

Telewarfare: the use of unmanned vehicles, ships, aircraft, weapons, or other devices that are remotely controlled, often at great distances from the battlefield or other locations, in direct support of military operations by providing real-time intelligence, surveillance, reconnaissance, and attack capabilities.

The focus is a study of human roles and risks inherent in telewarfare from an occupational medicine standpoint, and proposes a strategy to anticipate and mitigate risks known or believed to exist among telewarriors.

This paper specifically focuses on Airmen most likely to be engaged in telewarfare. Those Airmen include unmanned Remotely Piloted Aircraft (RPA) operators, sensor operators and analysts in Intelligence, Surveillance and Reconnaissance (ISR) activities, and includes Total Force constituents.

The contents of this paper were derived of open, unclassified documents.

Telewarfare and Military Medicine

White Paper/State of the Art Report On

AFMS Support to the Emerging Paradigm of Employed-in-Place Operations



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Executive Summary

This paper is the result of a Health Futures Development solicitation by the Air Force Medical Support Agency. While the planning and preparation of this document was a coordinated effort by multiple select experts in the subject area, two key individuals were responsible for the primary components of the document: Col H.J. Ortega Jr., Air Force Intelligence, Reconnaissance and Surveillance Agency, developed the Core Concept, and Dr Charles R. Fisher Jr. (under contract to Eagle Medical Services, LLC) provided research and content.

Examined in this document are the current state of the art, emerging technologies, and incumbent challenges in warfare operations conducted away from the kinetic battleground. The term “Telewarfare” and its derivatives is coined and defined below, and is used throughout this document.

“Telewarfare,” as used in this document, refers to the use of unmanned vehicles, ships, aircraft, weapons, or other devices that are remotely controlled, often at great distances from the battlefield or other locations. Telewarfare directly supports military operations by providing real-time intelligence, surveillance, reconnaissance, and attack capabilities, and has five distinguishing characteristics:

- 1) Telewarriors are combatants or have the potential to be considered a combatant under the Law of Armed Conflict (LOAC), and thus the potential for being targeted in place.
- 2) Operations conducted principally out of direct risk from kinetic battle but in contact with adversaries or with those in contact with adversaries.
- 3) Urgency and Immediacy – time pressures for real-time identification and/or “kill,” including potential loss of life if not accomplished.
- 4) Wartime (usually 24/7/365) battle rhythm based on a theater of operations.
- 5) Compartmented or secure operations.

Most Airmen, civilians, and contractors meeting this definition are resident within the Total Force Intelligence, Surveillance, and Reconnaissance (ISR) communities. This paper concentrates on this unique population.

Robotic technology, including Unmanned Aerial Systems (UAS) and Artificial Intelligence (AI) is growing at a rate that will have potential to surpass human intellect and potentially reduce the need for Air Force warriors on the kinetic battleground within the next generation. Each facet of technological advancement, including new human interfaces that permit total immersion in the virtual environment, multi-layer sensing, control of multiple simultaneous systems, and truly autonomous decision networks creates new psychological, physiological, moral and ethical challenges.

The telewarfare environment poses unique stresses to Airmen today, including 24/7 continuous operations in a nearly immersive, combat-related environment, the need for immediate assimilation of rapidly increasing

information, and the control of multiple complex systems. Risks inherent in prolonged shift work and direct combat involvement have been associated with psychological and physical stress. Initial reports of widespread post-traumatic stress disorder are probably exaggerated, but high levels of fatigue, burnout, and combat-related stress have been validated and are likely to continue despite advances in AI technologies. Telewarriors are combatants. The forward edge of the battle is not just in their main base building, but potentially their own home.

The Air Force Medical Service (AFMS) has a foundation of highly successful legacy combat support doctrine and methodology of research, care, and support of the aviator for 24/7 combat operations on the kinetic battleground. However, the AFMS may not be as well prepared for the rapid emergency of telewarfare that is fundamentally changing the face of modern combat. As such, military medicine must evolve to provide greater support and optimization of the telewarrior and their battlespace.

To assist with creating this paper, a panel of recognized experts reviewed the current state of telewarfare in an effort to characterize this expanding operational environment and associated stressors, and to identify long-term doctrinal constructs and short-term immediate solutions such as human factors and human performance sustainment/enhancement activities. Ultimately, the goal is to provide information which can be utilized to increase Airmen resilience and performance in this new form of combat.

To address these known and emerging risks, a series of broad goals was introduced. These broad goals were grouped into three essential recommendations:

- 1) Establish specific research activities, develop selection and retention standards based on scientifically-based factors, and develop a waiver authority and process for telewarriors.
- 2) Develop compartmented, specially-trained and specifically-staffed/constructed care teams and facilities for global support of telewarriors using a hub and spoke construct.
- 3) Restructure supporting installation Military Treatment Facility (MTF) for the continuous, priority support of combat operations and telewarriors.

Executing these broad suggestions will require examination of fundamental prioritization decisions for healthcare and research, as they will potentially add special care requirements for many, and suggest tighter integration of the Total Force telewarrior. Recommendations embedded within this document focus around improving knowledge and surveillance of the risks of this workplace, as well as increasing access to medical support and human performance advice and the development of telemedicine consultation networks. Although a DOTMLPF (Doctrine, Organization, Training, Materiel, Leadership, Personnel and Facilities) discussion is included, the panel of experts did not seek to establish milestones or doctrinal language within this document.

The AFMS, and the military in general, stand on the precipice of a new norm in warfare. Humans will continue to be combatants, but their partnership with AI and future adversaries will pose new challenges.

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AFMS Support to the Emerging Paradigm of Employed-in-Place Operations

INTRODUCTION

In 1903, a fragile aircraft little more than a kite, lifted from the sands of Kitty Hawk under its own power. In that moment, after nearly a century of learning, attempts and failures, man flew for the first time in a powered aircraft. It was a revolutionary moment. When the nation entered WWI 14 years later, the United States had yet to recognize its significance. The US had no Air Force. So little was known about operating in the 3D aviation environment, that when a team of newly-minted Army physicians evaluated the only combat-hardened American aviators, those of the Lafayette Esquadrielle, they disqualified all of them based on empirically derived measures of perfection. For years to come men died at the controls of aircraft because they were not suitable for the stresses of aviation or they succumbed to human frailty in the face of a hostile environment. In the early days, military medical services were neither connected sufficiently to the mission to understand the unique demands of the environment, nor familiar with medical and physiological characteristics needed to reduce risk. Technology raced ahead, and for a century medical science raced to catch up with the revolution in technology brought on by aviation.

Nearly a century later, headlines like “Remote-Control Warriors Suffer War Stress,”⁶⁴ and “Drone Pilots’ War Not Remote”¹¹³ topped sensational articles that cited rising suicide and stress-related illness rates among operators and crews of Unmanned Aerial Vehicles (UAVs.) At the same time, the Air Force Intelligence, Surveillance, and Reconnaissance Agency (AF ISR Agency) Command Surgeon identified an increased rate of suicide and stress among Intelligence, Surveillance, and Reconnaissance (ISR) members. Airmen losses and stresses *at home* – away from traditional combat – once again serve as a wake-up call for the Air Force Medical Service (AFMS). Another revolution in warfighting is occurring, and the rapid growth in technological capability is surging ahead of traditional medical support models. Few if any means exist to select warriors for this new war environment, and to anticipate and prevent stresses.

Due to the significance of this revolution in warfighting and the gaps and risks inherent in this rapid technological growth, the need became evident for a review of our state of knowledge and a visionary look at near and longer term requirements and doctrine for the medical support of warfighters who are remote from the immediate risk of personal injury, but who are fully invested in the prosecution of combat operations. Remote combat is described by Dr. P. W. Singer in “Wired for War,”⁸⁴ using the term “cubicle warriors” for those fighting the war from afar. Though inclusive of many in the Air Force, this term is not expansive enough to capture the broad spectrum of warriors. Thus, “Telewarfare” will be utilized in this document to describe warfighting capabilities and strategies away from mortal danger.

