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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This is a preliminary investigation of the feasibility of using simulation models to develop plans for the medical protection of European civilian populations in time of war or other major disasters. First, the functions required of a planning methodology were identified, such as estimating resource requirements, predicting casualty dispositions, and evaluating alternative disaster response procedures. Next, for each of two disaster manage- ment scenarios, the study described the basic elements or factors which describe the (Continues)		

20. ABSTRACT (Continued)

disaster management system: the primary action required of the system, criteria of success, quantifiable measures of success, and relevant data. Both scenarios considered ground and air assault by the enemy, using conventional weapons. In the first scenario, the civilian response is to "stay-put," i.e., the civilian population remains in place. The second scenario considers the controlled temporary dispersal or relocation of civilians residing in high-risk areas. Both scenarios appear to be amenable to detailed study using the concepts of the U.S. Navy's NAMES (Navy Amphibious Medical Evacuation Simulation) model and WWMMSS (World-Wide Military Medical Support System) model, in concert with wargaming models and traffic network models.

Further investigation of the applicability of these models is recommended, together with the development of the necessary data base.

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DEVELOPMENT OF A PLANNING METHODOLOGY
FOR THE MEDICAL PROTECTION OF EUROPEAN CIVILIAN POPULATIONS
IN TIME OF WAR OR MAJOR CIVIL DISASTERS

PRELIMINARY REPORT

INTRODUCTION

In October 1980, the Civil Defense Committee of NATO established a permanent Joint Civil/Military Medical Group (JC/MMG) to assist and provide advice on enhancing health care preparedness for civilian populations of the NATO Alliance in event of war or other major disasters. The United States, represented on the JC/MMG by the Office of the Assistant Secretary of Defense for Health Affairs (OASD(HA)), accepted the task of conducting studies pertinent to this issue in the areas of casualty estimation and classification, preventive medicine, movement of casualties, health and medical resources, medical evacuation, and the effects of nuclear, biological and chemical (NBC) environments. Additional studies were to be conducted simultaneously in other relevant topics by other nations of the NATO Alliance. The U.S. tasks were assigned to the Department of Preventive Medicine at the Uniformed Services University of the Health Sciences (USUHS).

The topics assigned to USUHS are interrelated issues, and the impact of each of these issues on the protection and survival of civilian populations in the event of war or other major disasters cannot be predicted in isolation from each other, or indeed in isolation from additional related issues such as communications, emergency medical care, transportation, refugee movement, training, and civil/military cooperation and coordination. A key question in addressing this problem is how to study these broad, but interrelated issues in a context that will display the effects of the various issues on a proposed system for the health care and survival of civilian populations in event of war or other major disasters.

The author, who is assisting USUHS in these studies, has initiated a program to address the problem of "how" by means of a planning methodology based on computer simulation. This technique is used extensively in military casualty medical care and evacuation planning and research [1,2,3,4].

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The advantages of computer simulation as the basis for a planning methodology are:

- It will provide, on a national and Alliance level, the means for developing predetermined plans for the protection and survival of civilian populations in the event of war or major civil disasters.
- It will provide the means to identify and resolve issues most demanding of attention at the national and Alliance level for the protection and survival of civilian populations.
- It will provide the means to determine appropriate areas for civil/military cooperation and coordination.

Two recent studies conducted for OASD(HA) support this approach.

A 1981 study by Cunningham et al (5) identified casualty evacuation and medical transportation issues relevant to Alliance action within the context of civil/military interface, and recommended many of these issues for action at the NATO level, as opposed to action by individual nations of the Alliance. These issues are shown in Table 1. For each issue recommended for NATO action, the Cunningham study then specified what type of action NATO should take.

The recommended types of NATO action fall into three categories (see Table 2).

- Providing information to national civil defense authorities.
- Training civil defense or medical personnel responsible for medical-related functions.
- Coordinating Alliance and national involvement, specifically in management and standardization efforts.

