their service in the Gulf, (2) current scientific evidence does not support the hypothesis that Gulf War veterans current illnesses were caused by a number of environmental risk factors, and (3) stress manifests in diverse ways and is likely to be an important contributing factor to the broad range of illnesses currently reported by Gulf War veterans (PAC, 1996, executive summary). Little new scientific information has emerged in the year following the report's release to question these findings with respect to the symptoms reported by large numbers of Gulf War veterans.

The PAC's conclusion regarding the likelihood that many Gulf War veterans illnesses may be stress-related may appear to be a "diagnosis by exclusion" due to their findings that the available scientific evidence did not support hypotheses that other major exposure possibilities were responsible for the broad spectrum of symptoms reported by many Gulf War veterans. However, one may argue that "stress" is the *only* potential exposure that could manifest as the wide variety of symptoms reported by a large proportion of the Gulf War veterans examined.

Unfortunately, little scientifically sound information for making this argument is to be found in the literature of studies performed on Gulf War veterans concerning the role of stress in the symptoms that they report. There is substantial confusion in the Gulf War illness literature concerning the role of stress. In part, this confusion may stem from a lack of clarity from the larger stress literature concerning the role(s) that stress plays in the occurrence of physical diseases and, more particularly, in the types of non-specific symptoms that have been reported frequently by Gulf War veterans. No doubt, some of the confusion in the Gulf War illness literature stems from authors' lack of precision in the use of language concerning stress. Some confusion probably stems from the language in the PAC final report that virtually equates "stress-related disorders" with psychological symptoms (PAC, 1996, pp. 73-79). Further, most of the available literature focuses on Post-

Traumatic Stress Disorder (PTSD, defined below), rather than the impact that sustained physical and psychological stressors may have had on veterans' health and symptom reporting.

WHAT IS STRESS?

Stress is defined as a process in which environmental demands tax or exceed the adaptive capacity of an organism, resulting in psychological and biological changes that may place persons at risk for disease (Cohen, Kessler & Gordon, 1995, p.3). It is important to distinguish between components of the stress process by referring to environmental components as environmental demands, *stressors*, or events; to subjective evaluations of stressfulness of a situation as appraisals or *perceptions of stress*; and to affective, behavioral, and biological responses to stressors or appraisals as *stress responses* (paraphrased from Cohen, Kessler & Gordon, 1995, p.4).

In the general stress literature there are three broad traditions of research of assessing the role of stress in disease risk (after Cohen, Kessler & Gordon, 1995):

- ! *Environmental*: a focus on assessment of environmental events that are objectively associated with substantial adaptive demands.
- ! *Psychological*: a focus on individuals subjective evaluations of the stressfulness of a situation and their abilities to cope with those demands.
- ! *Biological*: a focus on the biological systems activated by psychologically and physically demanding situations.

The environmental stressors in the Gulf War environment have been addressed in several investigations. Deployed veterans reported experiencing significant levels of stress in the Persian Gulf and continued distress upon returning home (Strech et al., 1996). Potential difficulties with using combat exposure questionnaires developed for the Vietnam War veterans to measure exposure among Gulf War veterans has been discussed, and previously developed questionnaires were modified to fit better the Gulf War experiences (e.g., see Wolfe, Brown & Kelley, 1993). Even though the casualty rate was low and the combat period was brief, the threat of chemical/biological warfare agents is noteworthy, as is the use of large numbers of National Guard / Reservists, who made rapid transitions both from and back to civilian life. There seems to be little argument that Gulf War military personnel experienced exposure to substantial physical and psychological stressors in addition to actual combat: heat, crowding, long periods of idle activity but high arousal, abrupt dislocation from family and work, the threat of chemical and biological weapons attacks, etc.

Much of the psychological approach in the general stress research has focused on cognitive-emotional theories of stress, e.g., the transactional model of stress and coping (Lazarus & Folkman, 1984): Stressful experiences are construed as *transactions* between the person and the environment

in which the impact of a stressor is mediated by the person's *appraisal* of the stressor and the coping resources as his/her disposal. The person evaluates the potential threat or harm of the stressor (*primary appraisal*) as well as his/her ability to change the situation or manage negative emotional reactions (*secondary appraisal*). *Coping* efforts are aimed at problem and emotional management. The *outcomes* of the coping process are functional status and psychological well-being. Mediators of both coping efforts and outcomes include the individual's dispositional coping style and social support (paraphrased from Lerman & Glanz, 1997). These concepts and theories have been incorporated into the military's models of combat stress (e.g., Gal & Jones, 1995), stress measurement instruments used in health studies, and undoubtedly underlie the stress reaction prevention efforts of the U.S. Army's Combat Stress Control Detachments (mentioned in PAC report, 1996, pp. 26-27).

Much of the biological literature on stress in humans has focused on the measurement of biological (hormonal, physiological, and immunological) stress responses (Cohen, Kessler & Gordon, 1995). A useful review of the neurobiological and endocrinological aspects of the "stress system" and conceptual linkages to pathophysiology and medical disorders is given by Chrousos & Gold (1992). The most convincing work in the stress literature has linked stressors to hormonal responses (Baum & Grunberg, 1995), heart disease (Krantz & Falconer, 1995) and immunological changes (Herbert & Cohen, 1993; Kiecolt-Glaser JK and Glaser, 1995). Little work on biological stress responses has been reported among Gulf War veterans, although one DOD-funded project of this type is ongoing (DOD #31).

In the past, the military has (understandably) focused on two areas of research with respect to the effects of stressors. One major area of military research has been investigation of the effects of environmental and psychological stressors (e.g., sleep deprivation, heat) on military job performance, i.e., the ergonomic impact of a wide variety of physical and psychological stressors. The other focus has been medical in nature. Military medical researchers have tended to focus on the effects of combat stressors in the production of psychiatric casualties such as acute combat reactions and acute PTSD, i.e., psychiatric disease resulting from experiencing extremely psychologically stressful events (Jones, 1995). Also understandably, the Department of Veterans Affairs has focused on the treatment of chronic PTSD.

WHAT IS PTSD?

Post-traumatic stress disorder is a type of anxiety disorder in which the patient has experienced or witnessed or was confronted with an unusually traumatic event that has both of the following elements: the event involved actual or threatened death or serious injury to the patient or to others, and the patient felt intense fear, horror, or helplessness (APA, 1987). The traumatic events have to be outside the range of usual experience (e.g., combat, rape, floods, abductions, and airplane crashes, but not "ordinary" life experiences such as bereavement, divorce, and serious illness) which most people would consider extremely traumatic. The disorder is characterized by (1) repeated re-

experiencing the traumatic event (e.g., through flashbacks or repeated distressing dreams), (2) persistent avoidance of stimuli associated with the trauma and numbing of general responsiveness, (3) persistent increased arousal not present before the event, (4) these symptoms have lasted longer than one month, and (5) these symptoms cause clinically important distress or impair work, social, or personal functioning. There is most often a delay of onset of the symptoms. Acute PTSD refers to symptoms that have lasted less than six months and chronic PTSD to symptoms lasting longer than six months. Common symptoms of PTSD patients may include sleep difficulties, exacerbation of drug/alcohol abuse, outbursts of anger, reduced social activity, and difficulty concentrating on tasks. Comorbidity with other psychiatric conditions occurs frequently. New to DSM-IV (APA, 1994) is the diagnosis category of "Acute Stress Disorder", which has similar criteria and symptoms to PTSD, although the symptoms develop immediately after the traumatic event and last for a few days to four weeks. The diagnosis of PTSD or acute stress disorder is made by a qualified psychiatrist.

A number of studies indicate that some proportion of Gulf War veterans have experienced symptoms compatible with PTSD (e.g., Perconte et al., 1993; Ross & Wonders, 1993; Sloan et al., 1995; Sutker et al., 1993). These research reports of Gulf War veterans have typically involved measurement of "symptoms of PTSD" or research case definitions derived from self-reported questionnaire scales. When others have referred to these studies (and sometimes in the reports of the studies themselves), the term "symptoms of PTSD" has often been shortened to just "PTSD". Such imprecision in language promotes confusion. Since these symptoms may not be specific to PTSD, and it is often not clear that study participants had experienced traumatic events in the Gulf War of the nature and intensity required for a diagnosis of PTSD, it is probably better to refer to the outcomes measured in these studies as simply "psychological symptoms" rather than "symptoms of PTSD".

The preoccupation with the concept of PTSD has also lead to arguments in the literature not central to investigating the role of stress in the reporting of symptoms by Gulf War veterans. For example, it has lead to a misguided attempt to show that the prevalence of PTSD among Gulf War veterans is not sufficient to support the notion that stress is the cause of all of the veterans symptoms (Haley, 1997). In fact, no study has been designed and conducted to adequately estimate the prevalence of PTSD among Gulf War veterans. Combining data from a number of studies, no matter how many, that were not designed and implemented properly to estimate the prevalence of a condition will not yield useful prevalence estimates. Also, surely the PAC's finding that stress is likely to be an important contributing factor to the broad range of illnesses currently reported by Gulf War veterans is not rebutted by a demonstration that the prevalence of one potentially stress-related outcome, "symptoms compatible with PTSD", *may not be* as high as some authors have reported.

The pre-occupation with the concept of PTSD whenever the role of stress in the symptoms of Gulf War veterans is discussed has helped to obscure the fact that virtually all differences observed between military personnel deployed to the Persian Gulf and appropriate comparison groups has been

in the self-reporting of physical and psychological symptoms. It seems more prudent to ask: What symptoms have been reported by Gulf War veterans and how might they be stress-related?

WHAT SYMPTOMS HAVE MANY GULF WAR VETERANS REPORTED?

Gulf War veterans have been observed to have a wide variety of health complaints. The most frequent primary diagnoses in the DOD's Comprehensive Clinical Evaluation Program were psychological conditions (18.4%), musculoskeletal conditions and connective tissue diseases (18.3%), symptoms, signs and ill-defined conditions (17.9%), respiratory system diseases (6.8%), digestive system diseases (6.3%), skin diseases (6.2%), and nervous system diseases (5.7%), while only 9.7% were found to be healthy. Conditions were counted differently in the VA's Registry, but a compatible pattern was observed. Patterns of symptom reporting quite compatible with the pattern of these categories have been observed in several epidemiologic studies of deployed and non-deployed Gulf War era military personnel (e.g., Iowa Study Group, 1997; Stretch et al., 1995).

It should be noted that the proportions of participants given above that were assigned each primary diagnosis illustrates the relative frequencies *within the self-referred clinical samples* and can not be generalized to the Gulf War population. Similarly, proportions of participants reporting symptoms in most of the other epidemiologic studies may be over-estimates of population prevalences, given the substantial participant self-selection in all of those studies except the Iowa study (Iowa Study Group, 1997).

In general, findings of diseases or abnormalities on objective measures of health status of Gulf era military personnel have not been observed in any of the few methodologically sound studies. One large-scale mortality study observed only an increase in unintentional illnesses among Gulf era military personnel (Kang & Bullman, 1996). Similarly, a large-scale study of morbidity (hospitalizations) among Gulf War veterans indicated no substantial excess of unexplained hospitalization among those who remained on active duty following the war (Gray et al., 1996). Other smaller studies, even among relatively self-selected or clinical groups, have shown no substantial increased abnormalities on objective neurologic (Newmark & Clayton, 1995), neuropsychological (Goldstein et al., 1995), and neuromuscular (Amato et al., 1997) tests among Gulf War veterans.

WHAT DO WE KNOW ABOUT THE REPORTING OF PHYSICAL SYMPTOMS IN GENERAL?

Self-reported symptoms are important sources of information in clinical medicine. In epidemiologic studies, they can be important outcomes when measured at the same time as other, objective measurements of health outcomes. In any case, they are subject to potential reporting bias and limitations of interpretation. The reporting of physical symptoms is moderated by a number of

factors. The following is a list of moderators of physical symptom reporting adapted from the presentation of Pennebaker (1994):

Individual factors:

- ! Gender: Females are more likely to report symptoms than males.
- ! Negative affectivity: Individuals with a history of reporting negative moods are more likely to report symptoms
- ! Traumatic experiences in childhood: Individuals with a history of traumatic experience in childhood are more likely to report symptoms
- ! Recent traumatic experiences: Individuals experiencing psychological upheavals (death of a family member, divorce, loss of job) in the past 6 months are more likely to report symptoms

Perceptual factors:

- ! Boring or tedious environment: amplifies bodily sensations
- ! Situations fraught with tension or anxiety: conflict at home or at work
- ! An appropriate trigger or causal attribution: new information about potentially harmful exposures

Social factors:

- ! Isolation at home or work: leaves more time to ponder bodily sensations, may increase anxiety, and not allow social comparison of experiences
- ! Social spread of the disorder: occurs along friendship lines
- ! Secondary gain: e.g., attention or relief from work or home responsibilities.

WHAT IS DISTINCTIVE ABOUT THE SYMPTOMS REPORTED BY GULF WAR VETERANS?

Although there have been some attempts to define "Gulf War illness" as a syndrome (e.g., Haley, Kurt & Horn, 1997), there is nothing unique about the spectrum of physical and psychological symptoms reported by a substantial proportion of returning Gulf War veterans. These symptoms are

frequently reported by healthy samples of normal individuals (Pennebaker, 1982). This constellation of symptoms is similar to that reported by many groups: patients diagnosed with somatization disorders (e.g., Robbins & Kirmayer, 1991); those meeting case definitions for Chronic Fatigue Syndrome, fibromyalgia, and Multiple Chemical Sensitivity (Buchwald & Garrity, 1994); Spanish Toxic Oil Syndrome sufferers (Lopez-Ibor et al., 1985); and a substantial proportion of populations exposed to natural and man-made disasters such as floods, earthquakes, and large fires (Bromet & Dew, 1995), radiation releases (Baum et al., 1983), and environmental chemical releases (Dayal et al., 1994). Further, it appears that similar symptoms have been reported by a proportion of all combatants in the U.S. military at least since the Civil War (Hyams, Wignall & Roswell, 1996).

It seems that a viable working hypothesis about what may be similar across this wide variety of exposures and conditions is stress.

HOW CAN WE KNOW WHETHER STRESS IS CONTRIBUTING FACTOR TO SYMPTOMS REPORTED BY GULF WAR VETERANS?

Unfortunately, most of the studies of health outcomes of Gulf War veterans have not been designed or implemented in such a way that scientifically defensible inferences can be made about any likely cause (including stress) of illnesses among Gulf War veterans. The large clinical registry studies (VA Registry and CCEP) have provided valuable information about the symptoms that a large number of self-selected Gulf War veterans have, but they were not designed to allow estimation of prevalence rates of symptoms or illnesses or to make scientific inferences about the relationships between potential risk factors and illnesses. Similarly, most of the studies that have been published concerning physical and psychological symptoms of various groups of Gulf War veterans have missing or inadequate comparison groups, inadequate participant sampling methods, and poor participation rates that make scientific inferences hazardous at best (e.g., Haley et al., 1997; Haley & Kurt, 1997; Ross & Wonders, 1993).