Most UAS require humans in the system near the aircraft to provide launch and recovery operations. Some systems rely on actual human control inputs, others give the human consent or a “vote” and finally, there are those that are fully autonomous.

A common feature of Air Force ISR operations is the use of highly networked systems that permit centralization of operations, but have networked/distributed control and analysis. The control of Large Unmanned Aerial Systems (LUAS) is typically centralized to locations in the US, but launch and recovery teams are routinely deployed to forward locations. Analysis of data is centralized, but it may not be centralized in the same location. Although the analysis and targeting solutions are an integrated team activity, team members may only communicate in virtual space and know each other only as an avatar or by a chat room name. Each of these members may fall under the leadership and guidance of different organizations, may be reliant on a different installation support milieu, and could find themselves as emotionally close to their virtual teammates as with members of their own organization.

The success of real-time ISR capability has created senior leader and commander expectation of immediate real-time feedback, targeting, and warning for ground units. Thus, the intelligence analyst no longer has the luxury of analyzing data and preparing tomorrow’s briefing, but is instead expected to have immediate answers and solutions in real time. This sense of immediacy and urgency represents a cultural shift for which individuals and agencies may not be prepared. Intel teams now find themselves not just second-guessed after the fact, but may be required to provide specific services and respond to conflicting guidance by empowered leaders in multiple levels of leadership of a single operation.

Telewarfare operations are continuous, and lack a deployment rhythm compared to traditional combat operations. Unlike theater combatants who prepare for weeks or months physically, psychologically, and emotionally, telewarriors are continuously embroiled in the combat milieu. The time stresses, battle rhythm, immediate life or death decisions and aftermath of death and destruction of combat are the same as their deployed counterparts. For telewarriors there is no build-up period or eager helping agencies preparing them for deployment. There are no joyful reunions and no recuperation when they return home. Unlike their deployed counterparts, they do not come “home” from battle; they go to battle every day as part of their job. Thus, today’s telewarrior faces a unique and unprecedented combat role, while at the same time subject to the daily rigors of home life.

Today’s telewarrior faces the spectre of being a combatant at home. With the high profile, common knowledge integration of entire Air National Guard (ANG) units into this milieu there could be a threat of hostility or even legal (within the Law of Armed Conflict, or LOAC) targeting of telewarriors. In a deployed environment, warriors are continuously cognizant of the risks they bear, and they take personal pride in their skill at mitigating the risks whether it is body armor, evasive skills or skillful flying. However, there is no Kevlar in the home, and there are no perimeter guards in the neighborhood. For the telewarrior, the Forward Edge of the Battle Area (FEBA) may be his or her home.

In spite of this new and evolving battlefield, Air Force medicine is fundamentally and structurally unchanged from its legacy beginnings. Though the formulation of hospitals and clinics has changed to reflect shifts to more outpatient care and rehabilitation, the episodic care models remain relatively

unchanged. The emergence and usage of biomarkers, genomics, and individualized medicine capabilities must be factored into future visioning of anticipatory clinical requirements. The definitions of combat risk and combat support must evolve and include front battle lines at home.

Within coming decades, Artificial Intelligence (AI) will allow machines to operate autonomously, to learn, and to make decisions without human input. Instead of the system being designed to be used by and responsive to inputs of the human, the system must be designed to be TRUSTED by the human. The human becomes a consentor or facilitator, but not the operator. The machine will do exactly what the machine decides it should do.

Parallel to this technological frontier is human interface development. Technology has been demonstrated for control of computers using brain/thought pattern alone. Technology exists and continues to be refined for direct stimulation of optical and auditory centers (e.g. cochlear implant – a first-generation technology). Given the rate of technological development, it seems possible, even likely, that systems will be available to directly “connect” an operator with the artificially intelligent machine and for the operator then to be immersed, virtually, in combat. It may not be fantasy to imagine a single “operator” controlling a swarm of unmanned combat vehicles using brain emission alone, with direct sensory input from each. In that case, could he be virtually “present” in first person and actually see or feel the death of his unmanned combat aerial vehicle virtual “appendage”? What of virtual relationships? Children are already known to bond with robots as they would a classmate, even with rudimentary technology.⁸⁸ As systems become artificially intelligent and interactive, what will be normal and abnormal human responses?

In order to scope the project into a manageable structure, this particular examination will be limited to ISR operations. All information in this paper is derived from open source unclassified literature, and the assemblage of information contained herein is similarly intended to stimulate thought, discussion and doctrinal development in an open and unclassified forum.

THE WORLD AS WE KNOW IT

Assessing AFMS support for current and future telewarfare operations is a fairly broad task, and will be viewed in this document as an occupational medicine challenge. Thus, we will examine the industry, the workers, the workplace, and the tasks inherent to the environment. Risks can then be derived to human health and well being, and based on those risks, begin to design preventive and interventional strategies specific to the industry.

THE “INDUSTRY”

The ISR “industry” is the overarching construct within which most telewarriors work. Under the ISR umbrella are a host of activities that are networked with a global enterprise that includes acquisition of data from airborne and ground-based sources and networked analysis, processing, exploitation and dissemination via a global team approach within the worldwide Distributed Common Ground System (DCGS). At the “front end” of the intelligence and surveillance machine are the Airmen and equipment-gathering data. Today’s data is reliant on UAS that carry complex, multiple-layer sensing equipment that

can beam images, signals, and other data in real time to battlefield leaders and analysts. In the USAF, the vehicles are referred to as RPA. However, in DoD parlance the term UAS refers to the entire system within which the RPA resides. The long-term USAF strategy is to largely or completely replace manned ISR assets with more capable, longer duration, configurable unmanned systems.¹⁰²

To be useful for commanders, data collected must be rapidly processed and analyzed into actionable product within minutes. Once the domain of the unit “Intel officer,” the workforce is now mostly composed of enlisted airborne and ground-based linguists and intelligence analysts.

There are two fundamental features of this “industry” that distinguish it from any other: (1) global networked warfighting, and (2) highly secure operations.

The UAS/ISR business today is distributed over the DoD's global information network and communications links that enable operations and support to any geographic theater or area of operations. Unmanned vehicles are controlled by teams both in theater and in CONUS. Data collected is distributed globally and real-time analysis and exploitation teams work together in a virtual environment without ever meeting, using “chat” features to develop recommendations for real-time exploitation. Thus, members of the same “team” may be a world apart, knowing each other only by a screen name or avatar. This global environment also enables and creates an expectation of continuous, uninterrupted 24/7 real-time analysis that is closely tied to the tactical battle rhythm. Finally, this global capability is designed to permit combat-related operations in a non-hostile shirtsleeve environment from fixed “main-base” facilities.

Highly secure operations are another hallmark of the industry; ISR operations from piloting of the aerial vehicles to gathering and analysis of data are performed behind security barriers and closed doors. “Green Door” or highly classified secure operations are the rule rather than the exception, meaning that these Airmen are held to very high levels of personal scrutiny. While most military members (medics included) obtain a “Secret” level clearance, ISR operations routinely occur within “Top Secret/Sensitive Compartmented Information” or TS/SCI. For the AFMS, this concept is important and will be a recurring theme in this analysis because few healthcare providers have a classification or need to know that permits them to discuss workplace issues with patients. Likewise, spouses and children may have only superficial knowledge of what the ISR member does. A more thorough explanation of the industry can be found in Appendix A.