Finally, the Cunningham study proposed a three-year action plan to develop, for NATO, an information system, a training system and a coordination system to resolve the identified issues. Implicit in the statements of the tasks proposed by the Cunningham report is that investigators will be able to identify information requirements, training requirements and coordination requirements, at the NATO level, for the various issues of command, control and communications, medical transportation and so forth. The report fails to

Table 1. MEDICAL EVACUATION AND TRANSPORTATION ISSUES*

Issues	Recommended for NATO Action
COMMAND, CONTROL, COMMUNICATIONS	
National C ³ Systems	-
C ³ Hardening	+
Alliance-Wide C ³ System	+
MEDICAL TRANSPORTATION	
Vulnerability	+
Suitability	+
Availability	+
National Transportation Systems	-
Requirements Estimate	+
Medical Identification	+
TRAFFIC CONTROL	
Control Mechanisms	+
Selection Criteria	+
National Traffic Control Systems	-
MATERIEL SUPPLY AND LOGISTICS	
National Supply Policies	-
Supply Availability	+
National Exchange Agreements	-
EDUCATION PROCESSES	
National Evacuation Systems	-
Triage	+
On-Site Care Requirements	+
Weapons Effects	+
On-Route Care	+
Decontamination/Protection	+
Routing Control	-
SAR	+
Transporter Requirements	+
CASUALTY ACCOUNTING	
National Accounting Systems	-
Accounting Requirements	+
TRANSBORDER EVACUATION	
National/International Agreements	-
Transborder Movement Requirements	+
Multilingual Arrangement	+

*Reproduced from "Movement of Casualties and Transportation of Medical Supplies," McLean Research Center, Inc., McLean, VA, 22101; 25 November 1981.

Table 2. RECOMMENDED NATO ACTION AREAS*

Potential NATO Action Areas	Type of Recommended Action			
	Information	Training	Coordination	
			Management	Standardization
COMMAND, CONTROL, COMMUNICATIONS				
C ³ Hardening	x			
Alliance-Wide C ³ System	x		x	x
MEDICAL TRANSPORTATION				
Vulnerability	x			
Suitability	x			
Availability	x		x	
Requirements Estimates	x			
Medical Identification				x
TRAFFIC CONTROL				
Control Mechanisms			x	x
Selection Criteria				x
MATERIEL SUPPLY				
Supply Availability	x		x	
EVACUATION PROCESSES				
Triage		x		
On-Site Care Requirements	x	x		
Expected Casualty Levels	x			
On-Route Care	x	x		
Decontamination/Protection	x	x		x
SAR (Search and Rescue)		x		
Transporter Requirements	x			
Weapons Effects	x			
CASUALTY ACCOUNTING				
Accounting Requirements	x			x
TRANSBORDER EVACUATION				
Movement Requirements	x		x	
Multilingual Arrangements	x			

*Reproduced from "Movement of Casualties and Transportation of Medical Supplies," McLean Research Center, Inc., McLean, VA 22101; 25 November 1981.

suggest just how these requirements will be identified, yet the report states "It is important to recognize that the majority of casualty evacuation and medical transportation issues are interdependent and are a subset of the much broader issue of medical resource management." Thus, while this report provides a solid discussion of relevant issues and contains an excellent bibliography, it does not address the question of how to study these interrelated issues in a context that is useful to NATO and the Alliance nations.

In a separate study for OASD(HA), H. Gordon addressed the topic of health and medical resources in the context of NATO contingency medical planning (6). While the Gordon report is essentially a proposal to investigate Alliance health and medical resource requirements and capabilities, it does identify relevant technical/political issues which need to be addressed, such as:

- How can preparedness be maintained over time?
- In what fashion can an integrated Allied capability assist member nations in augmenting and optimizing their resources?
- How should a new centralized medical management capability function in a practical sense within the NATO structure?

The report also proposes broad initiatives for addressing such issues, such as:

- Improve methodologies.
- Invest in advanced systems and control.
- Achieve consensus on management structure.
- Design highly effective integrated programs.

Finally, the Gordon report proposes a two-year work plan which would address three basic scenarios - conventional warfare, natural and non-military manmade disasters, and NBC warfare. For each scenario, the proposed program would 1) make an assessment of the threat and of the associated health and medical resource requirements, based on literature surveys and interviews; 2) establish existing capability and resources within NATO, based on data supplied by Alliance members; 3) compare projected requirements and existing capabilities; 4) propose an action program for Alliance nations to attain and maintain effective health and medical resource preparedness and coordination at national and Alliance levels.

Unfortunately, the health and medical resource requirements imposed by scenario-based threats cannot be determined solely by literature surveys and interviews. Every military medical planner knows that medical requirements for future combat situations cannot be predicated only on the basis of World War II, Korea and Vietnam experiences. H. Gordon's proposed initiative, "Improve methodologies," is very relevant to this topic. What is particularly needed is a planning methodology which would assess military threats and associated medical resource requirements, would show how the various issues pertinent to civilian protection and survival relate to each other, and would suggest and evaluate proposed programs to achieve medical readiness at national and Alliance levels.