There has been one well-designed and well-conducted population-based study of self-reported symptoms and exposures among Gulf War veterans (Iowa Study Group, 1997). Fortunately, the findings with respect to self-reported symptoms of this study are very consistent with many other studies that are potentially biased. That is, in this study of 3695 Gulf War veterans, those who were deployed to the Gulf (relative to those not deployed to the Gulf) reported more symptoms of depression (17% vs. 11%), PTSD (1.9% vs. 0.8%), chronic fatigue (1.3% vs. 0.3%), cognitive dysfunction (18.7% vs. 7.6%), bronchitis (3.7% vs. 2.7%), asthma (7.2% vs. 4.1%), fibromyalgia (19.2% vs. 9.6%), alcohol abuse (17.4% vs. 12.6%), anxiety (4.0% vs. 1.8%), and sexual discomfort (1.5% vs. 1.0%). It was also observed that the National Guard / Reserve group reported, in general, more symptoms than the regular military group. Interestingly, 83% of the regular military group and 96% of the National Guard / Reserve group reported exposure to psychological stressors.

This well-conducted study can provide an illustration of why post-event self-reported exposures are poor indicators of exposure in studies of this type. Virtually all of the self-reported symptom outcomes were each related to several of the exposure risk factors (e.g., solvents, smoke, infectious agents). Of the three outcomes reported in some detail (self-reported symptoms of depression, cognitive dysfunction, and fibromyalgia) for participants who were deployed to the Gulf, all three showed statistically significant prevalence differences between exposure risk groups based on each of at least eight different exposures. For all three of these outcomes (surprisingly) "ionizing/non-ionizing radiation" was the exposure risk having the largest prevalence difference, i.e., greater than that for solvents, lead, infectious agents, pesticides, chemical warfare agents, or pyridostigmine use. Few environmental health scientists would predict that the relationships between radiation and these three outcomes should be the strongest observed or would claim that they were biologically plausible. It seems likely that reporting biases created these relationships. (It should be noted that the authors of the paper did not emphasize or misinterpreted these findings. They are used here only to illustrate the hazards of interpreting relationships between self-reported exposures and outcomes based on self-report.)

Virtually all of the other studies of symptoms of Gulf War veterans have been conducted on samples that have participant (self-) selection bias so substantial that no valid inferences can be made from the data collected as to likely effects of environmental exposures in the Gulf War veteran population. Moreover, even when such sampling biases are well controlled, as in the Iowa study, if both the potential exposures and the outcomes (physical and psychological symptoms) are measured by means of self-report, no scientifically definitive conclusions concerning the potential relationships between these variables can be performed. Not only are both sets of measures subject to potential reporting biases, but the reporting biases will tend to be correlated, which will introduce artifactual relationships between the two sets of measurements (Cohen, Kessler & Gordon, 1995). Only in studies in which both the exposures and the outcomes are measured objectively on population-based samples with high participation rates will scientifically defensible inferences about relationships between those exposures and outcomes be possible.

HOW IS STRESS LIKELY TO AFFECT OUTCOMES IN HEALTH STUDIES?

Stress may have a negative impact on health research outcomes via at least four mechanisms:

- ! A direct effect on physical disease outcomes, e.g., chronic heart disease.
- ! A direct cause of psychopathology, e.g., PTSD or somatization disorder.
- ! Modulation of physiological action of infectious agents or inflammatory processes, e.g., increased susceptibility to infection.
- ! Modulation of the reporting of symptoms, e.g., changing the threshold for complaining about discomfort, the rating of intensity of discomfort, or considering discomfort debilitating.

There is no evidence that stressors in the Gulf War had a direct effect on physical disease outcomes. There have been diagnosed cases of PTSD that, by definition, would be evidence of the second mechanism, although the number of such diagnosed cases may not be large. Several studies of "symptoms of PTSD" might provide evidence of the second mechanism, if there the stress exposure measurements were assumed to be valid and sampling of participants were adequate. No studies of infectious agents or inflammatory processes among Gulf War veterans are available that relate those outcomes to stress exposures. No studies have been reported that address the fourth potential mechanism, and it is difficult to determine how to test it empirically. It would, at a minimum, require pre-deployment data on individuals trait negative affect (Watson & Pennebaker, 1989; Costa & McCrae, 1987). However, this mechanism is plausible, and if individuals with high negative affect volunteered to participate in the research studies than individuals with lower negative affect, it could account for many observed findings of increased reporting of a wide range of symptoms.

HOW CAN WE KNOW WHETHER STRESS IS CONTRIBUTING FACTOR TO SYMPTOMS REPORTED BY GULF WAR VETERANS?

We can't. It is not possible to test directly whether symptoms reported by Gulf War veterans are due to combinations of significant stressors that they experienced because retrospective reporting biases in assessing both exposures and symptoms cannot now be overcome.

However, we can evaluate whether data already collected on Gulf War veterans are consistent with predictions that we would make *if we assume* that the reported symptoms of many Gulf War veterans are due to exposure to significant non-toxic physical and psychological stressors. One would predict (A) that military personnel that were better inoculated against the potential effects of the physical and psychological stressors of Gulf War combat (e.g., active duty soldiers) would report fewer or less intense symptoms than those less well inoculated (e.g., reserve duty soldiers), assuming that the level of stressors experienced by the two groups were comparable. One would expect (B) that any new illness or discomfort would be more likely to be reported among those experiencing a recent significant set of stressors (i.e., Gulf War deployment) than among those not experiencing such intense stressors (e.g., deployment to Europe) or any new stressors (e.g., not deployed). One would predict (C) that military personnel experiencing conditions associated with substantial psychological distress after deployment, e.g., divorce or death in the family, would report more symptoms than those not having such experiences post-deployment. One would predict (D) that, relative to military personnel with poor social support at home, soldiers with better social support at home would report more acute symptoms in the Gulf War theatre (a weak prediction), but would report fewer symptoms after returning home (a stronger prediction). One would predict (E) that individuals having a history of childhood trauma or minor psychological trauma before deployment would report more symptoms after deployment than those without such a history. Evidence consistent with some of these predictions is available in reports of studies of Gulf War veterans, e.g., predictions A and B are supported by data in the Iowa Study (Iowa Study Group,

1997). Further, it may be possible to test some of these predictions (e.g., predictions C, D, and E) by performing additional analyses of data already collected on Gulf War veterans.

CONCLUSION

One should *not* read this report and come to the conclusion that it implies that the symptoms that many Gulf War military personnel have reported are simply "in their head". In truth, I do not know why so many Gulf War veterans are reporting symptoms, and the literature does not support me having a scientifically based opinion. I assume that some are experiencing conditions and disease processes that would have happened without deployment to the Gulf War. My honest conclusion is that it is quite plausible that exposure to physical and psychological stressors has exacerbated physical conditions already present in some, exacerbated psychological conditions present in some, and has decreased the threshold for complaining about ailments in some. I can think of no exposure other than the wide range of potent stressors that would have potential effects on the reporting of so many different types of symptoms.

DOD and the VA are currently funding several ongoing studies concerning stress symptoms. Unless they are population-based, the participation rates are high, and the exposures are measured objectively, they are unlikely to yield useful information about relationships between Gulf War exposures and subsequent symptoms.

The fact that most people exposed to even substantial stressors do not develop symptoms (even when a substantial number do) suggests that personal vulnerability factors may be involved. Therefore, it would seem prudent to investigate which factors might be protective for, and which factors may place individuals at risk for, experiencing symptoms following combat deployment.

RECOMMENDATIONS

Follow the PAC's recommendations on peer-review of research proposals and establishing external scientific advisory panels for large projects. The Gulf War veteran literature is loaded with papers describing studies with methodological flaws that weaken their generalizability, and in many cases their validity. Perhaps there would be fewer if all proposals had been subjected to rigorous peer review and the conduct of the studies were subjected to periodic scientific review.

Minimize the number of studies that do not have both objective exposure information and objective health outcome information. (This will probably follow if #1 is observed.) Studies relating self-reported exposures to self-reported symptoms or other measures derived from self-reports are not scientifically interpretable. Perhaps improved record-keeping of the locations of military personnel will help in developing objective exposure measures, and perhaps improved medical record-keeping of objective findings from medical tests will help provide objective health outcome measures. In

addition, improved automated techniques for acquiring health-related physiological and behavioral data might prove useful.

Fund research projects aimed at the identification of personal risk factors for the development of stress-related psychological and physical illness. For example, collect baseline data on "trait negative affect" on all individuals who may be sent into combat and perform prospective studies of how well measures of this construct predict subsequent complaints, actual disease, and use of medical services. Acquire baseline information on history of traumatic exposures, alcohol/substance abuse, etc.

Formally evaluate the effectiveness of combat stress prevention programs, e.g., the U.S. Army's Combat Stress Control Detachments, and expand them if they are found to be effective in minimizing combat and post-combat stress. What information or training prior to deployment can best "innoculate" military personnel to withstand better the whole range of combat deployment stressors? What information or procedures might improve the coping skills of military personnel post-deployment?

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AIR POLLUTANT EXPOSURE AND POTENTIAL HEALTH EFFECTS AMONG PERSIAN GULF WAR VETERANS

Prepared by: Michael Lebowitz, Ph.D., Professor of Medicine, Pulmonary and Critical Care Medicine; Professor and Director of Epidemiology, Arizona Prevention Center; Chair, Epidemiology Graduate Interdisciplinary Program, University of Arizona, Tucson

SUMMARY

EXPOSURES

The Persian Gulf War was associated with increased air pollution problems in some military operations areas occupied by U.S. personnel, and in some urban areas in Kuwait and Saudi Arabia. These problems included: i) occasional increased smoke from oil well fires (and some from use of unvented kerosene heaters in enclosed spaces); ii) some short-term increases in typical combustion gases (sulfur oxides -SO_x, and nitrogen oxides - NO_x) from oil well fires (and NO_x from increased vehicular exhaust in some areas); and iii) some increases in Volatile Organic Compounds (VOCs) related to oil well fires, increased vehicular exhaust (mostly in non-urban areas), vehicle-related activities (including sand suppression) by troops, and (it is estimated) from the use of unvented kerosene heaters.

These increases in air pollution were primarily localized to areas of military activity and areas downwind from the fires (when the plumes turned from prevailing—westerly and easterly—to southerly directions, which was not very frequent). The increases in particulate matter (PM) were incremental to existing high sand-related particulate matter (PM) found in these areas (a large proportion of which are fine particles). Some VOC and NO_x emissions increased in the region after the war with a return to industrial activities and vehicular traffic in urban areas. (These exposures were in addition to those normally experienced by deployed personnel in the theater of operations, and thus included exposures to some reasonably high levels of bacillus species, pollen, fungal spores.) (A Glossary of terms is at the end of the full report in the Appendix.)

POTENTIAL HEALTH EFFECTS

It can be assumed that some acute effects occurred, based on increased levels of particulate matter and irritant gases associated with the war [e.g., diesel and turbine engine fumes, kerosene heater exhaust, artillery-related smoke, etc.]. Respiratory problems (thought not to be related to oil-well-fire pollution) were reported by U.S. troops and DOD civilian contractors, (some of whom

had pre-existing cardiopulmonary disease and may also have been smokers), and resident civilians. Sick call for respiratory complaints among U.S. military personnel comprised 19% of all sick calls, compared to a sick call rate of 7% for military personnel stationed in the States. Other potentially relevant complaints (including gastro-intestinal (GI), eye, and neuropsychological symptoms), as possibly related to air pollution exposures, were said to increase in the U.S. personnel. Information on other foreign personnel and Persian Gulf troops is limited. However, a British prospective study of 125 troops reported no significant change in lung function due to deployment in Kuwait (cf Reference 15), though this may be questioned. Further studies continue.

A Kuwaiti study reported significant increases in respiratory illnesses in the residential area of Kuwait City (cf Reference 16). In their high-risk residential populations asthma admissions to hospital did not increase immediately, but admissions for chronic obstructive pulmonary diseases (COPD: bronchitis, emphysema, bronchiectasis) did (Jan.-April 1991). They also saw increases for GI illnesses, heart disease, and psychiatric complaints. [A surveillance system was organized, and an attempt was made to create a longitudinal study of exposed and asthmatics, (by a CDC medical epidemiologist) in Kuwait city, but it appears not to have come off.] Current status of residents is not really known, though some increase in asthma was reported to a visitor. It is unlikely that the temporary increases in air pollutants due to the war and its aftermath (including the oil well fires) will have a major long-term effect in civilian, resident populations, though some individuals may have been affected. An alert system and preventive education for physicians & civilians was also attempted; implementation appears not to have occurred. These attempts should be evaluated further before new studies are suggested, designed, or implemented in the civilian population of the affected countries.

One major problem emerged, that of desert sand pneumonitis, a prolonged respiratory inflammatory process (often with some fibrosis & lung destruction), at least in U.S. and British troops. This pneumonitis is currently thought to be related to inhalation of fine sand by previously unexposed individuals. Other exposures were thought to act as adjuvants, and the pneumonitis produced was thought to affect the immune system (which will be discussed further). An autopsy study (of troops) also revealed what the pathologist called obstructive bronchitis and bronchiolitis, as well as sand particles. The sand also produced ophthalmologic (eye) problems. Thus, for some newly-exposed individuals, some long-term problems, immunologic or respiratory, may have been created. Further, it is unknown presently what effects pre-conditions (including prior treatments in the military) and other possible exposures (e.g., exposure to chemical/biological warfare [CBW] agents) may have had in foreign personnel, acutely or chronically, alone or in combination. Some on-going studies are addressing these questions. These results should be evaluated further before some of the specific studies are implemented in the U.S. personnel who served in the Persian Gulf. However, a better review of records and further evaluation of those who served is warranted.

RECOMMENDATIONS

1. Record searches in the DoD and VA Registries and in the VA healthcare system should be made to determine if deployed personnel are experiencing more respiratory problems.
2. It should be determined if there have been more respiratory diseases reported in civilians in Kuwait, and, if so, what kind of diseases.
3. An epidemiological study should be performed of respiratory and other toxic endpoints associated with specific air pollutants indicated to be of concern. It can be performed in deployed and non-deployed personnel using appropriate physiological, immunological and techniques, biomarkers of effects, and epidemiological questionnaires (including location of deployment and exposure information).
4. Further studies of absorption, inhalation and ingestion of volatile organic and similar compounds used in the Desert Shield/Desert Storm theater of operations should be performed in controlled human exposure studies, using exposures at the maximum concentrations estimated for each of these pollutants. Physiological, immunological and neurological studies should be performed in these experiments.
5. Further inhalation toxicological studies should be performed using reasonable concentrations of mixtures of fine particles/diesel fumes with specific metals, and with some of the VOCs detected in the Gulf.
6. The DVA should start a more complete registry of all Gulf-deployed personnel seen in the VA system, with follow-up of 20 years, as a valuable determinant of long-term effects. Their rates of illness and death could be compared to similar aged U.S. residents. It would be of great benefit also if clinical work-ups of these personnel were standardized and included appropriate techniques for the various long-term effects expected (e.g., respiratory diseases, neurological diseases, cancer). The recommendations stemming from the IOM and PAC panels are also worthwhile.