The AN/GSQ-272 SENTINAL ISR Weapon System is the basis of today's and the foundation for tomorrow's global ISR activity. However, despite its formal designation, the system is actually not a device. Rather, the DCGS describes the assembly of people, practices and secure communications tools that enable real-time secure global communications and analysis. Initially comprised of five major Active Duty group-sized units at USAF main bases, the system has now been expanded to include dedicated ANG and Air Force Reserve installations and personnel.¹⁰ (See Appendix B)

CREW ENVIRONMENT

When compared to the pilot's traditional cockpit, telewarrior workstations today tend to be configured similar to a computer flight simulator using a joystick, keyboard and multiple video display monitors.

The typical work center has each operator seated at a computer workstation with multiple computer displays, where they remain continuously during the shift. The secure facilities are windowless, and typically kept dark. A brief walk outside may require multi-layer security gymnastics. Today's units operate with a small staff, and expectations for real-time intel continue to increase. Yet, typical work may be dull for days on end, punctuated by the rare "got 'em" moment when the global team finds and exploits that magic intelligence moment.

Design features of current workstations already being evaluated or developed include attention to seats engineered for prolonged seating, controls that are intuitive, and environmental controls. A common inconvenience is that due to the massive computing power required (which generates a constant hum), many current control facilities are typically kept refrigerator cold year-round. Because of the lack of standardization, though, it is hard to generalize physical characteristics and risks of all workstations now, and especially next-generation workstations

Today's DCGS bears little resemblance to the Cold War stereotype, as each center or node is its own command structure of approximately 500 people, in which each individual analyst, team of analysts, and communication experts are linked to and working with virtual groups around the globe. With continued advances in communications and real-time data exchange, the ability to seamlessly team virtually and share activity will be the normative way of doing business, creating paradigm shifts in command and control.

The "crew station" for future Large and Medium UAS will likely be similar in design and construct. Current philosophical trends seem to suggest that some means of human pilot control and override will be required even in an autonomous system. However, all proposed designs allow human control of multiple systems simultaneously. The predominant trend seems to build on a limited intervention scenario where the operator monitors multiple autonomous UAS using multiple screens or overlaid data, and troubleshoots errors if and when they occur. Capability currently exists, and has been demonstrated for automatic landing, taxiing, stationary and moving object avoidance.

TOTAL FORCE INTEGRATION CONSIDERATIONS

Total Force Integration, designed to combine active-duty, ANG, Reserve Airmen and civilian employees into an even more capable and efficient Air Force, has been highly successful, as it reduces the need to pull members away from home and jobs for extended overseas deployments. However, in reality the members still have to perform overseas deployments. Full integration of Total Force components into these missions poses significant legal and practical issues.

Legal considerations for ANG members begin with their legal status, and reflect issues common to all Total Force integrated units. ANG members fall under Title 32 and are generally tasked for the defense of the homeland, whereas Active Duty fall under Title 10. By law, Guardsmen under Title 32 orders cannot command Title 10 assets and vice versa. Thus, often more senior and seasoned Guardsmen face a limit in their ability to lead and command within blended units, so command is shared.

Because combat missions require "activation," the Reserve component and ANG Employed in Place (EIP) members are activated and deactivated multiple times a year, creating a significant administrative

burden. From an AFMS standpoint, this also creates periods of eligibility, ineligibility, and uncertainty throughout the year. Although operations are 24/7/365, non-located ANG units have no access to Active Duty Air Force (ADAF) medical or psychological care nearby. Traditional Guard providers are neither credentialed nor equipped to treat the activated Guardsmen routinely, though many do provide telephonic advice as able. Thus, Title 10-activated EIP Guardsmen must typically rely on any available TRICARE providers. Guardsmen under short activation periods (<31 days) are utilized on a rotating basis to ensure full-time coverage, being activated for only a few days while continuing their “day jobs.” Although Line of Duty determination is made specifically authorizing such care, Guardsmen who need mental health or counseling services must seek care from civilian providers, who have neither the clearance nor facilities to discuss TS/SCI workplace stressors.

LEGAL/ETHICAL CONSIDERATIONS OF TELEWARFARE AND THEIR RELEVANCE TO THE AFMS

“RPA Pilots Valid Targets, Experts Say” blares an Air Force Times headline.⁶³ This and other mainstream and military media headlines reflect a growing concern over the legal status of telewarriors as front lines are effectively re-drawn to include them. This is most readily apparent when considering operators of armed UAS who are employing kinetic tools in combat. Management of such considerations is important in the design of future AFMS support.

Most military members and leaders are well versed in the LOAC, their rights and responsibilities under the Geneva Conventions, and of the Code of Conduct. Although some may have a high degree of skepticism about our adversaries’ willingness or intent to honor rules and laws in war, it is a generally held principle that the US must. The introduction of telewarriors and robotics to the battlefield, however, poses a new challenge to long-standing principles and may pose new threats to telewarriors and others.

The LOAC and corollary doctrine draw a clear line between combatants and non-combatants. Combatants are “members of the regular armed forces...and irregular forces under responsible command, who carry their arms openly and distinguish themselves from the civilian population.” Non-combatants are pretty much everyone else, including “civilians, medical officers, corpsmen, chaplains, civilian war correspondents and technical representatives.”⁵¹ In the eyes of international law, anyone fitting the description of combatant would be considered a legal target for adversaries and entitled to the protections of the Geneva Conventions and corollary international protections.

In contrast, individuals engaged in combat who do not fit into the definition of combatant could be considered illegal combatants, e.g., mercenaries. They would therefore not be entitled to protection under international law and could actually be charged with War Crimes in a manner similar to US management of Taliban fighters and terrorists.⁴⁸

This is relevant to this discussion as it applies to telewarriors. Are today’s MQ-9 pilots, who acquire, target, track, and destroy the adversaries’ target from the control console at base X in CONUS combatants? The general opinion is that they are. Because they are uniformed military members in a well-defined combat operation within the military leadership they would be considered to fulfill the

definition of combatant. And thus, would be: (a) legitimate targets for the enemy, and (b) protected under international law. This seems cut and dry enough. However, the secondary consequence is that MQ-9 crews are indeed “in combat” by the very nature of their jobs. Yet, with the exception of the time they spend in the hardened confines of the installation, they and their families live and work in a totally unsecure environment.

This is particularly relevant to National Guardsmen. ANG units transition from a homeland defense mission to an EIP combat role, and there are justifiable concerns that telewarriors, combatants in fact, could be the targets of local hostility or hostile adversary action. Cyber attacks on their personal finances or reputation could be sufficient to damage a security clearance and thus disable a high value asset. The threat of physical danger in the US is no longer a remote unthinkable threat.

RPA pilots and other telewarriors are not the first to face such threats. Missileers and strategic bombing crews have faced similar concerns for decades. However, those alert crews were specially trained, were in a continuous state of alert for those tasks, never employed their weapons, and tended to be younger and unmarried.¹⁰² Today’s RPA pilot and crew are typically married with families, not necessarily prepared for continuous alert and force protection, and they are employing their weapons, the graphic, vivid consequences of which are viewed by millions of *YouTube* and other media viewers.

With the rapid emergence of Advanced Technology Demonstrators and other rapid prototype offensive weapon systems being pressed into service, the US has been forced to employ integrated military, civilian and contractor teams. In some cases those teams are armed and/or in the “kill chain;” these individuals may be similarly vulnerable to attack, but would not necessarily fall under the protective aegis of the military or even international law.