This report will describe the author's basic approach in developing such a planning methodology.

OBJECTIVE

The objective of this program is to produce a planning methodology to support the development of plans for providing health care to civilian populations in Western Europe in the event of military hostilities or other major disasters. This methodology must be capable of performing the following functions:

- evaluating and predicting the extent of threats to the health of the civilian population;
- estimating requirements for health care, food, water, shelter, sanitation, electric power, transportation, information and communication systems;
- predicting casualty dispositions, including mortality and morbidity;
- predicting the locations and impacts of bottlenecks in the disaster response systems;
- estimating the time and cost to carry out the disaster response operations;
- recommending the optimum use of available resources;
- evaluating alternative disaster response procedures and concepts;
- producing training material such as hand books to assist civil authorities, medical personnel and the civilian population in coping with the disaster;
- recommending civil/military cooperation and coordination mechanisms.

APPROACH

Existing wargaming, military, and medical simulation models have the capability to perform many of these functions, but none of the known models was developed for the specific purpose of this program, i.e., to evaluate concepts for the medical protection and survival of large civilian populations in time of war or other major disasters. Therefore, before attempting to adapt these models, or their concepts, to the present study, it is necessary that we formulate the basic logic of a disaster management system that will meet our objectives. This logic must describe the principal elements of the disaster management system in order to form the basis of a suitable simulation model. This logic is developed in a systematic way.

First, we must decide what is to be achieved, or what action is required of the disaster management system. Second, we want to describe some criteria which will be indicators of the success or effectiveness of the disaster management system. For example, some obvious criteria of success are: mortality and morbidity are minimized; people buried in rubble are rescued alive; survivors are protected from disease, hunger and the elements; costs are minimized.

These elements - the primary action required and the criteria of success - tell us in fairly general terms what the system (model) is to accomplish. However, neither element is quantitative - nothing mentioned thus far can be counted or measured. Necessary quantitative factors which will be important in the analysis and evaluation of the system are derived from these elements, however. First are the measures of success, which we will want to observe as output of the model. These include such data as the availability of rescue workers and medical personnel when needed, the number of missing who are rescued alive, the number of injured who recover, the time required to repair power, water, sanitation, communication and transportation facilities, and actual costs associated with relief operations.

Additional quantitative information is also needed to "drive" the model, both initially (input data) and continuously (model-generated data). Such data will include the location of emergency medical facilities, their current

capacity, medical personnel and medical resources; the location of emergency housing facilities, their capacity and resources; the location and capacity of transportation systems; the location and number of injured and types of injuries. The input data will be independent of the model logic and structure; by changing this data and evaluating the measures of success, the researcher discovers which of these factors most influence the success of the system. Sources of the input data include projections from past experience, intelligence reports, and new concepts. Budget allowances also are a factor to be considered.

Finally, the scenario must be selected, because all outcomes depend upon that.

SCENARIOS

As illustrated in Figure 1, the starting point or foundation of a planning methodology is the scenario. Here we will examine two scenarios, which differ only in the civilian response. Both scenarios consider enemy ground and air assault using conventional weapons. However, in the first scenario, the civilian response is to "stay-put", i.e., the civilian population remains in place. In the second scenario, the civilian response is that of temporary dispersal or relocation from high-risk areas, under the management and control of civil defense authorities.

On the following pages we will describe, for each of the two basic scenarios, the action required of the civil defense system, followed by criteria of success. We will then itemize quantifiable measures of success as well as additional quantifiable factors which affect these measures of success.

Scenario 1.