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MYCOPLASMA AND ILLNESS

Prepared by: Kevin Dybvig, Ph.D., Professor, Departments of Comparative Medicine and Microbiology, University of Alabama at Birmingham

SUMMARY

Although during the past 30 years the clinical significance of *Mycoplasma fermentans* has been at times the center of controversy, most studies indicate that this organism should be considered normal flora of the human genital tract and throat. The available data are insufficient to conclude that *M. fermentans* is more prevalent in veterans of the Persian Gulf War than in the general population. The only reports suggesting that *M. fermentans* may be more prevalent in Gulf War veterans are the work of Drs. Garth and Nancy Nicolson. These unconfirmed reports are based on the analysis of samples from a very small number of patients and are not technically rigorous. Moreover, even if *M. fermentans* were found to be prevalent in Gulf War veterans, there is no reason to believe this organism would be responsible for the unusual symptoms referred to collectively as Gulf War Illness (GWI). Consequently, the possibility that *M. fermentans* is involved in the etiology of GWI does not warrant serious consideration.

I. *M. FERMENTANS* AND HUMAN DISEASE - A HISTORICAL PERSPECTIVE

M. fermentans has never been generally accepted as a pathogen of humans or animals. This organism is considered to be a member of the normal human flora. It is also a common contaminant of culture systems used to propagate cells in the laboratory. *M. fermentans* has been at times suspected of causing various diseases in humans and, therefore, the center of some controversy. Studies suggesting that *M. fermentans* may be a human pathogen have often proven to be irreproducible, and whether this organism is a significant cause of human disease remains unclear.

A. *M. fermentans* and arthritis

In the late 1960's it was suggested that *M. fermentans* was a cause of rheumatoid arthritis (RA) (28). This suggestion stemmed from the isolation of organisms from the synovial fluid of symptomatic patients but lost favor because of the inability of other laboratories to replicate the findings (2). As is typical for mycoplasmas, the initial report describing the isolation of *M. fermentans* from synovial fluid may well have in actuality been an example of mycoplasma contamination of the serum component of the culture medium used to recover organisms. Recently, an association between *M. fermentans* and RA has been re-investigated using ultrasensitive polymerase chain reaction (PCR) methods. Although one laboratory reported finding *M. fermentans* DNA in synovial fluid from a large number of patients with RA (26, 27), another laboratory in a very well controlled study found no *M.*

fermentans DNA in synovial fluid from either normal patients or patients with RA (11). It is generally viewed that RA is an autoimmune disease and that the involvement of *M. fermentans* is unlikely (30).

B. *M. fermentans* and cancer

In the 1960's, some clinical observations suggested an association between infections by mycoplasmas and malignancies in humans (10). Introduction of mycoplasmas to cultures of baby hamster kidney cells was reported to induce cell transformation (19). *M. fermentans* was isolated from specimens of bone marrow chiefly obtained from leukemic patients (20) and shown to induce leukemoid disease in mice (22). Studies such as these gave rise to speculation that infection by mycoplasmas may induce malignant transformation in humans. However, the prevailing notion throughout the 1970's and 1980's was that *M. fermentans* was an opportunist. The reduced resistance of the host that accompanied leukemic disease was thought to facilitate low-grade infection by the mycoplasma. Interestingly, the possibility that persistent infection by *M. fermentans* may induce malignant transformation is being re-examined in the 1990's. *M. fermentans* has been shown to induce transformation of mouse embryo cells (29, 31). Mouse cells maintained in culture are very different from a whole animal. It cannot be overly emphasized that the ability to transform mouse cells in culture may have little relevance to malignancy in humans. The possibility that mycoplasma infection might lead to malignancy in humans is very remote.

C. *M. fermentans* and AIDS

M. fermentans received little scientific attention during the late 1970's and early 1980's, but once again returned as a focus for mycoplasma research in the late 1980's. What brought *M. fermentans* to the forefront was most likely a laboratory error resulting from contamination of a cell culture system with this organism. Dr. Shih Lo reportedly isolated a novel virus from patients with AIDS in 1986 (14). The virus was obtained by isolating DNA from AIDS patients and introducing the DNA directly into a mouse cell line by a process known as transfection. The "transfected" cells produced an infectious agent, the reportedly new virus. It was later determined that the infectious agent was not a virus at all but was a mycoplasma, originally identified by Dr. Lo as a new species, *M. incognitus*, and later correctly identified as *M. fermentans* (16, 24). For a variety of reasons, mycoplasma DNA cannot possibly transfect mammalian cells. Mammalian cells and mycoplasmas possess very different factors that regulate gene expression. The mycoplasmal promoters and ribosome binding sites that serve as important signals for gene expression (transcription) and protein synthesis (translation) would not be correctly recognized by mammalian cells (8). Also, mycoplasmas do not use the typical "universal" genetic code. In most organisms including mammals, the codon TGA is a stop codon signaling the end of protein synthesis. In mycoplasmas, TGA encodes the amino acid tryptophan. When expressed in other organisms, the TGA codons in the mycoplasma genes cause the production of prematurely truncated proteins that are not functional (7). For these reasons, mammalian cells cannot use mycoplasma DNA to synthesize mycoplasma proteins, and it is not possible that "transfected" mouse cells produced mycoplasmas. The initial report describing the isolation of *M.*

fermentans (the reputed novel virus) by transfection was clearly an error. The most logical explanation was that *M. fermentans* was present as a contaminant in the cell culture system used for the transfection experiments (9).

The erroneous report of isolation of a novel virus (later identified as *M. fermentans*) from AIDS patients led investigators to examine additional patients for the presence of this infectious agent. These studies provided clear evidence that about 10% of AIDS patients have detectable levels of *M. fermentans* DNA in their blood (5). Generally, investigators assumed this finding was merely a reflection of the fact that AIDS patients carry a high load of pathogenic and opportunistic microorganisms because of their suppressed immune systems. However, some investigators, most prominently Luc Montagnier (the discoverer of HIV), began studying the possibility that *M. fermentans* may be a cofactor stimulating the development of disease (AIDS) in HIV-positive patients (4). However, various studies indicated a lack of an association between *M. fermentans* and the stage of disease in HIV patients. Also, the incidence of *M. fermentans* in blood is the same (about 10%) in both HIV-positive and HIV-negative patients (12, 13). The conclusion from these studies and others is that *M. fermentans* is most likely part of the normal flora and is not involved in the progression of disease in HIV patients. Recently, Montagnier has conceded that HIV can cause AIDS in the absence of other cofactors such as *M. fermentans* (1).

D. *M. fermentans* and respiratory disease

Although *M. fermentans* appears to be a part of the normal human flora, there have been rare cases in which patients have died from respiratory failure from what may have been an infection by *M. fermentans*. Six such cases were reported, once again from the laboratory of Dr. Lo, in 1989 and three more in 1993 (15, 18). Unfortunately, confirmatory results from other laboratories have not been reported. Whether infection by *M. fermentans* was the primary cause of death in these patients is not known. If infection by *M. fermentans* was responsible for these deaths, an explanation is lacking for why an organism that is usually associated with human normal flora would cause an invasive, acute respiratory disease in these particular patients.

Dr. Lo's laboratory also has reported that *M. fermentans* can cause fatal disease in nonhuman primates (silvered leaf monkeys) (17). These experiments were performed using only four animals and have not been repeated in any laboratory. Also, inoculation of a different primate (macaques) with high doses of *M. fermentans* has thus far failed to produce disease (A. Blanchard, unpublished data). However, macaques and monkeys are different animals, and it is conceivable that *M. fermentans* might cause disease in one species of animal and not the other. Therefore, whether *M. fermentans* is capable of causing disease in nonhuman primates is an issue that will require more experimentation if it is to be resolved.

E. *M. fermentans* and AIDS-associated nephropathy

There has been one unconfirmed report, also from Dr. Lo's laboratory, of an association between *M. fermentans* and kidney disease in AIDS patients (3). The clinical diagnosis in these patients is AIDS-associated nephropathy. If the renal complications in these patients truly result from infection by *M. fermentans*, the logical conclusion would be that this organism is an opportunist capable of causing disease in specific situations such as when the host has a weakened immune system as is in AIDS patients.

F. Summary of *M. fermentans* and human disease

M. fermentans has at times been proposed to be a human pathogen causing a variety of different diseases (arthritis, cancer, AIDS, respiratory and kidney disease). The supporting evidence for any of these possibilities is scant at best, and this organism should still be considered part of the normal human flora. However, some microbes that have been considered normal flora in the past have been shown to be pathogenic. For example, *Helicobacter pylori* was for years considered to be non-pathogenic but has recently been shown to be a cause of stomach ulcers. Also, microbes which are considered normal flora can sometimes cause significant health problems in patients who are at risk because of other factors such as a compromised immune system or tissues that have been damaged from injury or infection with other pathogens. Infectious diseases are complicated and much is not known. It is conceivable that *M. fermentans* will one day be a recognized human pathogen.

II. *M. FERMENTANS* AND GULF WAR ILLNESS

A. Prevalence of *M. fermentans*

Few studies have examined the prevalence of *M. fermentans* in the general population because the organism is presumed to be normal flora. Most studies examining prevalence have focused on patients with specific disease symptoms in an effort to determine whether an association existed between presence of the organism and disease. These studies have involved small numbers of patients and have lacked an adequate assessment of the prevalence of organisms in the general population. Obviously, different studies reach different conclusions regarding the prevalence of *M. fermentans* depending on the diagnostic methods, the patient populations, and the particular types of samples that were examined.

One recent study reported the detection of *M. fermentans* in saliva from 40% (49 of 110) of healthy adults (6). A problem with this unconfirmed study is that sensitive PCR methods were used and the negative controls (samples known not to contain *M. fermentans*) were not convincing. The experiments were designed to PCR amplify *M. fermentans* DNA from saliva, and the negative controls were PCR reactions in which no test sample (saliva) was added. The authors evidently believed their negative controls worked; they thought no PCR product was obtained. However, from a careful examination of the photograph provided in the report, it appears that negative control samples may in fact have yielded a low level of *M. fermentans* PCR product. This could only result from DNA

contamination. If the negative controls give a positive PCR product (no matter how weak), the report cannot be trusted. When very sensitive PCR methods are employed, it is critical to ensure that samples are not accidentally contaminated with DNA prior to PCR analysis. Contamination of samples that are subjected to PCR analysis is a common problem and is one reason why it is important for other laboratories to independently verify findings. Therefore, the prevalence of *M. fermentans* in saliva from healthy adults must be considered unknown until confirmation is obtained from other laboratories. Other studies are also likely flawed because of contamination of samples with *M. fermentans* DNA prior to analysis. For example, a report describing the detection of *M. fermentans* DNA from lymph nodes of AIDS patients is questionable (25).

Reports indicate that blood from about 10% of the population contains *M. fermentans* DNA, and even a higher percentage of people may contain *M. fermentans* in the throat. A study from the Institut Pasteur in France reported finding *M. fermentans* DNA in blood from 8% of HIV-negative blood donors, 15% of HIV-negative patients from a sexually transmitted disease clinic, and 6% of HIV-positive patients (13). Another study from the United Kingdom reported finding *M. fermentans* DNA in blood from 10% of HIV-positive patients and 9% of HIV-negative patients from a sexually transmitted disease clinic (12). This latter study also found *M. fermentans* DNA in throat swabs from 23% of HIV-positive patients and 20% of HIV-negative patients.

It appears that *M. fermentans* DNA is commonly detected (5-20% of patients or blood donors) by PCR analysis of blood, throat, and possibly saliva samples. PCR is the most appropriate assay for the screening large numbers of patient samples because the principle alternative, isolation of *M. fermentans* organisms by culture, is usually difficult and unreliable. However, additional studies from multiple laboratories are required to truly ascertain the prevalence of this organism.

B. Prevalence of *M. fermentans* in Gulf War veterans

Because most investigators consider *M. fermentans* to be normal human flora, it is surprising that an effort was made to screen samples from Gulf War veterans for the presence of this organism. Blood samples from Gulf War veterans were analyzed by a technique developed by Drs. Garth and Nancy Nicolson and referred to as Nucleoprotein Gene Tracking (NGT). NGT is a procedure in which nucleoprotein is isolated from host cells, size fractionated on polyacrylamide gels, transferred to a hybridization membrane, and probed with DNA sequences specific for *M. fermentans*. This method is similar to commonly used Southern hybridization methods, except that nucleoprotein and not purified DNA is analyzed. The stated rationale for using this method was that some DNA sequences may be specifically trapped in nucleoprotein complexes (23). The claim was that sequences complexed with nucleoprotein might be lost with conventional Southern procedures, but would be detected using the NGT method. However, the NGT system is an inappropriate diagnostic method for detection of *M. fermentans*. Even if *M. fermentans* cells were themselves present inside human cells, the mycoplasma DNA would still reside inside the mycoplasma cell and not be complexed with human nucleoprotein. A serious concern is that the efficacy of the NGT method has not been

established. The sensitivity of the method has not been established by spiking control samples with known numbers of *M. fermentans* organisms. Similarly, the specificity of the method has not been established by spiking control samples with known numbers of organisms from other species of mycoplasma.

Using the NGT method, the Nicolsons reported finding *M. fermentans* DNA in 14 of 30 patients (21). A major drawback with this report is the lack of supporting documentation. Almost no data are shown in this publication or any other report published by the Nicolsons. There is only one sample from one individual (a single lane from a single gel) in which a putative nucleoprotein complex was actually shown to react with a *M. fermentans*-specific probe. The case history of this particular individual was not described. Case history has been provided for some patients, but photographs of the Gene Tracking data for these patients are not published. In the Nicolson study, *M. fermentans* DNA was not detected in any of 21 healthy individuals used as controls. However, it is premature to conclude that the incidence of *M. fermentans* in Gulf War veterans is higher or lower than it is in the general population because the Nicolson findings have not been confirmed by other laboratories. In addition to the uncertainty of the effectiveness of the NGT method, the number of samples analyzed from Gulf War veterans is few (only 30).