The rapid emergence of automated and networked decision systems complicates the concept of being “...under responsible command.”⁵¹ Military command authority has typically been measured in a linear fashion, defining a clearly responsible authority that by virtue of command is held responsible for the success or failure of combat. This *individual* is assumed to have ensured compliance with the LOAC, including correct and reasonable targeting decisions. With increasing reliance on automation, however, the question of who is in charge and who is culpable becomes much less clear. Dr. Singer notes an early tragic case of automation gone awry when a US Vincennes automated defense system identified an airliner as a potential threat. The crew, trusting the system over their instincts allowed the system to fire, killing all aboard the airliner. Who was culpable? In this case, since there were humans in the loop, of course the finger was pointed at the crew and their commander, though they were ultimately not held accountable. What if in this primitive situation there was no opportunity for human intervention as in some similar installation protection systems? Had the weapon fired with *no* opportunity for human intervention who really would be considered to have been responsible?⁸⁴

There are now fully autonomous combat aerial vehicles, robots and AI decision-making systems in existence. Near-future robotic weapons can be programmed to use AI to identify and destroy threats of a particular size, shape, and behavior located within its zone of operations. Consider a hypothetical situation where the AI misidentifies a group of schoolchildren wearing enemy-looking hand-me-down

clothing (like old BDU's) and it very effectively eliminates the "threat." Who is responsible? Who could have prevented this clear violation of international law? We are nearing a point in which the last human in the combat decision chain could be a contracted programmer or in which the "kill parameters" are reflected in the convoluted words of a DoD contract.

Potential scenarios like this prompt a near knee-jerk response by leaders and authorities at all levels that AI-operated offensive systems will retain a human in the loop. The human factor implications of this panacea response are considerable. To place a human in the loop will require an interface in which the human can truly and properly judge correctness of a kinetic situation. For that to work there has to be a built-in "*distrust*" of the automated system and willingness to override it. Yet, the very nature and design of AI is to build in high reliability and *high* "trust". Moreover, "trust" in AI systems seems to have a generational component, with younger generations being much more willing to trust the system to make the right decision and less likely to override it.²¹

The time-to-act loop in modern combat is also relentlessly shrinking. Only a generation ago kinetic action was planned days or weeks in advance, and although tactical decisions were made in real time, most big picture decisions were not. Today's warrior expects a flood of situational data within minutes, including target identification, coordinates and clearance to proceed – immediately. The time pressures to do so are at the limits of human capability. The decision loop in AI systems, though, is measured in milliseconds. A prevailing school of thought among other global superpowers is that as long as the system can be verified as having accounted for LOAC-driven targeting rules, using such a device does comply with international law. There is certainly considerable technical challenge in so designing a system.⁴ Therefore, is it reasonable to assume that AI-driven automated systems will be down-regulated to stop and wait seconds or minutes for human input, especially if the system is perceived as threatened? In the near term, though, it appears that USAF developmental direction is to include a human in the loop.

Medical staff will need to manage the stress on the human who must instantaneously assess, evaluate and react to an AI-driven request. We must assess how to build systems to mitigate human factors while preserving the human input, and how to develop meaningful human interfaces to permit instantaneous decision-making. This type of human in the loop planning adds complexity to an already complex fabric of combatants and responsibility. It seems inevitable that the human in the loop will be a single operator. Who these single operators will be is unclear, but by the nature of unmanned systems they are unlikely to be near the kinetic battlefield. They will, then, be offensive telewarriors yet may be junior analysts not trained or experienced as leaders traditionally empowered to make "kill" decisions. The senior airman seated at the video display could have stopped the attack on the school, but trusted the machine. Who is responsible? How will he react? How should he? What should the AFMS do for him?

The rapid growth of AI systems and true global networking creates a new leadership challenge. In the scenario above, assume that the team that trusted the AI system and told the senior airman to consent was a team of five analysts in three different groups scattered around the globe. What commander actually had control of that operation? On whose orders did the virtual team proceed?

The importance of legal and ethical considerations to the AFMS is several-fold: (1) The forward edge of battle is in CONUS, at the computers, homes and schools of telewarriors, and some are visible, well-known targets; (2) The US is increasingly thrusting contractors and civilians into combatant roles, both in the line of fire and in roles as telewarriors, and since military members in these activities are combatants, it is logical to assume the civilians and contractors are too; (3) Airmen placed in direct contact with the enemy may increasingly be younger, less experienced, and “flying” solo, perhaps with a virtual team for assistance but ultimately acting rapidly on instinct or trust to authorize a response; and (4) Human interfaces for AI are being developed today and will continue to be developed into the future.

MAJOR THEMES

It has become clear that the emerging environment of telewarfare is unique, and likely to evolve into a more highly challenging environment over the next decades. For the past century, the Air Force and Air Corps have been synonymous with aircraft as a tool to deliver weapons, people, cargo and relief globally. The Airmen conducting these missions are the image of the Air Force.

The AFMS has built itself largely around the missions of these classic aviators by building and maintaining a research infrastructure, specific education and training, and providing specialized, customized healthcare for aircrew. For the foreseeable future the Air Force will continue to identify itself with Airmen in aircraft, but we are likely to be training a final generation of career fighter pilots and the day will come, possibly within the careers of our young Airmen when the last airlifters will enter training.

The emerging leaders in combat projection within the USAF are currently resident in the ISR community. That world brings with it security and access considerations unique to it, and creates barriers to medical investigation and human optimization activities. However, what we learn from today’s operations will form the foundation for a future dominated by similar stand-off power projection, remote operations and extended duration capability. We must be prepared to fundamentally shift our emphasis as technology enters realms we have not anticipated and telewarriors become the new high value mission of the USAF.

Examining today’s known risks for the telewarrior reveals several major recurring themes for AFMS support:

- *Specific scientifically-based selection criteria for telewarriors – redefining ARMA (Adaptability Rating for Military Aviation)*
- *Human-Systems Integration role*
- *Medic role in training Telewarfare leaders (shift work, fatigue, stress)*
- *Preparation of front-line medical personnel to support this unique environment*
- *Anticipatory and Participatory Care for Telewarriors as a unique at-risk group*

Each of these recurring themes should sound familiar to Air Force Aerospace Medicine leaders as they harken to the priorities that have guided aeromedical research and practice for decades.

“...because of lack of fundamental research...aircrew members often were required to perform highly skilled jobs under conditions disadvantageous to human activity...This problem dictated three fundamental approaches: (1) consideration of human design in aircraft... (2) Selection of aircrew members on the basis of those human qualities which make for efficient combat airmen; and (3) training of aircrew members... [to] enable them to survive and perform efficiently...”

(Col) Dr. W. R. Lovelace, A.P. Gagge Lt Col and Dr. C. W. Bray 1946⁵⁹

Those early principles remain valid today, and have evolved to an increasing recognition of prevention and tailored clinical care as a means to further enhance the capabilities of the human in the adverse environment.

Selection of Telewarriors

The concepts of preventive psychology, genetic-based risk stratification and use of cognitive and psychological selection have long been taboo as potentially discriminatory. However, as capability emerges to use them ethically and effectively, they will necessarily become part of the preventive medicine strategy of the AFMS and the military at large. There are decades of literature regarding the efficacy of scientific selection criteria regarding aviation and space flight, and over the decades there have been varying levels of effort to specifically select Airmen for other careers based on ability and skills. The recent decades of war, though, have truly highlighted the need for specific, custom selection for many non-aviation career fields.