Ground and air assault by the enemy in a specified region, using conventional weapons. The region will be defended by friendly forces. Friendly forces, weapons systems and supplies will be in the region prior to hostilities. The

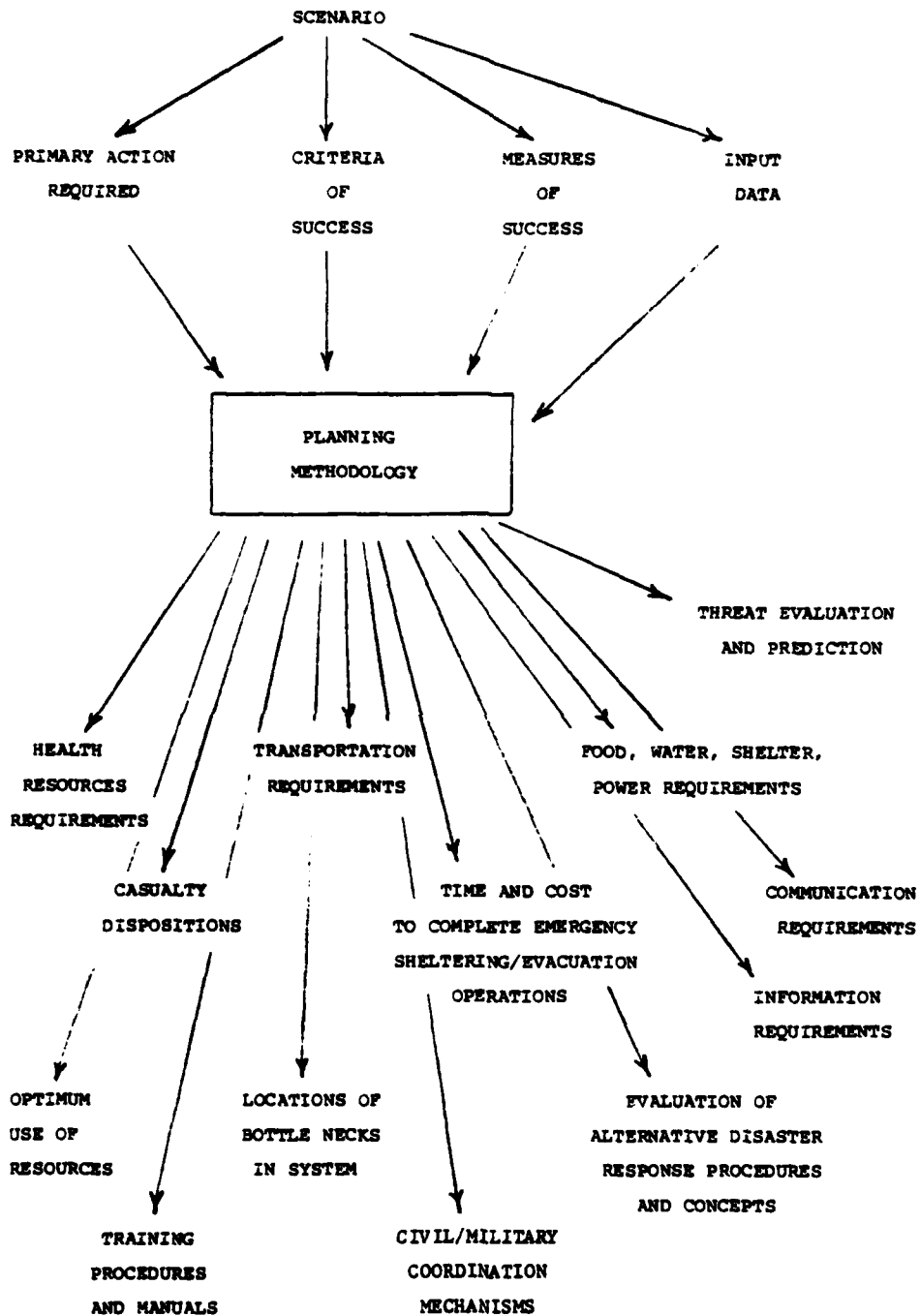


Fig. 1. - Development of Planning Methodology

civilian population may or may not receive a warning of the impending hostilities before they occur.

Civilian response: "stay put", i.e., civilian population remains in place.

Comment:

Since civilians in enemy-held territory will be subject to enemy control, it is impossible for us to plan for the medical care and protection of civilians in those circumstances unless agreements are made beforehand by opposing forces regarding such care.

Therefore we will focus our immediate attention on the safety and well-being of civilians who remain in-country in regions controlled by friendly forces. These regions may be subjected to enemy air and missile attacks, with resulting mass civilian casualties. The regions may also be inundated by civilian refugees fleeing from other areas. Friendly military forces may also be present in large numbers.

Action required of civil defense system.

- Maintenance of vital community life support and public health systems.
- Management of mass civilian casualties, including the identification and disposition of the dead; search and rescue of the missing; emergency medical care and hospitalization of the sick and injured; emergency sheltering, feeding and care of survivors, including refugees; and prevention of disease.