As explained above, the NGT method is inappropriate for detection of *M. fermentans* in samples from Gulf War veterans because *M. fermentans* DNA resides within the mycoplasma cell and would not be present in the material assayed by this procedure, namely, host nucleoprotein. An indication of the unreliability of this technique is evidenced by the Nicolsons' finding of *M. fermentans* DNA and HIV DNA sequences present in the same nucleoprotein complexes. Some regions of the HIV genome were detected but not others, indicating that HIV in its entirety was absent. Based on this finding, the Nicolsons concluded that HIV sequences may have been inserted into *M. fermentans* by genetic engineering, with the engineered strain being released into the environment either accidentally or intentionally. The reality is that genetic engineering of *M. fermentans* is not technically feasible at the present time and certainly did not occur prior to the Gulf War. Methods for genetic engineering have been established for a few species of mycoplasma but not for *M. fermentans* (8). Also, viruses that infect humans and other animals cannot infect bacteria and mycoplasmas. One reason for this is that bacteria lack the receptors the virus needs to attach to the cell's membrane. In the case of HIV, *M. fermentans* lacks the CD4 receptor. Therefore, HIV could not enter the mycoplasma. Because the NGT method yielded an impossible result (*M. fermentans* DNA complexed with HIV DNA), none of the data obtained using this method can be trusted. Therefore, there are no valid data linking *M. fermentans* with GWI.

C. Could *M. fermentans* cause disease with symptoms similar to GWI?

Because *M. fermentans* is generally considered normal human flora, it is expected that most individuals colonized by *M. fermentans* would be healthy and have no symptoms of disease. However, as mentioned above, many microbes that are usually considered normal flora can be pathogenic if

the patient is immunocompromised. Also, there is ample evidence that synergistic interactions can occur when multiple infections are simultaneously occurring in an individual. Therefore, it is conceivable that *M. fermentans* is normal human flora and yet rarely capable of causing disease (although not demonstrated to date).

If *M. fermentans* can cause human disease, what would be the expected symptoms? Obviously, any comments in this area are speculative. Many mycoplasma species are respiratory pathogens, and as noted above, there is some evidence to suggest that *M. fermentans* may rarely be associated with respiratory disease. Also, as noted above, *M. fermentans* DNA has been reportedly detected in 20% of throat samples from HIV-positive and HIV-negative individuals. It certainly is conceivable that *M. fermentans* may cause respiratory problems and sore throats in some individuals. During an active infection, other symptoms such as fatigue and fever may be expected. These symptoms would most likely be temporary, disappearing as the infection ran its course. Several species of mycoplasma can cause arthritis in various animal hosts. It is, therefore, conceivable that *M. fermentans* could be associated with joint pain in some individuals (but, this again becomes speculative).

Specific cases involving subjects who are Gulf War veterans and have tested positive for the presence of *M. fermentans* DNA in blood samples have been reported by the Nicolsons. Most of these individuals reportedly had an array of symptoms including skin rashes, vision problems, memory loss, diarrhea, and sleep problems (21). None of these symptoms are associated with any known disease caused by any species of mycoplasma. The possibility that *M. fermentans* is responsible for these symptoms is too remote to be seriously considered based on the available scientific evidence.

FINAL COMMENTS

It is very common for individuals to come in contact with potentially dangerous microbial pathogens. These microbes are usually cleared from the body in a short period of time and result in no disease. Therefore, the mere presence of organisms, even if they are known human pathogens, is not necessarily a health concern. One factor to be considered is the site where organisms are found. For example, a particular bacterium may be of no concern if located in the intestine but a significant concern if found in the lung. Another factor is the overall health of the individual. A third factor is the virulence of the particular strain of bacteria that is found. For example, some strains of *Escherichia coli* would be considered normal flora of the human intestinal tract whereas other strains would cause potentially significant problems such as severe diarrhea. Unfortunately, virtually nothing is known about factors (if they exist) that may make one strain of mycoplasma more virulent than another. Therefore, no test is available to determine whether an individual is colonized with a particularly virulent strain. Lastly, the quantity of bacteria present in a patient is important. Often, a strain of bacteria will not cause disease unless it is present in high numbers. This is a drawback to most studies that use DNA detection to identify the presence of microbes in a host. *M. fermentans* DNA may be detected in blood or other samples from a patient, but the quantity of organisms is unknown. Because *M. fermentans* is apparently present in many healthy people, investigators are

skeptical about its pathogenic potential. However, the possibility that some strains of *M. fermentans* may be especially virulent and cause disease in susceptible individuals who happen to come in contact with a high number of such organisms cannot at this time be proven or disproven. Even an intensive effort by many laboratories could not resolve this issue in a short period of time. It would take years of research to determine whether *M. fermentans* is not simply normal flora but in fact a pathogen, but such expenditures definitely are not justified by the evidence available.

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EPIDEMIOLOGICAL STUDIES OF THE REPRODUCTIVE HEALTH OF PERSIAN GULF WAR VETERANS

**Prepared by: Shanna Swan, Ph.D., Chief, Reproductive Epidemiology Section, California
Department of Health Services**

INTRODUCTION

This report reviews the epidemiologic studies that have been, and are being, conducted to assess the reproductive health of personnel that served in the 1990-91 Persian Gulf War (PGW). To this end, I have attempted to review all relevant published studies, as well as proposals, protocols, and questionnaires for ongoing studies. I have included all studies whose results were published in scientific journals or presented at scientific meetings as of December 1, 1997, as well as studies that were in progress as of that date.

With a few notable exceptions (e.g. the Oregon Health Sciences University study, and the Klemm Analysis Group Study), the completed and ongoing studies are severely limited by their incomplete exposure assessment. Because PGW veterans were potentially exposed to a wide range of chemical, biological, physical and psychological stressors, and because exposure varied with time of deployment, location, service and occupation, the deployment-nondeployment exposure classification used in most of these studies is likely to classify veterans inaccurately with respect to many exposures. As discussed in the report, these limitations are likely to result in underestimates of the risks of PGW exposure. These studies are also quite limited in their statistical power to detect increased risks of rare outcomes. Further, many of these studies are limited by their exclusion of a large proportion of PGW-exposed veterans including those no longer in active service, and National Guard/Reservists. Most of the birth defect studies, in particular, are limited by their exclusion of births in civilian hospitals, and diagnoses after the birth hospitalization.

CURRENT STUDIES

Five studies were published by December 1997 which include data on the reproductive health of PGW veterans. These are: Stretch *et al* (1995), Penman *et al* (1996), Iowa Persian Gulf Study Group (1997), Cowan *et al* (1997), and Araneta *et al* (1997). Three of these (Penman, Cowan and Araneta) examined the relationship between birth defects and PGW exposure. In connection with the Araneta publication I also discuss an additional source of case ascertainment for Goldenhar Syndrome, which is the subject of the Araneta study. The remaining two completed studies (Stretch

and the Iowa Persian Gulf Study Group) examined PGW exposure and self-reported symptoms, which included one or more reproductive symptoms or conditions.

Stretch *et al* (1995) analyze symptoms self-reported by deployed and non-deployed veterans using questionnaires mailed to 16,167 active duty and reserve personnel in the states of Hawaii and Pennsylvania. Their low response rate (31%) may be due, in part, to the fact that questionnaires were distributed to units rather than to individuals. The only reproductive outcome that was reported in this publication was "menstrual difficulties". Among active duty respondents, rates of this outcome were low and similar in deployed and non-deployed (1.7% and 1.5% respectively). Rates among reservists were higher than those reported by active duty personnel and 34% higher among deployed than non-deployed (3.1% and 2.3% respectively).

Penman *et al* (1996) evaluated birth defects and other health problems among children of veterans of two Mississippi guard units who had served in the PGW. The medical records of all (282) children of these veterans were reviewed. No concurrent control group was utilized; rates were compared to those expected from birth defects surveillance systems and previous surveys. Among 254 (90%) who were interviewed, 54 reported births that were conceived post-deployment. Medical record review was conducted to ascertain birth defects (major and minor), premature births, low birth weight and other health problems. Five birth defects (three major, two minor), five cases of low birth weight, and no stillbirths or deaths noted. No increased risks were observed compared to rates from surveillance systems. No attempt was made to characterize exposure.

The Iowa Persian Gulf Study Group (1997) estimated the prevalence of self-reported symptoms and illnesses among military personnel deployed during the PGW compared to personnel on active duty at the same time, but not deployed to the PGW (non-PGW). For this purpose, a stratified random sample was used to select a study population of 4,886 Iowa veterans. Each individual was classified as either PGW regular military, PGW National Guard/Reserve, non-PGW regular military and non-PGW National Guard/Reserve. Subjects were interviewed regarding a range of medical and psychiatric conditions. The only reproductive outcome that was reported in this publication was "symptoms of sexual discomfort". The prevalence of sexual discomfort among female partners was approximately doubled among PGW veterans compared to non-PGW veterans (5.0% vs. 2.4% for regular military and 5.4% vs. 2.1% among National Guard Reservists). Both of these comparisons were statistically significant at the 95% level.

Cowan *et al* (1997) studied the relationship between service in the PGW and the overall risk of birth defects for all US veterans. For this purpose the authors accessed live births at 135 military hospitals between 1991 and 1993. During that time, 33,998 infants were born to PGW veterans and 41,463 to non-deployed veterans at these hospitals. Birth defects, as routinely recorded on birth records, were obtained for all live births. Military records were accessed to obtain information on military service and deployment locations. Exposure was defined simply as "deployment to the PGW". While no association between PGW service and birth defects was seen for male service

members, among females there was a small, but statistically significant, increase. Using the broadest definition of congenital malformations, malformations were noted in 10.32% of births to deployed veterans versus 9.2% to nondeployed [unadjusted relative risk 1.12, 95% confidence interval (CI) (1.00 to 1.25)]. After adjustment for race, marital status and branch of service the relative risk was reduced to 1.07 (95% CI 0.94-1.22). The risk of a severe birth defect was slightly (and not significantly) lower among children of active duty women than among children of non-deployed (2.0% versus 2.1%), and both were similar to that reported by the CDC (1.9%). Six commonly occurring groups of defects were examined and none were associated with PGW exposure either in men or women. Crude (unadjusted) birth rates were significantly higher in PGW veterans than non-deployed (95.6 per 1,000 versus 93.3 per thousand). The ratio of male to female births was similar in deployed and non-deployed veterans.

The frequency of occurrence of Goldenhar Syndrome, the most severe group of anomalies to form an oculo-auricular-vertebral syndrome was estimated in deployed and non-deployed veterans by Araneta *et al* (1997). The authors ascertained cases diagnosed at birth among infants born to active-duty military personnel in military hospital using a broad screen of hospital discharge diagnoses. Potential cases were identified using 66 ICD-9-CM codes, including the general category "anomaly of skull and face bones", and selected ear anomalies. Medical record review by expert reviewers, blinded to exposure status, was used to identify definite cases of Goldenhar Syndrome among these potential cases. For all the seven cases identified, the father was the parent in the military. Five of these were offspring of PGW veterans (14.7 cases per 100,000) and two were offspring of non-deployed veterans (4.8 cases per 100,000). Thus, the relative risk was elevated (relative risk = 3.0, 95% CI 0.6 – 20.6) though not statistically significantly. The rate observed in PGW exposed was significantly higher than that reported by either the Hawaii Birth Defects Program or the Metropolitan Atlanta Congenital Defects program (4-5 per 100,000).

The Association of Birth Defect Children (ABDC) actively solicits the reporting of birth defects. As part of this activity, 18 cases of Goldenhar Syndrome were identified in veterans; 15 were deployed to the PGW. Since this registry is more likely to obtain case referrals from exposed veterans, it cannot be assumed to include a representative sample of unexposed cases.

ONGOING STUDIES

I have identified eight ongoing studies that should provide additional information on the risk of adverse reproductive outcomes among PGW veterans.

Study 3 is a comparative study of pregnancy outcomes among PGW veterans (male and female) and other active duty personnel. I could not determine whether other outcomes will be examined in this study.

Study 4 is examining differences between PGW veterans and non-deployed veterans with respect to infertility, time to conception and risk of miscarriage. In Phase I of this study a questionnaire was mailed to a random sample of 16,000 couples (8,000 couples for which one or both deployed to the PGW, and 8,000 for which neither deployed). Currently the participation rate is 46%. Phase II will consist of a telephone interview of 5,000 couples to obtain detailed information on exposures and known risk factors for infertility and miscarriage. The following four categories of married couples are included: (1) woman served in the PGW; (2) man served in the PGW; (3) woman served in the military during the PGW, but not in the Gulf area; and (4) man served in the military during the PGW, but not in the Gulf area.

Study 7 is examining the prevalence of congenital anomalies in the seven states that maintain active birth defects surveillance systems. These include all birth defects diagnosed in live births during the first year of life and in still births. This study also proposes to compare rates of preterm birth, low birth weight and still birth between PGW veterans and non-deployed veterans in the seven states. Births between 1989 and 1993 will be included in order to compare conceptions prior to, during, and after the PGW.

The California Birth Defects Monitoring Program (CBDMP) will conduct a feasibility study to determine: (1) whether Department of Defense (DOD) data on births to active duty military personnel are sufficient to allow the CBDMP to locate the medical records of these children during their first year of life; (2) whether hospital record review is possible at DOD facilities, particularly those which may be closed or have incomplete medical record information; (3) whether DOD information about structural congenital anomalies is sufficiently accurate, compared to complete hospital medical record information. This study will also determine if DOD information about the identity of inactive (separated) personnel can be linked to California vital records and CBDMP files, neither of which contains social security information.

The most unusual reproductive tract abnormality reported by PGW veterans and their spouses is the "Gulf War Vaginal Burning Syndrome". In cases of this syndrome, which can be local or systemic, severe vaginal burning and pain are reported to occur immediately on contact with the spouse's seminal fluid. A study being conducted by the University of Cincinnati has, as its first goal to determine whether this syndrome in PGW veterans is due to the same immune responses previously described for cases in the general community. Ten cases in which the husband is an exposed veteran as well as ten unaffected spouses of exposed veterans will be selected for comparison. The second goal of the study is to identify seminal plasma proteins involved in the pathogenesis of this syndrome in spouses of PGW veterans, to determine whether these are the same as the proteins identified in cases in the general population. For this purpose, five ejaculates, collected over five consecutive days will be obtained and used to isolate seminal plasma proteins from each male participant. Women will then be tested for sensitivity to these seminal proteins using skin prick tests. The third study goal is to determine the effects of PGW exposures on human seminal plasma obtained from both PGW-exposed and non-exposed males.