One of the better examples of why selection is so important comes from recent work with a special operations field that had an unacceptably high washout rate. When the AFMS began specific evaluation of psychological and physical requirements, it became apparent that the requirements for success in that career were markedly different than the normative Airman. Building on that information the AFMS researchers were able to develop methods to identify 86% of successful graduates. Using standard ASVAB (Armed Services Vocational Aptitude Battery) and ability-based selection resulted in selection of candidates with less than 10% graduation rate.¹⁷

Specific selection of Airmen is fundamentally a medical task, and is an essential element of Preventive Medicine. Most occupational medicine physicians will recognize the workload analysis and development of criteria to prevent illness and injury as a core activity. Thus, it seems incumbent on the AFMS to consider actively engaging in the guidance and direction of selection technologies and policy. This level of engagement was the principle recommendation of UAS commanders, human factor researchers, and ACC and AF/SG aircrew standards experts.⁹⁸

As a result, the AFMS will find it necessary to clearly codify specific qualification testing and guidance in a manner not previously acceptable. To truly optimize future telewarriors, the specific psychological and cognitive abilities will have to be defined for all roles. Candidates will be tested and selected or rejected on thresholds established through clinical research. Specific screening for fatigue tolerance and maintenance of vigilance could have vast cross-over to other disciplines in the military and civilian community.

Finally, selection of Airmen includes continued evaluation as a means to prevent injury or illness. The AFMS has a role to play in utilizing existing and future health and behavioral data to guide focused interventions among higher risk telewarriors. Using similar methodology will provide objective measures to guide informed decision making for continued qualification. Examples could include early identification and supportive care for transient psychological issues, versus empirically removing the Airman from a secure environment or early identification of individuals at risk of sleep disorders before their symptoms manifest in the shift work environment again, with a focus on ensuring they can do their work. For any of this to occur, scientifically-based, well-supported guidelines for initial and continued qualification will have to be crafted and kept current.

Direct Involvement

A fundamental precept in occupational medicine is for the healthcare provider to understand the workplace and the risks within it. Today's telewarriors face unique stresses of the workplace that may be poorly understood or totally uncharacterized even today. Future telewarfare workplaces will create unique moral, ethical, psychological and physiological challenges. Shift work challenges are likely to remain a fixture of continuous telewarfare operations, but future workplaces are likely to feature technological solutions that may reduce or add to the workload and stress of operators. The most effective way to properly characterize and select for required skill sets will be direct involvement of interested and knowledgeable healthcare providers. Leaders in telewarfare may have little or no training in shift work management, recognition and management of stress, anxiety or depression, or in addressing cognitive workload difficulties. There is great opportunity for well-trained medical personnel to work with telewarfare leaders to develop their skills in management of a medically and psychologically high-risk workforce. Innovative solutions like "follow the sun" networking methodology could alleviate shift work stress, and secure networked healthcare operations could provide truly global reach for medics.

One of the oldest and most effective interventions in medicine remains the "hallway consult." The embedded healthcare provider concept is particularly important in these units on a number of levels. At the most basic level are medical providers who know the unit and the personnel, and are more likely to pick up on changes in behavior or "hear" of potential issues early enough to intervene. However, the other critical aspect to embedded healthcare providers may well be to gain an appreciation of stresses on the families and/or the impact of family stresses on the members. In the face of real or perceived threats, families may become a limiting factor for telewarriors, and specific focus on their care and safety will become paramount. Moreover, developing a trust relationship with families may provide a window of insight into the mind and psychology of the telewarrior. It is the medical provider who may best be able to assist units to focus on development of resilience strategies, and to guide those in trouble to effective readjustment known to be among the most effective means to reduce psychopathology among returning warriors.⁸²

Access to care is a critical and particularly problematic issue for National Guard EIP units as their intrinsic medical capability may be part-time at best or not easily accessible. During the most vulnerable periods for POST-TRAUMATIC STRESS DISORDER (PTSD) or related combat stress, 30-180 days after the trauma, there is often no source of care available to them that has any linkage to the mission or the mission

stresses. Medical personnel embedded in or related to the mission could provide access to these Guardsmen and would be a force multiplier and provide significant psychological relief to telewarrior units.

Even among active duty units, access to care has been cited as a significant issue for telewarriors due to shift work requirements and combat support role. In deployed settings medical providers and warriors are on similar combat battle rhythms, and warriors who are ill are seen, treated and returned to duty when needed, 24/7. However, on telewarrior installations, ONLY the telewarriors are on a combat battle rhythm and as a general rule the units are only tenant organizations, so small that installation leaders find it difficult to expect the whole installation to be on a 24-hour clock for them. That means telewarriors must violate shift work hygiene to make routine installation requirements, including medical care.

UAS front-enders have been designated as aircrew, and at a minimum see a flight surgeon that has basic awareness of their duties on an annual basis. The vast majority of telewarriors, however, are not currently designated as aircrew and do not have the benefit of being assigned to an aerospace medicine team.

Trained, Focused Medics

Panelists frequently noted that few medical providers are well versed regarding what telewarriors do today, and even fewer have a vision for tomorrow's stresses and methods. With the exception of brief introductory-level material for flight surgeons and residents in aerospace medicine, there is no formal training for any medical providers on the missions and unique medical, moral, ethical and legal stresses and threats faced by the combatants and their families. Although the Behavior Optimization Program and Family Health Initiative are excellent efforts to improve access and do bring psychological care to the primary care environment, relatively few primary care physicians are trained and fully empowered to devote time and energy to managing stress and anxiety unique to the telewarrior mission. In some clinics this may create a tacit requirement for telewarriors to seek formal mental health clinic care for their stress. Given time, training and resources most family practice physicians will find it within their scope of practice to manage the issues of telewarriors at the front line and to do so effectively. Specifically trained operational psychologists as members of the primary care team should be highly valued in the support of telewarrior operations.

Similarly, it is likely that a minority of supporting medical providers is trained to recognize, evaluate and help prevent shift work-related sleep disorders and other manifestations of fatigue and reduced vigilance. Without specific guidance, decision trees and approved solutions within the context of TS/SCI environments even fewer medical providers have well-founded, scientifically valid methods to treat and return telewarriors to duty. This further creates distrust of the medical community among the TS/SCI-cleared warrior. To truly be optimal combat support medical personnel, those who directly support telewarrior units should receive specific training and tools to manage the typical stresses of 24/7 combatants in a manner similar to the training used to prepare medical personnel to care for battlefield combatants.

WORKPLACE RISKS AND STRATEGIES FOR INTERVENTION

This analysis of the telewarfare environment is predicated on assumptions that the environment and/or the Airmen who comprise the workforce are: (a) a unique, compartmented population of warriors; (b) exposed to stimuli unique to this workforce; (c) subject to unique definable risks, and (d) those definable risks are causing or will cause threats to health and well being. Understanding risks and trends already present could help to shape long-term strategy to prevent future adverse health effects.

At Beale AFB, DCGS telewarriors were found to have significantly higher utilization of mental health services than other organizations on the installation²² despite considerable perceived taboo against such counseling. In a recent report one senior evaluator described fatigue, ops tempo and scheduling practices as “at the core of a number of ADAF troops’ decline into remarkable demonstrations of abnormal behavior, low self-esteem, alcohol abuse, reckless personal practices, neglect of personal hygiene and refusal to perform duties,”⁶⁵ and in a recent unpublished analysis USAF researchers found a statistically higher prevalence of suicide, misuse of prescription drugs, use of illicit drugs and partner emotional abuse among cohorts associated with secure operations when compared with other high risk AF populations.¹¹ Although not studied in telewarrior populations, some authors suggest partner and child abuse and maladaptive behavior have been common among deployed, older Guardsmen,⁵⁴ thus this too could be a theoretical concern as more Reserve and Guard members are utilized in compartmented telewarfare roles. Additionally, Air Force fitness data from September 2011 suggests a higher rate of fitness failure among ISR agencies than other comparably sized units.⁷¹

That these phenomena are uniquely related to telewarfare may best be illustrated using AF ISR Agency data during the past decade. Following the 9/11 attacks there was rapid growth in warfighting capability, including pressing into service unmanned and manned reconnaissance capabilities on an unprecedented scale. During those years Air Force members deployed by the hundreds of thousands, and yet the Air Force maintained very low rates of suicide and serious events. Yet, behind the cloistered walls of the ISR Agency, the rate of serious events rose precipitously, and remains 31% higher than total AF as of 2008.^{72, 77}

Although these rates have normalized to match the rest of the USAF as of 2011, clearly there were unique risks to health and well being among telewarriors that manifested in unhealthy and even tragic behaviors. Left unchecked, with the rapid growth of technology and future demands, we may assume long-term trends will continue to remain unfavorable, and perhaps worsen.