Criteria of success.

- Civilian mortality and morbidity are minimized.
- Survivors are protected from hunger, disease and the elements.
- Family separations are minimized.
- Harmful emotional/psychological effects are minimized.
- Personal property losses are minimized.
- Crime control maintained. No looting or vandalism.

- Vital community service operations, such as power, water, food, health care, communications, transportation, restored quickly if disrupted.

Measures of success.

- Time required for civilian population to take shelter or otherwise protect themselves before and during hostilities.
- Number of civilians killed or injured during hostilities.
- Time required to identify and dispose of the dead.
- Time required to rescue the missing.
- Number of missing who are rescued alive.
- Time required to provide emergency medical care to the injured.
- Number of injured who recover.
- Time required to obtain emergency housing, food, water and other necessities for survivors and refugees.
- Number of survivors, including refugees, who contract diseases related to or caused by the disruption of normal community services.
- Time required to reunite separated families.
- Number of thefts and other crimes attributable to the situation.
- Time required to repair disrupted community life support systems, including power, water, health, sanitation, communication and transportation facilities.

Factors which affect measures of success.

- Timeliness of decision by authorities to warn civilian population of impending hostilities.
- Time required to notify civilian population to take protective action.
- Time of day that civilians receive warning.
- Number of civilians involved, and types, such as children, infirmed, institutionalized.
- Time required for civilian population to take protective action.
- Types of protective action taken by the civilian population, e.g. use of bomb shelters, underground community housing facilities, refugee camps.

- Time required to alert support personnel who will direct and assist the civilian population to take protective action, e.g., civil defense personnel, medical personnel.
- Number and types of support personnel.
- Rate of advance of the Forward Edge of the Battle Area (FEBA).
- Capacities of community housing facilities used to protect the displaced civilians, including food, water, sanitation, medicine.
- Capacities of health care facilities available to civilians, including medical personnel, surgical and laboratory facilities.
- Procedures to be followed for care and protection of civilians who are too incapacitated to leave their homes.

Scenario 2.

Ground and air assault by the enemy in a specified region, using conventional weapons. The region will be defended by friendly forces. Friendly forces, weapons systems and supplies will be in the region prior to hostilities. The civilian population may or may not receive a warning of the impending hostilities before they occur.

Civilian response: temporary dispersal/relocation.

Action required of civil defense system.

- Management and control of temporary dispersal or relocation of civilian population residing in high-risk areas.
- Preservation of vital community service operations in anticipation of return to normal activities following the hostilities.

Criteria of success.

- Population relocated without injury or disease, or exposure to hostilities.
- Family separations minimized.
- Harmful emotional/psychological effects minimized.
- Relocation process kept under control, e.g. no "refugees" without a known destination.

- Personal property losses minimized.
- Crime control maintained. No looting or vandalism.
- Vital community service operations restored quickly following hostilities (power, water, food, heat, communications, transportation).
- Industrial/commercial operations (jobs, productivity) restored quickly following hostilities.

Measures of success.

- Time required to relocate population.
- Number of civilians exposed to hostilities during relocation.
- Number of civilians killed or injured in accidents during relocation.
- Number of civilians who contract an illness or disease attributable to the relocation.
- Number of vehicular accidents attributable to the relocation process.
- Number of thefts and similar crimes attributable to the relocation.

Factors which affect measures of success.

- Timeliness of decision by authorities to warn population of danger.
- Time required to alert support personnel who will manage and control the relocation procedures, e.g. civil defense personnel, medical personnel, airlift crews, bus drivers, etc.
- Number of support personnel, and types of support personnel.
- Time required for civilians to get ready to relocate.
- Time of day that relocation process begins.
- Number and types of people to be relocated, including the infirmed and institutionalized.
- Distances civilians must travel to reach safe refuge.
- Mode of travel, e.g. air or ground, if ground, public or private.
- Location of airfields to be used for relocation.
- Road conditions.
- Weather conditions.
- State of communication facilities.

- Relocation management procedures, e.g. which areas are evacuated first, where do the people go, and by what methods of transportation; do people gather at specified locations or zones for further transportation instructions or do they make their own arrangements?
- Time available to evacuate an area, i.e., speed of advance of the Forward Edge of the Battle Area (FEBA).
- Capacity of support facilities at destination sites, e.g. housing, food, water, sanitation, medical care.
- Procedures to be followed for care and protection of civilians who cannot be relocated, e.g. those seriously ill.