The Oregon Health Sciences University study will identify risk factors for Persian Gulf War Unexplained Illness (PGWUI) in veterans from the northwestern United States. For this purpose a population-based questionnaire is being mailed to a representative sample of deployed veterans within the following strata; (1) pre-combat (Desert Shield) only; (2) combat (Desert Storm) only; (3) post-combat (desert cleanup) only; and (4) two or more of these. By using a sampling strategy based on period of deployment, the role of potential risk factors such as Pyridostigmine bromide, special vaccinations and combat stress can be isolated and analyzed. Respondents to the mailed survey will provide the study population for the clinical case-control phase of the study. In this phase, the nature and pattern of exposures in cases of PGWUI and controls will be compared. A total of 250 cases and controls will be recruited for clinical testing within four months of responding to the survey.

The Department of Veterans Affairs, is conducting a three-phase study which includes a range of reproductive endpoints. In Phase I, a mailed questionnaire was sent to a random sample of 15,000 PGW veterans and a control sample of 15,000 Gulf-era veterans. To validate responses and evaluate effects of a low response rate (50%), in Phase II, 2,000 respondents among the deployed, and 2,000 among the non-deployed are being contacted by phone to obtain permission to review medical records. Further, a random sample of 8,000 non-respondents was selected to compare respondents and non-respondents. In Phase III physical examinations will be conducted on 1,000 veterans randomly selected from each group (deployed and non-deployed) as well as their family members.

The Klemm Analysis Group is conducting a two-year study comparing the health status of 10,000 women who served in the PGW with 10,000 Gulf-era military women. For this purpose a questionnaire has been developed inquiring about symptoms and conditions including adverse reproductive outcomes such as infertility, pre-term births, still births and birth defects. Detailed information on exposures before, during and after the PGW is being elicited.

RECOMMENDATIONS FOR FURTHER STUDY

Most of the studies of the reproductive health of PGW veterans conducted to date include only limited exposure assessment. The most notable exception is the Oregon Health Sciences University Study (OHSU), which can be taken as a model for this purpose. The Klemm Analysis Group questionnaire also includes a strong exposure assessment component. The birth defect studies are particularly weak in this respect, with the exception of the Iowa study, which contains a fairly extensive exposure component. Therefore, I recommend that a nested-case-control study be imbedded in Study 7, and a detailed exposure assessment be conducted, perhaps using the OHSU instrument for consistency and later comparison across studies.

The study of Arenata *et al* documents an increased risk of Goldenhar Syndrome among potentially exposed veterans. However, this increase is not statistically significant, possibly due to small numbers. Therefore, I recommend expanding this study, both to obtain additional cases and

to improve the exposure assessment. To this end I recommend first evaluating the possible additional cases of Goldenhar Syndrome which have been identified by the ABDC registry. It should be determined whether any of the 15 exposed cases identified by the ABDC includes cases that should have been identified by the Araneta *et al* study protocol but were inadvertently missed. In other words, were all ten of the additional exposed cases identified by the ABDC ineligible for the Araneta study? Conversely, were all five exposed cases identified in Araneta *et al* included among the ABDC cases? It is also recommended that systematic case ascertainment for Goldenhar Syndrome be expanded in both deployed and nondeployed veterans, including births to separated personnel and all births to veterans in civilian hospitals. Ascertainment throughout the first year of life, using the full medical records would be ideal. In addition, it is important to obtain detailed exposure information on all cases and a sample of controls, perhaps using the Oregon Health Sciences' questionnaire to obtain exposure information. It is also important to determine whether the cases of Goldenhar were the first live births born to veterans post-deployment. A causal relationship between this syndrome and births after one or more healthy babies seems unlikely.

The Oregon Health Sciences' University is has provided a tentative definition of Persian Gulf War Unexplained Illness (PGWUI), and is ascertaining cases of PGWUI in the Northwest. Since it is still uncertain what exposures are most relevant for reproductive illness in PGW veterans, I recommend looking for an increased incidence of reproductive abnormalities in cases of PGWUI. It is plausible that these veterans, most affected systemically by these exposures, would also exhibit more reproductive dysfunction in connection with PGW exposures. This reproductive assessment should be as complete as possible and should include serum hormone analyses on cases of PGWUI in the Northwest cohort. In addition, it would be valuable to examine semen quality in male cases. To date none of these studies has examined semen quality of veterans. Females could be asked to maintain a detailed dairy recording menstruation, frequency of intercourse and use of contraception that would allow for a precise analysis of time to conception. If daily urine samples were obtained as well, assays would provide information on early fetal loss. (See Tier II analyses, Table 6 in the full report in Appendix L).

Several sources of misclassification in the birth defect studies conducted or underway are listed above. I recommend that the magnitude of the resulting misclassification be estimated using a sample of births from Study 7. This analysis would probably have to be limited to the five states that have active birth defect surveillance for infants up to one year of age throughout the state (thus excluding California and Georgia). This could be done by obtaining as complete an ascertainment of birth defects as possible on the selected sample, and then determining how many of these birth defects would have been missed if; (1) only the birth record had been used; (2) only military hospitals had been used; (3) only active-duty personnel had been included. The degree of under reporting could then be examined as a function of severity of the defect and other covariates.

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GULF WAR REPRODUCTIVE HAZARDS

Prepared by: Melissa McDiarmid, M.D., M.P.H., Associate Professor of Medicine, Occupational Health Project, University of Maryland; and Director, Depleted Uranium Follow-Up Program, Baltimore Veterans Affairs' Medical Center

SUMMARY

Deployed Desert Storm/Desert Shield personnel encountered a complex ambient environment which included chemical, physical and biologic hazards, as well as those of warfare itself. The complexity of this environmental matrix, the lack of record keeping for various potential exposures and the passage of time since the conflict have conspired to muddle associations between environmental exposures and any health effect—including those affecting reproduction.

Further complicating our ability to draw inferences between Gulf War service and reproductive health harm is the apparent relatively high frequency of spontaneously occurring or "background" adverse reproductive effects such as infertility, spontaneous abortions (miscarriages) and birth defects. For example, the conception rate per menstrual cycle of normal couples of reproductive age having unprotected intercourse approaches 50%. However, the viable pregnancy rate, i.e., pregnancy resulting in the birth of a viable child, is about 25% (Soules, 1985). Major fetal malformations occur in about 3% of liveborn babies, and other impairments such as low birth weight occur in many more (Kalter and Warkany, 1983).

MECHANISM OF REPRODUCTIVE TOXICITY

Although there are gender-mediated differences in chemically induced adverse reproductive outcomes, the majority of well-tested chemicals have demonstrated adverse reproductive outcomes in both males and females (Paul and Himmelstein, 1988). Adverse effects caused by reproductive toxicant exposure may be manifested at many sites in the complex pathway of reproductive function beginning with gametogeneses, and continuing through gamete interaction (fertilization), embryonic and fetal development and growth, parturition and sexual maturation of the offspring. Various biologically plausible mechanisms exist that could explain an adverse reproductive event resulting from a Gulf War exposure. These include both genetically mediated (mutation) and non-genetically-mediated events.

MALE-MEDIATED EFFECTS

The biologic plausibility of male-mediated reproductive effects has been increasingly considered and scientific evidence for such effects has grown rapidly. Wyrobek has recently reviewed the evidence for male-mediated effects manifested beyond fertilization and the multi-generational context in which reproductive health must be studied (Wyrobek, 1993).

The process of spermatogenesis, characterized by rapid cell development in the testes, is a likely target of mutagens which ordinarily interact with dividing cells. Multiple outcomes could result from such interactions including male infertility and spontaneous abortion. Besides genotoxic mechanisms, other epigenetic and non-genetic mechanisms modulate male reproductive health at the level of the normal physiologic function and the control of erection and ejaculation. Neurotoxic agents such as lead (Lancranjan, 1975) and inorganic mercury (Wharton, 1983) may thus affect sexual function.

A male contribution to spontaneous abortion can be hypothesized via a mutagenic insult to the sperm (Wyrobek, 1993), paraoccupational exposure resulting in home contamination and maternal exposure (McDiarmid and Weaver, 1993), concentration of the agent in semen (Stachel et al., 1989) and direct transmission of the agent on sperm (Yazigi et al., 1991).

REPRODUCTIVE OUTCOMES - BIOLOGIC PLAUSIBILITY

A review of the published literature, as well as reports of the Presidential Advisory Committee (PAC) and the Institute of Medicine (IOM), and minutes of the PAC hearings on Reproductive Health of Gulf War Veterans and PAC staff consultations on reproductive health was performed. These sources reflect similar over-arching opinion on the biologic plausibility of reproductive health harm, methods to ascertain potential health effects, strengths and weaknesses of existing evidence, and recommendations for the future.

While the prevalence of malformations is variously reported at about 3-5% of newborns, increasing to 10% after the first two years of life, the general public's lack of knowledge of this baseline prevalence has helped to feed fears regarding clusters of birth defects. Epidemiologic studies to date have failed to show any excess of birth defects among deployed PGW veterans, although some studies are methodologically limited and others are ongoing. Various experts testified that chasing clusters is not a good use of the public health dollar when both statistical power and exposure assessment data are so lacking. As well, very few of the major birth defects have a recognized, discrete mechanism of causation making associations between outcomes and deployment exposure difficult.

The majority of the testimony was focused on male-mediated effects due to the disproportionate number of men deployed (about 700,000) versus women (35-50,000). The most consistent consensus among experts testifying regarding mechanisms of insult resulting in reproductive health harm focused on germ cell or other damage by a direct-acting mutagenic agent. The most commonly expected outcome from such an exposure would be a spontaneous abortion due to non-viability from chromosomal aberrations or other insult in the product of conception. Other opportunities for exposure to a toxic substance included a discussion of transport of a toxicant in seminal fluid and secondary paraoccupational exposure of the woman to contaminants tracked home by the man on the clothes and shoes. These mechanisms have been suggested in other occupational/environmental settings and enjoy more relative consensus than further issues to be discussed.

From p. 160 of his testimony, Dr. Robert Brent states "There is no epidemiological information to support the suggestion that there is an increase in congenital malformations in the offspring of Desert Storm... The nature of the malformations, the types of exposures, prior studies involving human exposures to mutagenic agents and the concept of biologic plausibility make it very unlikely that there is an increase in the incidence of malformations in offspring." From p. 161, "We would not be in the present dilemma if we had a national program of congenital malformation surveillance involving every birth in the U.S."

SELF-REPORTED REPRODUCTIVE HEALTH PROBLEMS

There has been concern among PGW veterans regarding reproductive health and the questions of any adverse reproductive outcomes being deployment - related. Early versions of the CCEP and VA Gulf War Registry Examination questionnaires have been criticized for inadequate attention to these outcomes. The VA has since revised its questionnaire to include a more detailed reproductive health assessment. Dr. Susan Mather, Chief of DVA's directorate of Environmental Medicine and Public Health relates that 53,000 veterans were seen using the old questionnaire and all of these people were mailed the updated questionnaire in the last year. She estimated that about 20,000 had been returned, but were still being analyzed. She also mentioned that phase III of the Gulf War Registry Health Examination program, although looking at a small subset of the total population, will include an evaluation of spouses and children. These approaches are appropriate given the time elapsed since exposure and the attendant epidemiologic problems which arise from this.

EXPOSURE ASSESSMENT

OVERVIEW

The principal resource cited in the variety of reports reviewed regarding the exposure assessment performed for the presence of reproductive toxicants in the Gulf War theater is the U.S. General

Accounting Office (GAO) report to the chairman, Committee on Veterans Affairs U.S. Senate. This August, 1994 document addressed a number of questions regarding reproductive health concerns in the Gulf, only one of which was a charge to characterize potential reproductive toxicants present. The report identified twenty-one agents distributed among three broad hazard types - pesticides, oil fires and soil samples, and decontaminating agents. The methodology used by GAO to assemble this list was only cursorily described to include interviews and document review. As well, the lack of any non-chemical hazards identified demonstrates a limited understanding of the array of reproductive toxicants with a potential role in health risk assessment.

The classical approach in performing an exposure assessment begins with assembling candidate toxicants present in the exposure cohort's environment. This process was partially completed by the GAO. Clearly, however, the non-chemical reproductive toxicants must also be cataloged. I will attempt to at least begin that process later in this report.

After identification of hazards, the next step in an exposure assessment is the determination of exposure dose. It is this critical step that is always challenging, but in this present scenario, all but impossible to achieve. As the GAO report states, "... we did not ascertain ... exposure rates for service men and service women for these toxicants... nor perform a risk assessment of these exposures and how they might relate to possible reproductive dysfunction...". In introducing the GAO findings in testimony before the Senate Committee, Capitol Issue Area Director, Kwai-Cheng Chan stated that (referring to the twenty-one toxicants cited above), "... the concentration levels of these compounds are unknown and so are the exposure rates for specific units".

Therefore, not only are quantitative assignments of exposure dose impossible to make for a given toxicant and a given service person, or even service unit, a qualitative assignment of exposure cannot even be reliably made.

Reinforcing this observation is Dr. Grace LeMaster's testimony to the Presidential Advisory Committee staff consultation on reproductive health of Gulf War veterans, page 34: "... exposures cannot be characterized very well. It is my understanding that even vaccination records were not kept... across all these pregnancies, you have no idea what the exposures are, it's almost like three strikes against uncovering anything in this particular situation."

While the absence of environmental sampling data for the twenty-one toxicants is understandable given the deployment scenario, as may be understood for who used how much pyridostigmine, the lack of performance type records, such as vaccination data, is less comprehensible.

Also disconcerting are the anecdotal reports cited in the GAO report. This from page two of that report (referring to the hazardous exposures in the Gulf) "such as the extensive use of diesel fuel as

a sand suppressant in and around encampments, the burning of human waste with fuel oil, the presence of fuel in shower water, and the drying of sleeping bags with leaded vehicle exhaust..."

It appears that the most that is possible regarding exposure assessment will be very coarse assumptions made about certain deployed groups. Refinement as to individual toxicant exposure to an individual service person will be extremely difficult.

One potential approach to examining at least a "first cut" assessment might be that described in Dr. Linda Shortridge's testimony to the Presidential Advisory Committee (page 413). She is describing exposure assessment methodology that is being used at the University of Oregon and some of their epidemiologic studies. Regarding exposure assessment, she states, "We do, however, have an opportunity to compare and contrast groups of veterans who had separate sets of potential exposure, because they were deployed in the theater of operations for distinct identifiable periods." This might be a potentially useful and "transportable" approach to at least qualitatively refine different populations who, because of calendar time in the theater, were necessarily exposed (or not) to some different toxic substances.

EPIDEMIOLOGY OF SELF-REPORTED ENVIRONMENTAL EXPOSURES

The 1996 summary of the Department of Defense's (DOD) Comprehensive Clinical Evaluation Program (CCEP) for Persian Gulf War Veterans included data for more than 18,000 returned service members who requested a complete health evaluation. Part of the health evaluation involved questionnaire completion of a self-reported environmental history. The questions elicited information about food and water intake, and personal habits, such as smoking and exposure to passive smoke, as well as questions regarding the more uncommon chemical environmental exposures. Obviously, the circumstances of exposure, and what determines the individual service member's positive response, are variable. Frequency of exposure is also not obtained by this method. Nonetheless, it gives a sketch of what individual soldiers reported.