It is possible and imperative to study this legally, ethically, functionally, and operationally unique subset of individuals and work centers. It is critical to design effective strategies to prevent illness and injury, optimize the effectiveness of telewarriors, and to diagnose and treat illnesses and injuries as they occur. The end result should be to rehabilitate telewarriors with intent to return them safely to duty.

ENVIRONMENTAL RISKS

PHYSICAL RISKS

REPETITIVE MOTION DISORDERS AND ISSUES OF PROLONGED COMPUTER USE

Ergonomic risks of work centers do, and will continue to vary considerably between work centers, type of analysis, and method of display. However, common themes are present, and are likely to continue to be factors in the future. Work centers for current UAS operations and most ISR operations are essentially chairs, desks and fixed or non-fixed computer flat panel displays. UAS Predator/Reaper control stations feature ergonomically-designed seating with workstations that feature keyboard, trackball/mouse and joystick layout typical of an integrated gaming platform.

Work centers for DCGS/ISR operators and analysts are typical for most DoD computer workstations with keyboard/mouse/displays mounted on a computer desk. Most analyst tasks require prolonged attention to a screen, and communication is often performed via multiple simultaneous “chat” windows opened on a screen. Thus, major theoretical ergonomic concerns revolve around prolonged seated position, repetitive motion disorders typical of keyboard/computer workstation use, and the visual/optical effects of continuous use of LCD or other displays. Each of these is well characterized in occupational medicine literature and will not be detailed here.

Linguists and some signals analysts face a unique and mostly uncharacterized occupational challenge regarding the use of headsets for long-duration auditory monitoring and decryption. The auditory volume enabled in the headsets and similar devices could itself pose an occupational risk for hearing loss unless volume controls and limits are incorporated. There could be theoretical health risks from long-term monitoring of “static” or “white noise,” as there is an elevated rate of noise-induced hearing loss observed among airborne linguists.⁷⁹

TEMPERATURE AND LIGHTING

Temperature control is often cited as an environmental consideration for ISR operations. Many ISR and UAS operations are heavily dependent on computers and technological solutions that require the environment to be kept cool to optimize computerized systems performance and minimize the chance of overheating sensitive equipment. It is common for workers to perform their duties in sweaters and coats, only to emerge into a hot desert environment for the trip home. Environmental considerations of this type of work center are typical of a very dry, enclosed work center including the usual allergy and respiratory complaints.

Lighting is an important consideration for telewarriors. In general, work centers are kept cool and dark; this creates the net effect of working in a cave. Potential occupational considerations of prolonged or continuous darkness are primarily physiological and psychological. Future work centers using more efficient modern display technology should be less reliant on darkness to optimize effectiveness of individual workers, and it seems logical that illumination could be improved.

SICK BUILDING OR SIMILAR ISSUES

Highly secure buildings are typically windowless, environmentally-controlled buildings. As in all tightly sealed structures, there is an ever-present risk of the “sick building” phenomena; however, modern HVAC systems and design with high exchange rates are likely to be the norm in newer structures. Nonetheless, the enclosed, relatively confined working areas may be a good environment for rapid spread of respiratory illnesses, and may be a factor in return-to-work decisions, negatively impacting force health integrity and sustainment.

PHYSIOLOGICAL RISKS

FATIGUE AND SHIFT WORK

Fatigue and shift work requirements of today’s telewarriors may be the single greatest risk to their health and welfare. As a result of the unrelenting operations tempo, continued increasing availability of data, ever-expanding thirst for information, and the Air Force’s chronic limitations on manpower, all DCGS and UAV operations are 24/7/365 operations. Fatigue resulting from poor scheduling practices is a recurrent theme in after-action reports and studies of the DCGS/ISR/UAV communities.^{11, 14, 44, 65, 70, 89}

Shift work is not a new issue in occupational medicine, nor is it unique to this community or the USAF. Methods to minimize shift work fatigue and to optimize scheduling practices have been extensively studied for decades, and the Air Force has fielded excellent tools for operational employment, but with variable utilization.

Within the USAF, the two populations first extensively studied for optimized shift work scheduling methodology were air traffic controllers and security forces.^{60, 61, 67, 68} From these efforts, specific aids were developed to optimize aircrew scheduling, and subsequently expanded and optimized for all operations. The Fatigue Avoidance Scheduling Tool (FAST), first fielded in 2001 and modified thereafter, provided a method to tailor scheduling to the inherent sleep cycle of individuals with intent to optimize their window of performance. The tool was somewhat difficult to use and was more applicable to individual operators than populations. However, building on the Sleep, Activity, Fatigue, and Task Effectiveness (SAFTE) methodology, Miller et al⁷⁴ and others developed a Shift work Scheduler Interface (SSI) specifically focused on security forces continuous operations. In order to use any of these tools, however, leaders must have specific instruction and must understand the methodology used to optimize performance that underlies them.

No standardized or research-based shift work scheduling tool, however, seems to be a panacea. In some studies, officially recommended solutions were not favorably viewed. This may reflect a blind spot in all standard scheduling methodology for social and family interaction. Optimized scheduling tends to be heavily weighted to account for an individual’s circadian rhythm and natural shifts. However, no methodology adequately accounts for the effect of a child’s school play or a required official formation during the “sleep” or “reconstitution” period, as they tend to break the sleep cycle, and the long sunny drive home may even reset the natural rhythm of the shift worker.

There are several variables that enter into a shift work schedule such as fixed versus rotating shifts, fast and slow rotation, and 8 versus 12-hour shifts (others, of course are possible). Most employees typically

prefer fewer 12-hour shifts only if they result in more days off. However, in practice some studies have found marked increases in errors in the 8-12th hours. Folkard and Tucker³¹ found that “risk increased in an approximately exponential fashion with time on shift, such that in the twelfth hour it was more than double that during the first 8.” Similarly, they found that successive night shifts contributed to risk, with the risk of an incident at work rising nightly to as much as 17% higher on the third successive night shift.

Fixed shifts, in which workers tend to work the same shift for extended periods of time are common in the civilian workforce and less so in the military. These shifts in which individuals work all days or all nights provide a great deal of stability, but tend to lead eventually to dissatisfaction, especially among “night shift” workers as they necessarily must break their sleep hygiene practices to conduct usual activities of living in a “day-oriented” world, leading most agencies to choose some form of a rotating shift.

Among aircrew, specific workday lengths with mandatory rest periods are prescribed. Intuitively, it would seem that a carefully prescribed sleep/work cycle and a high level of training among the aviators would make them less susceptible to the effects of sleep deprivation and shift work suffered by non-aviator straight-shift workers. Thompson et al evaluated that premise among operational UAS operators (MQ-1) and found no protective effect of aviator scheduling limitations.^{89, 93} This likely reflects the difference between the aviator duties of telewarriors and their traditional aviation counterparts. Traditional aviators, even in a sustained combat operation, tend to have time to prepare for a particular cycle of duty (e.g. 0300 launch), and during the times they are not flying they are truly off duty. Traditional aviator surge operations tend to be of relatively short duration. UAS operators, on the other hand, have been engaged in “surge” operations non-stop for a decade, and their operational cycles are more like standard shift work schedules than those of traditional aviators.