SIMULATION MODEL DEVELOPMENT

Both scenarios just described require very similar action on the part of disaster management and medical authorities. Scenario 1 requires the medical care and evacuation of large civilian populations. Input data for a model of this scenario will include the location of refugee camps and shelters, the location of medical facilities, the number and types of medical personnel, transportation resources and facilities, etc. Scenario 2 also requires the medical care and evacuation of large civilian populations, and input data for a model of this scenario will include the locations of areas that will receive refugees, transportation routes and resources, medical facilities, etc. While casualty management procedures may differ in the two scenarios, and certainly will differ in different countries, it appears that the concepts and basic logic of the Navy's NAMES model (Navy Amphibious Medical Evacuation Simulation) and WWMSS model (World-Wide Military Medical Support System) are applicable to both scenarios (2). NAMES is a medical treatment and evacuation model developed during the 1970's at the Naval Research Laboratory (NRL) to evaluate medical procedures for supporting Marine Corps combat operations. It is a high-resolution model capable of producing very detailed information regarding the care of mass casualties, and medical and transportation resources required and utilized. Medical treatment is provided at different echelons or levels of care, ranging from self-help or "buddy"-help to full hospital facilities. Casualties receive medical care and are evacuated on a priority basis, which is specified by the model user. The NAMES model has been used by the U.S. Military Departments to test the effectiveness of

various casualty management procedures and to identify bottle necks in proposed medical systems before those systems are put into effect. In 1980 NAMES became known as the World-Wide Military Medical Support System (WMMSS) simulation model, as an indication of its capability to assist in the development of wartime medical support planning and patient management all the way from the Forward Edge of the Battle Area (FEBA), throughout the entire Theater of Operations and into the Continental United States (CONUS).

The ease with which the currently operational WMMSS model (not just its concepts and logic) might be adapted to the present study is still undetermined. Several factors must yet be clarified, chief of which are the following:

- The changing effect (time-wise) of the military situation on ground transportation must be introduced. This will depend specifically on the movement of the FEBA, and also on the entire military situation. For this reason, development of a suitable simulation model must be closely associated with military wargaming models and transportation network models. The Studies, Analysis and Gaming Agency (SAGA) of the Organization of the U.S. Joint Chiefs of Staff has compiled a catalog of 363 wargaming and military simulation models currently in general use throughout the U.S. Department of Defense and in the defense establishments of Australia, Canada, England and Germany (7). SAGA makes extensive use of such models, as does the U.S. Army Concepts Analysis Agency, which develops additional models to meet its special needs. Both of these agencies have offered to assist in this program.
- The availability of necessary data from Alliance nations is absolutely essential. This includes data which describes the military situation as well as data which describes the disaster management system of each nation, expected numbers of casualties, expected numbers of refugees, transportation networks and their capacities, and other data described earlier in the discussions of the two scenarios being considered. Many NATO nations have already provided pertinent information on their state of civil preparedness to the NATO Senior Civil Emergency Planning Committee (SCEPC). Personal communication with authorities in the various nations of the Alliance is needed to obtain all of the required information.

- The large size of the data base that will be required to analyze the disaster management operation within each nation, and especially at the Alliance level, will necessitate some compromise in the high-resolution structure of the current WWMSS model. Indeed, this high-resolution structure is probably not needed or desirable in all circumstances, especially at the Alliance level. There are computer programming techniques now in use that permit the aggregation of entities where high-resolution is not absolutely essential, and this technique is expected to find application in this study.

CONCLUSIONS AND RECOMMENDATIONS

The measures of success and other key factors of disaster management systems for the medical protection of civilian populations in time of war or other major disasters have been identified for two scenarios in a NATO conventional warfare environment. It appears that the concepts and logic of the Navy's NAMES (Navy Amphibious Medical Evacuation Simulation) model and WWMSS model (World-Wide Military Medical Support System) can be applied to develop a planning methodology for such disaster management systems for nations of the NATO Alliance and also for the Alliance itself. Further investigation of the applicability of NAMES/WWMSS is recommended, in concert with wargaming and transportation network models. Development of the essential data base should be carried out concurrently, with the assistance of the civil defense and medical authorities in the various NATO countries as well as in the Alliance.

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