A similar battery of questions were included in the Department of Veterans Affairs (DVA) Persian Gulf Registry questionnaire. Responses elicited are displayed in Table 1. Of interest is the close agreement between the two sources on frequency of environmental exposures. Passive cigarette smoke, diesel exposure, oil fire smoke and tent heater fumes were most commonly reported.

The detail of the questions in both the DOD's CCEP assessment, and the DVA's assessment however, are problematic. Without adding to the number of questions either health assessment battery currently includes, more refinement of the language used in crafting questions, and some guidance given to participants about what type of exposure constitutes a clinically important "yes" to the question, could greatly enhance the value of this information.

Table 1. Frequency of Self-Reported Environmental Exposures in Gulf War Veterans (GWV)^a and Active Duty Service Member (ADS)^b

EXPOSURE	POSITIVE RESPONSE	
	GWV ^a (%)	ADS ^b (%)
Passive Cigarette Smoke	88.5	88
Diesel/Other Fuels/Petrochemical Fumes	90.4	88
Oil Fire Smoke	72.6	71
Tank Heater Fumes	66.6	70
Pyridostigmine Bromide	64.2	74
Personal Pesticide Use	66.7	66
Burning Trash/Feces	73.9	N/A
Skin Exposure to Fuel	73.7	N/A
ATE Non-US Food	71.3	66
Chemical Agent Resistant Paint (CARC)	34.5	47
Solvent /Paints	53.6	48
Anthrax Immunization	48.7	49
Ate Contaminated Food	33.2	21
Microwaves	34.2	N/A
Bathed in Contaminated Water	28.6	20
Bathed in Non-Military Water	30.5	N/A
Bathed in/Drank Non-US Water	N/A	32
Botulism Vaccine	26.8	26
Depleted Uranium	14.2	15
Nerve Gas	14.1	61
Took Oral Meds to Prevent Malaria	N/A	22
Mustard Gas/Blistering Agent	N/A	25
Chemical Alarm	N/A	65
Witnessed Casualty	N/A	56
Witnessed SCUD Attack	N/A	54
Witnessed Actual Combat	N/A	37
Wounded in Combat	N/A	2

^a = From Office of Public Health & Environmental Hazards, DVA, "Review of DVA Revised Gulf War Registry & In-Patient Treatment Files (12/97); N = 10,075

^b = Percent based on participants who answered Yes or No (excludes unknown) from DOD CCEP for PGW Veterans (4/96); N = 18,075

EXPOSURE ASSESSMENT IN REPRODUCTIVE HEALTH STUDIES

Most of the studies of reproductive health of Persian Gulf War veterans, whether they be those that have been completed, or those that are ongoing, suffer from extremely weak exposure assessment. A majority of the studies use exposure assessment definitions as simple as those deployed being exposed, and those non-deployed being unexposed for controls. This is clearly inadequate.

Of the studies that are ongoing, again the very large hospital based medical record studies, such as the Cowan and Calderon studies, as well as the Araneta studies 3, 4 and 7, referred to in Dr. Swan's report, all have this significant weakness of having no address of exposure assessment, except deployment status. Of other studies that are ongoing, several do, however, address environmental exposures. These include the National Health Survey performed by the Department of Veterans Affairs; the University of Oregon's evaluation; and the planned study by the KLEMM group of 10,000 Persian Gulf War deployed women compared to non-deployed woman.

Also of interest, we should mention that the clinical study at the University of Cincinnati, looking at seminal plasma hypersensitivity reactions plans to address in a research format some of the environmental agents which may be active here by introducing some of these environmental substances in an in vitro system during the assessment of seminal plasma hypersensitivity. This type of inclusion of environmental effectors in a research protocol is something that we should like to see in future research studies.

The principal barrier to elucidating what happened or might have happened in the Gulf is the absence of exposure data. While a list of reproductive toxicants present somewhere in the Gulf theater can be drawn, its completeness and more importantly, the lack of individual or even military unit exposure information (by type of agent, concentration, duration of exposure) collude to limit what information might be drawn from the list of suspect agents. As well, the other confounding issues, not the least of which is the physiologic and psychologic impact of deployment and war making, make assigning an association of a specific exposure to a specific adverse outcome extremely difficult. None the less, there is some limited value in listing the reproductive toxicants present in the GW theater.

CANDIDATE REPRODUCTIVE TOXICANTS

The Government Accounting Office (GAO) was asked by the Senate Veterans' Affairs Committee to specify reproductive toxicants to which deployed troops were potentially exposed. In their August 1994 report to the Senate Committee, the GAO identified three broad categories of reproductive toxicants present in the Persian Gulf area: Pesticides, oil fire contaminants and decontaminating agents. The GAO was unable to supply exposure dose data nor could they determine which specific units were exposed (if at all) to each of the agents. In addition to the agents the GAO listed, other reviews have also considered exposure to pyridostigmine bromide (PB),

the prophylactic for nerve agent exposure, the various vaccine exposures, possible biologic agent exposure and mustard agent exposure. Reproductive and developmental toxicity data, as well as epidemiologic results, where available, are summarized in this section.

Frequently reported birth defects observed in the offspring of pesticide-exposed populations include neural tube defects, limb reduction defects and facial clefts. (White FM et. al., 1988; Field and Kerr 1979; Balarajan and McDowall, 1983; M. Paul, 1993). Facial clefts and neural tube defects have also been found in some, but not consistently, in studies of herbicide exposed agricultural workers and in one study of Vietnam Veterans exposed to the herbicide Agent Orange. Clarity on this issue has been hampered by lack of exposure data and small sample sizes. Limb reduction defects have been associated with residence in farming areas and agricultural work (Schwartz DA, et. al., 1986; Schwartz and Longerfo, 1988).

Maternal pesticide exposure has been found to increase the risk of facial clefts (Brogan et. al., 1980; Gordon and Shy, 1981) and for all congenital abnormalities. There has also been some disagreement in the literature regarding increased risk for spina bifida with some reporting an increase and others not seeing one (White et. al., 1988; Golding and Sladden, 1983). Also of interest, in an interview study of crop duster pilots and their sibling controls, there was no difference between groups in number of birth defects in offspring (Roan et. al, 1984).

Generally these studies have examined people with an occupational exposure to pesticides, thus presuming a relatively longer duration of exposure opportunity and higher exposure intensity than would be the case for environmentally exposed persons (pesticide users). While adverse reproductive outcome cannot be ruled out in low level exposures to pesticides (OPs) for example, such adverse effects are much less likely in the environmentally (low dose) exposed service member population than in populations occupationally exposed, such as pesticide applicators and farm workers.

OIL FIRES AND SOIL SAMPLES

A number of toxic constituents characterize oil fire exposures, with much attention given to the polycyclic aromatic hydrocarbon benzo (a) pyrene.

BENZO (A) PYRENE

Environmental characterization of Kuwait oil-well fires indicated the likely presence of numerous genotoxic contaminants. Mutagenic products of combustion including polycyclic aromatic hydrocarbons (PAH) such as benzo (a) pyrene (BAP) were a concern in performing a health risk assessment for troops deployed to Kuwait in June - September, 1991. As part of a larger health assessment of these troops, the U.S. Army Environment Hygiene Agency (USAEHA) assessed the potential for mutagenic exposure. The study employed a generic measure of mutagen exposure, sister chromatid exchange (SCE).

Frequencies of sister chromatid exchange (SCE), a measure of genotoxic exposure, were assessed in military troops deployed to Kuwait in 1991. Soldiers completed health questionnaires and had blood collected prior to, during and following deployment to Kuwait. Frequency of spontaneous SCE was determined on blood samples as a measure of mutagenic exposure. Compared to pre-deployment baseline SCE frequency means, levels obtained two months into the Kuwaiti deployment were significantly increased ($P < 0.001$) and persisted for at least one month after return to Germany. Outcome was unaffected by known personal SCE effect modifiers including smoking, age, and diet.

This study reveals a highly significant increase in mean SCE for a population of soldiers serving in Kuwait while oil-well fires burned. This increase persisted for at least one month following return to their pre-deployment assignment in Germany. Environmental exposures not due to burning oil fires may have also caused the observed increases in SCE.

The authors concluded that although a statistical increase in SCE frequency has been demonstrated in troops deployed to Kuwait, implying a genotoxic exposure, multiple candidates exist as the potential cause of this observation. At present, SCE elevations are thought to measure exposure to some genotoxic agent, but the long-term health consequences of this phenomenon have not been determined in this or other populations' exposure to genotoxicants. (McDiarmid, et al., 1995).

Another aspect of the Army's larger health risk assessment determined environmental PAH exposure which revealed low ambient levels of PAHs in the areas where soldiers were working in Kuwait. As well, measures of PAH interactions with human blood lymphocyte DNA (PAH-DNA adducts) and aromatic-DNA adducts were at their lowest levels in Kuwait compared to levels in Germany. (Poirier M. et al., in preparation).

DECONTAMINATING AGENTS

Ethylene -glycol-monomethyl ether (2-ME) and a related compound, ethylene glycolmonoethyl ether (2-EE) are widely used in industry in paints, varnishes, and thinners, and as solvents in the textile and semi-conductor industries. Health effects data in animals and humans, together with estimates of large numbers of workers potentially exposed (850,000 U.S. workers, according to NIOSH) has prompted the OSHA to begin rule-making to limit worker exposure to 0.1 ppm for 2-ME and 0.5 PPM for 2-EE for an eight hour time weighted average (TWA) exposure. This is the first OSHA rule-making specifically driven by the adverse reproductive health effects of a workplace agent.

PYRIDOSTIGMINE BROMIDE

Pyridostigmine bromide (PB) is a cholinergic agonist used in the treatment of myasthenia gravis. PB has not been demonstrated to cause increased congenital defects in rats, when exposed throughout pregnancy (Levine, 1991). A number of myasthenic women treated with PB during pregnancy have not had adverse effects in offspring attributed to the drug (Pleuche, 1979). The American Academy of Pediatrics and the WHO working group on drugs and lactation have classified pyridostigmine as compatible with breast-feeding (AAP, 1994; WHO 1988).

NON-CHEMICAL HAZARDS

A number of non-chemical hazards have been identified which may impact the reproductive health of the Persian Gulf deployed. These hazards have been recently reviewed by Agnew et al., 1991 and include heat and biohazards.

COMMENTS ON GAO RECOMMENDATIONS

Prior to making my recommendations, I would first like to comment on the recommendations that the GAO made in their testimony from August 5, 1994 regarding reproductive hazards during Operation Desert Storm. They made four recommendations at that time. The first was to guide the Secretary of Veterans' Affairs to direct a revised and expanded questionnaire and to re-register veterans who had already completed the VA registry examination in order to include reproductive health endpoints in their surveillance. I understand that this is already being done.

Secondly, they recommend that the Environmental Protection Agency, Department of Health and Human Services and DOD make additional scientific inquiry into possible synergistic effects of multiple exposures to hazards found in the Persian Gulf War. This needs to be commented upon. This would be an extremely difficult task in that even some of the individual hazards have not adequately been reviewed for reproductive and developmental toxicity, and more importantly, the exposure assessments are so poor that it is hard to see the sense that this suggestion makes. It would not be a good use of the public health dollar to start here. Rather, there are some more fundamental issues that need to be addressed by DOD that include exposure assessments and basic hazard surveillance.

The GAO's third recommendation involved establishing baseline data on various reproductive outcomes, including birth outcomes, infertility and miscarriage rates among active duty military, reservists, presumably before future conflicts. While this is a laudatory notion, it is extremely complicated, though less daunting than their follow-up suggestion which is to ascertain exposures of reproductive toxicants and some type of a warning system when the concentrations of exposure rise to what they call "dangerous levels in future conflicts". It is unclear to me how this could be done and what is a realistic way of monitoring this separate from a more basic approach which is to

use a classical industrial hygiene hierarchy of control technology which I will say more about in my recommendations.

The fourth GAO recommendation was that the DOD should develop procedures to better ensure that troops are informed of possible reproductive toxicants before future deployments and to monitor exposure levels to such hazards. Again, the hazard communication piece of this recommendation is appropriate and can certainly be built into existing training. The notion of monitoring exposure concentrations, however, is a little more naive. I think that it is more likely that exposures can be minimized by substitution and elimination of known reproductive toxicants where possible, which included the minimizing of inappropriate use of certain reproductive toxicants that have been reported by GAO and I am going to discuss further below.

RECOMMENDATIONS

1. My first recommendation would be to "stop stupid stuff". This is language used in agency parlance to mean do not keep doing things that are not defensible. Examples here are those documented in various testimony, including the use of diesel fuel as a sand suppressant and using leaded gasoline exhaust for drying sleeping bags. These presented absolutely preventable and inappropriate overexposure to reproductive toxicants in the Gulf War theater. These types of examples of easily preventable scenarios are those that need to be included in some type of a hazard communication course or program for all deployed, especially for those that are going to be supervising ground troops.
2. There is a need to develop an environmental hazardous materials training program. I would suggest here an approach similar to the National Institutes for Environmental Health Science (NIEHS) model for workers exposed to hazardous materials (hazmat). There are three or four tiers of training, the first being the most basic and the shortest, an awareness level of training, the second being more comprehensive perhaps for someone who will have some response capability, and finally a third and higher levels, perhaps a master or trainer level where there is much more detail pursued. This approach is based on a National Fire Protection Association (NFPA) standard on Professional Competence of Responders to Hazardous Materials Incidents (NFPA 472). The general purpose of the standard is to reduce the number of incidents, injuries and illnesses resulting from hazmat incidents. The scenarios reported of the inappropriate overexposure by using toxic substances in the wrong way I think are the best examples of case studies that could be used to promote the notion that there is a right way and a wrong way to handle a hazardous substance. In addition, the hazardous materials training can include some of the various health effects training and could be very similar to the hazard communication training that is required in various work places and also has been suggested by a number of experts who have testified in the various forums that were convened to examine this problem. This also would mirror recommendations for training that the GAO made as well.