Moreover, the workload of a UAS crew is fundamentally different than those of a traditional airframe, requiring sustained vigilance, but little physical or intellectual “action” during the vigilance period. Even in sustained operations, airlift crews on autopilot for long “drones” have tasks in the aircraft, windows to look out of, and approaches and landings to plan. Some researchers suggest that the maximum period for sustained effective vigilance is 4 hours.⁶⁷ Thus, an 8 or 12-hour orbiting UAS mission challenges those limits.

Among studied UAS front-end crews (see Appendix B), 55% met criteria for Shift Work Sleep Disorder (SWSD), and a vast majority reported fatigue and decreased mood and quality of life. Note that at the time of this study all UAS operators were pilots mission-rated in other aircraft, and thus should have been at least somewhat familiar with scheduling/fatigue management. The researchers found greater impact on performance and quality of life and poorer acceptance of the rapid rotation methodology in contrast to Miller et al recommendations.⁸⁹ Similar studies among RPA pilots found no objective benefit of one methodology over the other.⁹²

Air traffic controllers are similar in many respects to telewarriors in that they must support continuous operations and must maintain very high vigilance despite potentially long periods of inactivity. Studies

of this population have long demonstrated significantly increased error rates late at night, high rates of fatigue, burnout, and reduced vigilance.^{60, 61}

The adverse effects of continued shift work may not, however, simply be a reflection of poor leadership decisions, inadequate staff or high vigilance/low stimulation work. The considerable body of evidence regarding shift work supports the notion that there is great individual variability in tolerance of shift work. Rutenfranz et al reviewed existing world literature on shift work (comparing among other things 3-crew 12-hour shifts, 4-crew 8-hour shifts, and irregular shifts) and arrived at several conclusions of significance for the telewarrior.⁸⁰

Multiple studies also reflected a consistent pattern of perceived or actual social isolation among shift workers. Shift workers, due to their irregular schedules, were significantly less likely to participate in social, community and sports activities than peers,¹⁰⁰ a factor that could further contribute to dissatisfaction. Similarly, other studies as reviewed by Berger and Hobbs⁷ have demonstrated more frequent social isolation, divorce, and substance abuse among shift workers than peers. Social isolation will be further discussed below as an independent risk factor.

Not all shift work can be painted with the same brush. Studies of offshore oil rig operators and maritime operators who are intermittently “deployed” to the rigs for several months, then return home for several months have reported a different set of health effects primarily revolving around generalized anxiety and separation. In fact, among these workers a “healthy worker” effect is often seen.⁹ This population may be more similar to forward-deployed Air Force members who seem, anecdotally, to have few problems with shift work while deployed. Thus, risks of shift work seem to be associated with impaired interaction with the non-shift-working world; to be correlated to certain selection factors; to be interrelated with social isolation; and to be aggravated by unpredictable or short cycles with little reconstitution time.

MITIGATION STRATEGIES

Prevention:

Selection of Telewarriors (Shift Work): The AFMS may have a role in developing scientifically valid selection standards that may include genetic and psychological factors leading to more effective fatigue tolerance and vigilance capabilities.

Research Focus: As the AFMS moves to more participatory and individually tailored medicine, there is an even greater role in applied research and in the development and deployment of selection tools for telewarriors. Analogous to the initial pioneering work into aviation medicine, the AFMS stands now on the cusp of new explorations into human physiologic response and psychosocial adaptation to AI and robotic technology. Research should include biomarker and genetic indicators of fatigue tolerance and physiological correlates to successful maintenance of vigilance, as well as psychological and clinical considerations of extended duration combat operations and responses to immersive environments. Work being done for RPA operators can serve as a basis, though relatively little has been done even in that domain to define an effective Human Systems Integration effort.⁹¹

Selection Criteria: There is no doubt as to the effectiveness of scientifically-based selection methodologies. Current lack of consensus on “ownership” of the tasks and roles of the AFMS versus the Line of the Air Force in fundamental research and in construction of pertinent policy are significant barriers to effective selection of optimal telewarriors. It is likely that as the use of telewarriors increases, demand for advanced skill in multilayer data interpretation will grow, and more specialized human skills will be required. For operational medicine, selection of telewarriors could and likely will be a major frontier for scientific selection using psychological, physiological and genomic standards rather than traditional fitness standards based on physical deployment requirements. Selection methodologies must be developed and applied that will identify warriors most capable of operating in extended combat situations, and who will be most resistant to stresses of telecombat. Currently there are few standards (mostly geared toward RPA pilots and sensor operators) to guide selection.

Prevention of Desynchrony: A repeated concern of shift workers is that unlike deployed installations, their CONUS servicing facility is not conducive to combat-driven schedules. As AFMS leadership guides installation preventive strategies, consideration should be given to ensure appointments and installation services are available to shift workers to avoid disruption of sleep cycles.

Optimization:

The skill sets represented in the AFMS include the greatest body of experience and training in fatigue management, scheduling optimization and human factors in the Air Force. Thus, the AFMS has a role in formal training and guidance for leadership. Moreover, as science advances, the AFMS may be able to identify optimal genetic and psychologically-based physiological rhythms, allowing personalized scheduling (e.g. 12 hours, 8 hours, 6 hours, or non-rotating) in a manner that optimizes each individual’s capabilities.

Shift Work Guidance: Few leaders have formal training in the management of shift-work schedules and in strategies to identify optimal schedules on an individual basis. The AFMS should consider development of training programs for telewarfare leaders and deployment of tools to help guide optimal strategies for maintenance of vigilance.

Development of Fatigue Monitoring: The major performance impacts of fatigue are loss of vigilance, and increased errors. The AFMS should leverage existing and developmental technologies to field monitoring capabilities for error tracking and vigilance monitoring. Existing technologies include but are not limited to biomarkers of fatigue, eye/expression monitoring and task error tracking.

Diagnosis, Treatment and Rehabilitation:

Identifying Shift Work Sleep Disorders: Relatively few medical providers in installation clinics are likely to be formally trained in the identification and management of shift work-related stresses, or in the identification of physical and psychological complaints associated with shift work. The AFMS should embark on an effort to ensure medical personnel supporting continuous combat operations/shift-work schedules are formally trained in the recognition and treatment of shift work-related illness, and are specifically aware of the missions, criticality, and options for treatment available for telewarriors in these environments.

Tailored Treatment: The AFMS must develop a strategy and practice guidelines for consistent management of fatigue, SWSD, and other symptoms of desynchrony. Simply placing the telewarrior on quarters is likely to worsen the symptoms and further impede adaptation; it could potentially have a ripple effect across the unit and on others who may already be on the edge.

Access: Telewarriors and other shift workers find it difficult to meet standardized daytime appointments, especially those made days or weeks in advance. MTFs serving 24/7 operations should make available limited sick call or open-access capabilities that enable access during or immediately adjacent to the shift worker's shifts, and provide sufficient flexibility to prevent the necessity for shift workers to report to the clinic in the middle of their "night".

SEASONAL AFFECTIVE DISORDER

A theoretical consideration unique to the telewarrior, particularly the analyst, is Seasonal Affective Disorder (SAD). Telewarriors working stable shifts that require them to work and live in the dark could have SAD symptoms. Although it is possible that rotating schedules can reduce the risk of SAD, not all telewarriors perform rotating schedules.

MITIGATION STRATEGIES

Prevention: The AFMS has a role in assessing the actual risk of SAD in this community. A useful data point would be an analysis of computer monitors as a suitable light source. Moreover, working with leadership, medics may be able to affect changes to the illumination of the work center that obviate the problem.