3. Medical records for vaccinations and other types of health interventions must be kept. It is incomprehensible that these data were not kept during the Persian Gulf War conflict. Electronic dog tagging and other types of electronic code readers could be used and are used throughout the military to keep track of a number of less important issues and there really is no good explanation for failure to complete these types of records.
4. Documentation of pyridostigmine bromide directions given to troops needs to be made. In addition, because of the question about the potential toxicity of pyridostigmine bromide and the questionable evolution regarding safety available in the literature, it makes sense to be more careful regarding the hazard communication training that goes on for pyridostigmine bromide and to give consideration to how usage of pyridostigmine bromide could be tracked in conflict situations.
5. Serious consideration needs to be given to establishing a birth defects registry. GAO recommends looking at various outcomes in the military as a baseline, but other experts had also suggested that this really needs to be something established on a national basis. Precisely because of our inability to look at national norms, our current dilemma of trying to measure an excess of some type of untoward event in the deployed has been confounded. It is quite clear that much more of the public health dollar has been spent than would have been necessary had these types of registries been in place. The DOD could go a long way as a significant partner to HHS in contributing funding to assist in setting up this very needed national resource, and it is clear that the DOD would be a significant recipient and beneficiary of this resource in future conflicts.
6. The recent down-sizing of occupational medicine capacity in the Army at the Center for Health Promotion and Preventive Medicine (CHPPM) Aberdeen and the apparent lack of recognition the need for this expertise by the Army facility and elsewhere needs to be addressed. Many of the above cited "stupid" practices and under-recognition of toxic hazards would have been readily recognizable and easily prevented by occupational medicine personnel who possess training and expertise in toxicology and hazard prevention. The future likelihood of deployments involving ever-more complex toxic substances in weapons systems, CW counter measures, other medications and the chemical exposures of deployment itself suggest the strategic need for a substantial occupational medicine expertise.

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CARCINOGENS IN THE PERSIAN GULF CONFLICT

Prepared by: Melissa McDiarmid, M.D., M.P.H., Associate Professor of Medicine, Occupational Health Project, University of Maryland; and Director, Depleted Uranium Follow-Up Program, Baltimore Veterans Affairs' Medical Center

INTRODUCTION

The complexity and range of environmental hazards to which deployed Desert Storm/Desert Shield personnel had exposure opportunity include members of every known hazard class: biologic agents, chemical and physical agents as well as those of warfare itself. Beyond identifying the presence of potential environmental hazards however, to assess the health risk of exposed personnel knowledge of the exposure circumstances, duration and dose of these agents is also crucial. The absence of these data severely limit the ability of public health professionals to make assessments about potential future health risk. This is generally true about most chronic health outcomes, including cancer risk, although the relatively short duration of exposure in the Gulf (months) and our current understanding of the mechanism of cancer development, make determinations of cancer risk perhaps a bit easier to elucidate than some other disease outcome.

What is known about the mechanism by which a cancer develops in humans does help clarify the likelihood for cancer development resulting from Gulf War deployment. It is generally accepted that cancer arises not from a one-time exposure, but from a series of exposures in importantly-timed multiple stages. Generally, a one time exposure is not sufficient to cause a cancer. Rather, subsequent exposures to cancer causing agents are usually required to "promote" cancer development, as are other subsequent exposures to modulating substances which may act to enhance (or mitigate) cancer "progression."

Usually these stages take place over long periods of time (years). Our knowledge of environmentally-associated cancer can be derived from occupational cohorts. Again, generally, occupational cancers-for example lung cancer in asbestos workers-develop over a prolonged duration of exposure and generally observe a "dose-response" model. That is, the most exposed workers (those with highest dose or longest duration of exposure) are the ones most likely to develop cancer. Those with a casual exposure, for a short duration, tend not to develop a malignancy. As well, cancer development usually is not observed until ten years or more after first exposure. This time lag is termed "latency". The latency issue suggests that any cancer excesses looked for now in Gulf-deployed troops would likely not be attributed to deployment because insufficient time has passed since first exposure.

There were carcinogens present in the Gulf War theater. However, this statement only addresses (and partially so) the hazard identification step—the first of four needed to assess cancer risk. The lack of exposure assessment data forces reliance on crude estimates of likely exposure.

The broad categories of toxic substances present in the Gulf which the GAO assembled for reproductive toxicity consideration can be used here to organize classes of substances which are potentially carcinogenic. Reproductive and developmental toxicants share common mechanisms with carcinogens such as an ability to interact with a cell's genetic material (genotoxicity) and interactions with a cell's communication abilities, (Vainio, 1989) which also suggest the appropriateness of using the GAO list as a starting place.

CARCINOGENS

EPIDEMIOLOGIC EVIDENCE

In examining the case for deployment-related cancer excess, we must look to epidemiologic studies. Two mortality studies of PGW veterans have been conducted (Kang and Bullman, 1995; Writer et al, 1996). Neither found excess mortality for cancer when compared to that experienced by troops deployed elsewhere during the same period.

Another study of hospitalized PGW veterans reported in preliminary findings (Coate et al, 1995) pre-war versus post-war hospitalization rates for active duty troops deployed to the PG between August 1990 and July 1991 with those of un-deployed veterans. The study found no increase of hospitalization for any cause among PGW veteran compared to control veterans.

The Cancer experience of active duty PGW service members is similar to that reflected in the epidemiologic studies. "Cancer is rare among CCEP enrollees." (PAC Report pg.61) The types of cancer found most frequently (lymphomas, skin cancer and testicular cancer) are among the most commonly found in males of the deployed age group. These same findings are reported in the DVA experience. "Cancer also is rare among individuals in VA's Registry. There does not appear to be an unusual incidence of any specific type of cancer in this population." (PAC Report pg. 61) The same three most common cancer types seen in the CCEP population were reported in the VA registry cohort. Thus both epidemiologic evidence and registry data sources are corroborating no cancer excesses in the PGW exposed cohort.

Exposure Assessment

Epidemiology of Self-Reported Environmental Exposures

The 1996 summary of the Department of Defense's (DOD) Comprehensive Clinical Evaluation Program (CCEP) for Persian Gulf War Veterans included data for more than 18,000 returned service

members who requested a complete health evaluation. Part of the health evaluation involved questionnaire completion of a self-reported environmental history.

A similar battery of questions were included in the Department of Veterans Affairs (DVA) Persian Gulf Registry questionnaire. Responses elicited are displayed in Table 1 (Please refer to subsection "Gulf War Reproductive Hazards" above). Of interest is the close agreement between the two sources on frequency of environmental exposures. Passive cigarette smoke, diesel exposure, oil fire smoke and tent heater fumes were most commonly reported.

The detail of the questions in both the DOD's CCEP assessment, and the DVA's assessment is problematic, however. The exposure scenario requires refinement. There are some substances for which we are more interested in chronic exposure, such as petrochemicals, diesel and particulates, and discriminating phrases could be added to those questions to enhance response value. For other substances, we are interested in only one time exposure, such as mustard agent, but even then, we are interested in whether there was skin contact or true breathing of fumes, such as in a fire or explosion.

Without adding to the number of questions either health assessment battery currently includes, more refinement of the language used in crafting questions, and some guidance given to participants about what type of exposure constitutes a clinically important "yes" to the question, could greatly enhance the value of this information. (See recommendations section).

Candidate Carcinogens

A number of carcinogens or potentially carcinogenic substances have been referred to as present in the Gulf War theater both by the IOM Committee and the PAC. I have attempted to include those substances and also have reviewed the GAO Report on Reproductive hazards to identify possible carcinogens on that list. A discussion on those agents' toxicology and evidence of carcinogenicity is displayed in an appendix. In addition, several examples of each type of hazard class will be reviewed in the text.

Pesticides

There is documentation that the DOD shipped large volumes of one OC-Lindane to the Gulf. A commonly encountered organochlorine insecticide, it is the agent used to treat head lice. (PAC p.106).

According to the National Toxicology Program (NTP), there is sufficient evidence for the carcinogenicity of various isomers of hexachlorocyclohexane (a substituent of lindane) in animals. There is inadequate human evidence for carcinogenicity however.

Sarin (O- isopropyl methylphosphonic acid)

Sarin is a chemical warfare agent which is a potentially lethal cholinesterase inhibitor. It is not listed on the IARC or NTP carcinogen list (Sidell, 1992).

Possible exposure to sarin or other Chemical Biological Warfare (CBW) agents from atmospheric dispersion after bombing and destruction of Iraqi CBW facilities have been raised in PAC reports and IOM discussions. While atmospheric models of such an exposure are controversial at best, the IOM Committee counsels "... There is no available evidence in human or animal studies to date that exposure to nerve agents at low levels that do not produce any detectable acute clinical or physiological manifestations results in any chronic or long-term adverse health effects." IOM Report page 50.

While the committee went on to make recommendations of some issues which required further research (e.g. long-term, low level exposure effects), they stated that they "...relied heavily on known toxicological and pathological effects and existing knowledge regarding short and long-term health effects of CBW agents and on findings reported from extensive DOD and DVA clinical evaluations of veterans. "As well there has been no confirmed report of clinical manifestations of acute nerve agent exposure. (IOM report pg. 50).

As has been discussed throughout this document, while a number of toxic agents were present in the GW theater, the duration and chronicity as well as intensity of exposure figure into the likelihood of adverse health effects development. This is especially true of carcinogen exposure. While some of the commonly used pesticides are animal carcinogens, they are not recognized human carcinogens and the expected exposure scenarios make cancer development unlikely.

Oil Fire and Soil Contaminants

Volatile Organic Compounds

A health study of Army personnel deployed from Germany to Kuwait in June-September 1991 included an assessment of blood concentrations of several commonly encountered volatile organic compounds (VOCs). Concern about VOC exposure from possible oil well fires suggested this component of the comprehensive health study.

Subjects were assessed in three phases, in Germany prior to deployment; several weeks after deployment in Kuwait; and upon return to Germany. Generally, there were not significant differences in findings in the three phases and VOC results were considered within the range of levels determined to be normal U.S. reference levels.

Investigators have reported only one significant elevation in VOCs among a large number of Kuwait-deployed servicemen and that was to the compound tetrachloroethylene (PCE). This compound is not usually associated with oil fires, but was also found to be higher in some firefighters in Kuwait. One suspicion is that these elevations are due to PCE exposure during weapons cleaning. (Personal Communication, D. Ashley, NCEH, CDC, Atlanta)

Particulate Matter/Air Pollutants

Dr. Lebowitz's report on air pollutants summarizes the work of a number of different investigators regarding air pollutants of different classes including particulate matter (PM), some metals and oxides of Nitrogen (NO_x) and sulfur dioxide (SO₂). He feels there is evidence for "likely acute health hazards and potential for some chronic health hazards" (Lebowitz). I believe that this broad statement is about as precise as anyone can get given the exposure assessment limitations. For some of the air pollutants Dr. Lebowitz discusses, the data are better than they are for some other toxicant classes found in the theater. I don't think the duration of exposure to the air pollutant concentrations discussed here would significantly contribute to cancer risk of the a deployed service member.

Diesel Exhaust

Diesel exhaust is a complex made up of gases and particulate produced as a waste product from diesel-powered equipment. Its major components include carbon dioxide, carbon monoxide, oxides of nitrogen and particulates. Animal studies have consistently demonstrated significant increases in lung tumors in chronically exposed (at least 24 months) animals. (IARC, 1989). Also numerous epidemiologic studies in humans demonstrate excess cancer risk (NIOSH 1988, IARC 1989). The International Agency for Research on Cancer (IARC) classifies diesel exhaust as a probable human carcinogen (Group 2A).

Benzo (a) pyrene

A number of toxic constituents characterize oil fire exposures, with much attention given to the polycyclic aromatic hydrocarbon benzo (a) pyrene. Environmental characterization of Kuwait oil-well fires indicated the likely presence of numerous genotoxic contaminants. Mutagenic products of combustion including polycyclic aromatic hydrocarbons (PAH) such as benzo (a) pyrene (BAP) were a concern in performing a health risk assessment for troops deployed to Kuwait in June - September, 1991. As part of a larger health assessment of these troops, the U.S. Army Environment Hygiene Agency (USAEHA) assessed the potential for mutagenic exposure. The study employed a generic measure of mutagen exposure, sister chromatid exchange (SCE).

Frequencies of sister chromatid exchange (SCE), a measure of genotoxic exposure, were assessed in military troops deployed to Kuwait in 1991. Soldiers completed health questionnaires and had blood collected prior to, during and following deployment to Kuwait. Compared to pre-deployment

baseline SCE frequency means, levels obtained two months into the Kuwaiti deployment were significantly increased ($P < 0.001$) and persisted for at least one month after return to Germany. Outcome was unaffected by known personal SCE effect modifiers including smoking, age, and diet.

The authors concluded that although a statistical increase in SCE frequency has been demonstrated in troops deployed to Kuwait, implying a genotoxic exposure, multiple candidates exist as the potential cause of this observation. At present, SCE elevations are thought to measure exposure to some genotoxic agent, but the long-term health consequences of this phenomenon have not been determined in this or other populations' exposure to genotoxicants. (McDiarmid, et al., 1995).

Another aspect of the Army's larger health risk assessment determined environmental PAH exposure which revealed low ambient levels of PAHs in the areas where soldiers were working in Kuwait. As well, measures of PAH interactions with human blood lymphocyte DNA (PAH-DNA adducts) and aromatic-DNA adducts were at their lowest levels in Kuwait compared to levels in Germany. (Poirier M. et al., in preparation). These results suggest that the SCE elevations observed by McDiarmid's group in this same cohort of soldiers are not due to environmental PAH exposure.

Other Toxicants

Depleted Uranium (DU)

Uranium is a naturally occurring heavy metal found in the earth's crust which is an alpha-emitting radioactive nuclide. It occurs in several isotopic combinations. Naturally occurring uranium is an isotopic mixture of U^{234} (0.005%), U^{235} (0.711%) and U^{238} (99.284%).

Depleted uranium is a byproduct of the uranium enrichment process and is a uranium compound "depleted" of U^{235} and U^{234} . Thus DU possess a radioactive activity about 60% that of naturally uranium. The Nuclear Regulatory Commission's (NRC) standard for public exposure to "man-made" sources of radiation is 100 mrem/year above background (10.CFR 20.1301).

Potential radiologic health effects from external DU exposure are thought to be small. The primary external hazards from DU are β and γ radiation. These emissions are generated by the radioactive decay of trace-levels of uranium daughter (decay) products. The radiation exposure that Army personnel receive depends on the amount of DU present, the DU component or piece of equipment in question, (kinetic energy penetrator, DU armor, etc.), the configuration (in manufacture, in storage, uploaded on a vehicle, bare penetrator, etc.) and the exposure time. The radioactive properties of DU have the greatest potential for health impacts when DU is internalized. DU can be internalized through inhalation or ingestion.

Internalized DU delivers radiation wherever it migrates in the body. Within the body, α radiation is the most important contributor to the radiation hazard posed by DU. The radiation dose to critical body organs depends on the amount of time that DU resides in the organs. When this value is known or estimated, cancer and hereditary risk estimates can be determined. (ICRP, 1977).

Health Risks from Chemical Toxicity

Because the radioactivity of DU is very low, the chemical toxicity of DU may be the more significant contributor to human health risk. Other heavy metals—such as lead, chromium, tungsten, and uranium—are also chemically toxic. The toxic properties of DU and uranium have been broadly studied (Voegtlin and Hodge, 1949, 1953; Stokinger et al., 1981; Kathren and Weber, 1988; Leggett, 1989; Diamond, 1989; Kocher, 1989; Zhao and Zhao, 1990).

As has been the case throughout this report, the absence of exposure assessment data severely limit what can be said about a soldier's potential risk of a cancer outcome from a "DU" exposure. It is believed by a majority of investigators involved in following the DU-exposed soldiers from the several "friendly fire" incidents, that those soldiers with retained metal fragments are and were likely the "most exposed" because their fragment retention constitutes an "on-going" exposure of some seven year's duration. The inhalation exposures that accompanied those events are thought likely to be of greater intensity than other exposure scenarios that have been described including those involving potential exposure during rescue operations, decontamination and equipment overhaul and preparation for transport; and even more remotely exposed, in fact, more aptly environmentally rather than occupationally exposed, those with "bystander" exposure (walking by a burning Bradley, for example.) These examples constitute a model of "concentric rings" of exposure, with those involved in the friendly fire incidents in the center, those involved in the rescue, decontamination (decon) or possibly rare health surveillance activities in an intermediate circle and the more remotely, possibly one-time, environmentally exposed in the outer-most circle.

A number of human epidemiologic studies have been done in uranium miners exposed to uranium (and other potentially toxic substances in mines) over the past 30 years. Although several of these studies have found lung cancer excesses in miners, attributing these excesses to uranium has been difficult due to the presence of other hazards in the mines including radon gas, silica, other metals and possibly miners' smoking (Samet et al 1984, Gottlieb and Husen 1982; Summarized by ASTDR 1997).

These data regarding elemental uranium suggest that the radiologic cancer risk of DU exposure is likely even lower than that for elemental uranium due to the relatively lower radioactive activity of DU (0.4 uCi/gm) compared to elemental uranium (0.7 uCi/gm).

In summary, while DU is a radiologic hazard, its relatively low radiologic activity, the low likelihood of prolonged duration of exposure (except for the group with retained metal fragments),

combined with the mechanistic issues the multi-stage theory of carcinogenesis implies, suggests that a significant cancer risk from DU exposure is small. This is the opinion of both the IOM Committee and the PAC.

Mustard Agent

Mustard agent, an alkylating chemical weapon, is capable of causing covalent binding of an alkyl group (small carbon-containing groups) to genetic material (the DNA of a cell). Hence it possesses mutagenic and potentially carcinogenic activity. It is highly reactive and can cause skin and eye burns acutely. There is evidence of an increase in lung cancer from exposure. (IOM, 1993; ATSDR, 1992.)

One confirmed case of mustard agent exposure has been documented in a soldier exploring a captured bunker in Southern Iraq on March 1, 1991. It is unlikely that there was widespread or significant exposure to mustard agent in the absence of other reports of acute effects.

Aflatoxin

Aflatoxin, a naturally occurring toxin elaborated from mold growing on some stored grains, peanuts or other food stuff under certain storage conditions, is raised as a potential environmental carcinogen. There is epidemiologic evidence that aflatoxin ingestion is associated with an excess of liver cancer and that liver cancer incidence is higher in geographic areas where there is aflatoxin excess (e.g. China) (Wogan, 1992). However, the exposure scenario and evidence which could make this toxicant a plausible candidate for widespread concern is absent.

Increased rates of liver cancer could result decades following low-level exposure, although available evidence reviewed by the committee does not indicate such exposures occurred during the Gulf War." PAC Report p. 112.

RESEARCH REGARDING CANCER

There is little government sponsored ongoing research activity, specifically regarding cancer risk. Given the summary of biologic plausibility and exposure scenarios recounted thus far, this lack of activity is not particularly inappropriate. If there is a cancer excess to be documented in deployed troops, we know that the latency between first exposure, and onset of disease, is usually many years (normally at least ten), and therefore any excesses are still to be found in the future.

There are a number of applied (rather than human epidemiologic) studies ongoing which do relate to potential cancer risk. These include the study titled "Biomarkers of Susceptibility and Polycyclic Aromatic Hydrocarbon (PAH) Exposure", part of the U.S. Army Kuwaiti oil fire health risk assessment (project # HHS-3). The depleted uranium (DU) basic studies, including an animal

study of imbedded DU metal fragments (project #DOD-7A) being done at the Armed Forces Radiobiology Research Institute (AFRRI) in Bethesda, and an inhalation toxicology study of DU fragment carcinogenicity (project #DOD-7B) performed at the Inhalation Toxicology Laboratory of the Department of Energy in Albuquerque are also ongoing.

Some studies already completed have helped inform this report. For example, the U.S. Army Kuwaiti oil fire health risk assessment results (DOD-16; DOD-18) have been reported in this document in the section discussing polycyclic aromatic hydrocarbons and volatile organic compounds.

Although listed as environmental toxicology studies, several of these projects may have important input regarding exposure assessment for carcinogens. These include the characterization of emissions from tent heaters (project #DOD-34) ongoing at the U.S. DOE Laboratory at Albuquerque, the Persian Gulf Veterans Health Tracking System (project #DOD-19) at the Center for Health Promotion and Preventive Medicine (CHPPM) at Aberdeen, and the Retrospective Verification of Mustard Gas Exposure Project (VA-47) at the Louisville VAMC, may contribute. Although this study's aim is to correlate mustard gas exposure to reproductive risk, its applicability to cancer risk is also clear.

Another basic research study with a non-cancer focus, but with potential application to the cancer question, is a project titled "DNA Damage From Chemical Agents, and its Repair" (project #VA-6D) at the Portland VAMC. Here the focus is on nervous system insult from mustard exposure. However, some of the measures of DNA- mustard interactions (DNA adducts) may be applicable to cancer (and reproductive hazard) questions.

Epidemiologic studies that are examining the cancer question include an ongoing mortality study of veterans (project VA-1) and a completed study of U.S. military personnel (project #DOD-15). Also of interest is an ongoing Boston VAMC study of Gulf War and Vietnam veterans cancer incidence (project VA-4C). This study involves linking rosters of Gulf War veterans to state cancer registries in the New England area. These record linkage studies tend not to focus on specific environmental exposures, but would look as Persian Gulf War service as the exposure, and compare results to non-Persian Gulf War deployed veterans. This is a reasonable way to do surveillance for the unlikely, but possible cancer excesses which might arise from Persian Gulf War deployment.

RECOMMENDATIONS

1. The inappropriate use and application of toxic substances (diesel fuel used as a sand suppressant) needs to be identified and stopped. Training in hazardous materials handling and

common sense handling of these substances needs to be implemented. There is a need to develop an environmental hazardous materials training program. I would suggest here an approach similar to the National Institutes for Environmental Health Science (NIEHS) model for workers exposed to hazardous materials (hazmat). There are three or four tiers of training, the first being the most basic and the shortest, an awareness level of training, the second being more comprehensive perhaps for someone who will have some response capability, and finally a third and higher levels, perhaps a master or trainer level where there is much more detail pursued. This approach is based on a National Fire Protection Association (NFPA) standard on Professional Competence of Responders to Hazardous Materials Incidents (NFPA 472). The general purpose of the standard is to reduce the number of incidents, injuries and illnesses resulting from hazmat incidents. The scenarios reported of the inappropriate overexposure by using toxic substances in the wrong way I think are the best examples of case studies that could be used to promote the notion that there is a right way and a wrong way to handle a hazardous substance. In addition, the hazardous materials training can include some of the various health effects training and could be very similar to the hazard communication training that is required in various work places and also has been suggested by a number of experts who have testified in the various forums that were convened to examine this problem. This also would mirror recommendations for training that the GAO made as well. The NIEHS model of tiered hazmat training is suggested.

2. Exposure assessment questions on self-reported clinical evaluations of DVA and DOD require refinement. While a fairly complete "laundry list" of potential exposures is elicited, information regarding crucial aspects of the exposure are lost because of the way the question is worded. Most of the questions from both sources are worded like: "While in the Persian Gulf, do you believe you were exposed to any of the following?" It is not clear to the service member what constitutes a positive answer. For example, exposure to diesel fumes, the most common affirmative response reported (90% of veterans and 88% of active duty service members) could likely have been elicited by anyone riding in a vehicle. More discriminating information could have been elicited, such as attempting to determine more intense exposure, that is occupational diesel exposure arising from, say, assignment to vehicle maintenance or transport. This compared to an "environmental" exposure opportunity of any vehicle rider, which is what is suggested by an open ended question like "have you ever been exposed?". This simple discrimination would lend some semi-quantitative information about exposure intensity. The DVA questionnaire gives a good example of a simple improvement in questioning, which refines the information elicited. When asking about diesel or petrochemical exposure, it asked about skin contact. While it is understood that only so much detail can be captured, some simple refinement of questions could enhance the value of the information obtained without increasing the number of questions. Tightening up the overall summary questions from "were you ever" to "were you, as part of your job duties working with"; or "did you have skin exposure to..."; or "other than bystander exposure, did you work with or regularly (define time frequency appropriate to the substance in question) handle substance X?"

3. As the PAC report suggested, surveillance for cancer development can be planned for and implemented although care to refine exposure assessment questions for epidemiologic tools needs to be brought to the process. Similar suggestions regarding exposure assessment as discussed in #2 above also apply here. PAC Rec. pg. 126. "DOD & VA should perform long-term mortality studies of GW veterans appropriate for investigating cancer rates in the Gulf War veteran population in coming decades."
4. Future surveillance of the DU-exposed "friendly fire" cohort is required. This group is perhaps the only undisputed carcinogen-exposed cohort identified from the deployment. Although we are heartened by good health outcomes up to now and the relatively lower radioactive intensity of DU compared to natural uranium, the exposure circumstances of retained metal fragments have not been previously encountered and represents an on-going exposure. We are obliged to follow them forward.
5. Some mechanism should be crafted to allow investigations working on potentially over-lapping areas but in separate disciplines to communicate. For example, work on a method to verify mustard gas exposure being pursued at the Louisville VAMC should be discussed with investigators at the Portland VAMC, also looking at mustard-DNA interactions but from a neurotoxicity vantage point. One group's work may inform the other's.
6. The recent down-sizing of occupational medicine capacity in the Army and the apparent lack of recognition of the need for this expertise by the Army at the Center for Health Promotion and Preventive Medicine (CHPPM) Aberdeen and elsewhere needs to be addressed. Many of the above cited "stupid" practices and under-recognition of toxic hazards would have been readily recognizable and easily prevented by occupational medicine personnel who possess training and expertise in toxicology and hazard prevention. The future likelihood of deployments involving ever-more complex toxic substances in weapons systems, CW counter measures, other medications and the chemical exposures of deployment itself suggest the strategic need for a substantial occupational medicine expertise.

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GLOSSARY

AAC	Austin Automation Center (VA)
ACADA	Automatic Chemical Agent Detector/Alarm
ACIS	Arms Control Intelligence Staff
AFTAC	U.S. Air Force Technical Assistance Center
ARCENT	Army Central Command
ATSD (IO)	Assistant to the Secretary of Defense (Intelligence Oversight)
ATSDR	Agency for Toxic Substances and Disease Registry (HHS)
BVA	Board of Veterans Appeals
BW	Biological warfare or biological weapons
CARC	Chemical agent resistant coating
CBW	Chemical and biological warfare or weapons
CCEP	Comprehensive Clinical Evaluation Program (DOD)
CDC	Centers for Disease Control and Prevention (HHS)
CENTCOM	U.S. Central Command (DOD)
CFR	Code of Federal Regulation
CIA	Central Intelligence Agency
CL	Cutaneous leishmaniasis
CNS	Central nervous system

United States Senate Committee on Veterans' Affairs

CW	Chemical warfare or chemical weapons
DEET	N,N-diethyl-m-toluamide (a pesticide)
DIA	Defense Intelligence Agency
DMDC	Defense Manpower Data Center
DOD	Department of Defense
DOE	Department of Energy
DSB	Defense Science Board
DU	Depleted uranium
EOD	Explosive ordnance disposal
EPA	U.S. Environmental Protection Agency
ESG	Environmental Support Group
F	Fahrenheit
FDA	U.S. Food and Drug Administration
FM	Fibromyalgia
GAO	General Accounting Office
GA	Tabun (a nerve agent)
GB	Sarin (a nerve agent)
GD	Soman (a nerve agent)
GW	Gulf War
HHS	U.S. Department of Health and Human Service
IG	Inspector General

IND	Investigational New Drug
IOM	Institute of Medicine
J-2	Intelligence Directorate (Joint Chiefs of Staff)
J-3	Operations Directorate (Joint Chiefs of Staff)
JCS	Joint Chiefs of Staff
JIC	Joint Intelligence Center
JILE	Joint Intelligence Liaison Element
KTO	Kuwaiti Theater of Operations
MOPP	Mission-oriented protective posture
NBC	Nuclear/biological/chemical
NIH	National Institutes of Health (HHS)
NIOSH	National Institute for Occupational Safety and Health (HHS)
NJIC	National Joint Intelligence Center (DOD)
NMIST	National Military Intelligence Support Teams (DOD)
NRC	Nuclear Regulatory Commission
NSA	National Security Agency
NSC	National Security Council
O & M	Operations and Maintenance Account (DOD)
OIG	Office of the Inspector General (VA)
OP	Organophosphorous/phosphate
OPIDN	Organophosphate-induced delayed neurotoxicity

United States Senate Committee on Veterans' Affairs

OSAGWI	Office of the Special Assistant for Gulf War Illnesses
PAC	Presidential Advisory Committee on Gulf War Veterans' Illnesses
PAH	Polycyclic aromatic hydrocarbons
PB	Pyridostigmine bromide
PGIT	Persian Gulf Veterans' Illnesses Investigation Team (DOD)
PGR	Persian Gulf Registry (VA)
PGW	Persian Gulf War
PIC	Personal Information Carrier
PM	Particulate matter
PRD	Presidential Review Directive
PTSD	Post-traumatic stress disorder
SIU	Special Investigation Unit on Gulf War Illnesses (SVAC)
SPCHU	Special Anti-Chemical Warfare Unit (Czech Republic)
SVAC	Senate Committee on Veterans' Affairs
UK	United Kingdom
UN	United Nations
UNSCOM	United Nations Special Commission (on Iraq)
US	United States
USACHPPM	U.S. Army Center for Health Promotion and Preventive Medicine
V	Elemental vanadium, rare metal
VA	Department of Veterans Affairs

VAMC	Veterans Administration Medical Center
VBA	Veterans Benefits Administration
VHA	Veterans Health Administration
VISN	Veterans Integrated Service Network
VOC	Volatile organic compound
VX	Chemical nerve agent

NOTES

Introduction

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