Diagnosis: As noted above, few medics directly supporting the telewarfare mission are likely to be aware of the work environment of the telewarrior. Thus, non-specific fatigue or emotional complaints may well be misdiagnosed. Unless specifically prepared, few physicians working traditional day shifts in the sunny southwest US are likely to consider SAD as a potential diagnosis. The AFMS should ensure that physicians directly supporting telewarfare operations are well versed in the unique challenges and workplace stresses of telewarriors, including risks of working in the dark.

SENSORY OVERLOAD

Analysts have multiple layers of information from airborne, space-based and ground-based sources simultaneously available to them. Sensor operators must multi-task using a suite of surveillance equipment covering multiple sites and tasks.

In the future, RPA pilots will be required to control and or monitor swarms of vehicles simultaneously. This will require vigilance for multiple simultaneous inputs and will potentially require "arbitration" between automated systems. Methods to display and prioritize inputs from multiple RPAs simultaneously in an effective fashion are not yet known. Task saturation and information overload is a prescient issue.^{24,26,39,46}

Today's analyst typically operates at a workstation that does not differ significantly from a typical Windows®-based computer station. Each analyst may have multiple chat windows working continuously while monitoring video or other surveillance from multiple sources. Long periods of "nothing

happening” may be punctuated with a blast of input from multiple sources and demands for immediate interpretation and staffing for action.

Individuals react differently to high volumes of simultaneously-presented data, depending on their perceptual abilities, processing speed and capabilities, and their ability to spatialize. Three-dimensional spatialization ability is a key differentiator among those who are most able to multi-task in the military environment.¹⁸ Proficiency in the video gaming environment may be a marker for individuals more able to trust AI systems and rapidly process data from multiple sources. Similarly, researchers have found subpopulations within UAS operations that are more able to utilize automation to aid in rapid paced multi-tasking than others independent of training or experience.²¹

Prevention

Selection of Airmen: It seems clear that there are subpopulations more able to tolerate rapid processing of information and to process it in a fashion that does not cause anxiety or overload feelings. The AFMS should consider research into this phenomenon and develop methods to identify Airmen most able to manage multiple sensory inputs. In a similar fashion, as display and presentation methodology advances, the AFMS should consider more traditional issues such as color vision and auditory discrimination in the context of tailored selection standards for some workstations.

COVERT OR HIDDEN HEALTH ISSUES

The intelligence culture of secrecy combined with demands of shift work and chronically inadequate staffing may lead to reduced willingness to seek healthcare for appropriate purposes. This could lead to a tendency to choose self-medication or unhealthy behavior as a means of coping. A recurrent theme of on-site interviews and analysis of telewarriors, both “front end” and “back-end” revealed a culture of independence, distrust and avoidance that translated to their unwillingness to seek medical treatment.^{14, 44, 50, 65} This is further complicated by a scheduling system that can make access to healthcare nearly impossible for rotating shift workers.

Most telewarriors work within the cloistered confines of a highly secure environment with its own culture of secrecy and security. Few healthcare providers have ever entered the work center, and even fewer of them have the security clearance to know the activities performed inside. Therefore, telewarriors find themselves without a healthcare provider they can consider trustworthy. To address these issues, some servicing installations have developed a highly knowledgeable trusting relationship with these populations, and at many of those locations at least one healthcare provider does have the required TS/SCI clearance to enter the workplace.

Further contributing to potential barriers to healthcare utilization is a lack of standards for continued security and access. Standards for continued security operations are very general, not widely known or understood within the medical community and may be arbitrarily applied. Pathologizing normal stress responses to combat by characterizing them as “abnormal” further adds stigma and barriers to care.¹⁰²

SEDENTARY WORK

The physical health risks of sedentary work are well known. The work of a telewarrior is almost exclusively performed during hours of seated work before a computer screen. While many telewarriors

make time for continued healthy lifestyles and some units work diligently to enable and encourage fitness activities, the fundamental risk of repetitive unbroken hours of sitting remains constant.

Risks of obesity and physical deconditioning are also well known, and higher than average poor or failing fitness rates among ISR units would suggest a basis for concern. Moreover, lack of physical activity and its corollary sensory deprivation (discussed below) is associated with decreased motivation, reduced concentration and persistent feelings of depression and anxiety.¹⁰² In the future, an individual's state of fitness and the ability to tolerate physical stress may be important considerations in telewarrior selection.

MITIGATION STRATEGIES

Prevention:

Advancements in technology may permit healthcare providers to influence workstation design and display methodology to encourage physical activity. Innovative uses of technologies (e.g. Wii-type control) or active workstations (foot treadles, kinetic chairs, etc.) are technologies available today that could mitigate some sedentary tendencies. Future technologies could be leveraged to further reduce the amount of seated/sedentary work.

EARLY IDENTIFICATION OF AT-RISK WARRIORS

Effectively using existing healthcare (ESSENCE) and fitness data allows identification of individuals with combinations of disease and health risks attributable to inactivity. As we move toward a more individualized and participative care model, it should be possible for medical providers dedicated to these units to individually identify and target specific interventions for telewarriors suffering from early effects of sedentary lifestyles.

POOR NUTRITION

One participant in the panel of experts described a typical telewarrior's day as including "...Gummi Bears and Coke for lunch." The problems of poor diet are magnified among shift workers, as their schedule often precludes typical meals. Moreover, single telewarriors who are also shift workers are potentially more likely to have poor dietary habits than those with families, as they may choose fast food on the way home rather than a balanced diet. This is not a trend unique to telewarriors and there seems to be little hope on the horizon for the US culture to turn the trend. Thus it is likely that this will remain a long-term consideration.

MITIGATION STRATEGIES

Prevention:

The AFMS has a cadre of nutrition and fitness experts who may play an individual and unit role in working with services and unit leaders to provide healthy dietary options for shift workers.

SELF MEDICATION

Multiple participants in the expert panel cited self medication and abuse of supplements as a growing concern with today's telewarriors. The cited causes of this include shift-work stresses, reluctance to seek medical care, and concerns over security or flying status if using prescribed therapies. The stresses

of shift work have been previously described, and with the vast preponderance of telewarriors engaged in 24/7 operations, fatigue is a major concern. A wide variety of “pick-me-ups” on the market reflect a wide cultural acceptance of stimulants to combat fatigue, and they are a way of life among telewarriors. While some of these supplements may be effective fatigue countermeasures, the chronic and pervasive use of stimulants can be unhealthy and may mask more serious psychopathology.

The use of other nutritional supplements may be of similar concern. For non-aviators there is little or no guidance aside from prohibitions on the use of supplements that mimic illicit drugs. Telewarriors may have little if any interaction with the medical community, and may be unaware of the potential adverse (or beneficial) effects of supplements. Some telewarriors may be unaware they are using supplements at all as many are now commonly mixed into “health” drinks (e.g. ginseng, guarana, Kava, St. John’s Wort, etc.) In the absence of scientifically-based, authoritative guidance it is likely that telewarriors will continue to use a variety of nutritional supplements to offset or mask symptoms of fatigue and dysphoria either by intent or accident.

MITIGATION STRATEGIES

Prevention (Self Medication):

Education and Training: The AFMS can play a role in education and training on the potential effects and benefits of supplements and their proper and safe use. One area of potential influence is to partner with DCGS and UAS teams and their leadership to develop educational resources, tool kits, and on-site advice.

Optimization (Self Medication):

It is entirely possible that some supplements may be beneficial in managing and sustaining long duration shift work. Traditional shift work methodology discounts their use, and current Air Force fatigue management strategies and policies are geared toward exceptional use for single missions rather than extended sustained operations. Additional research is needed to determine the potential benefits and risks associated with long-term supplement use before Air Force guidance can be developed.

PSYCHOLOGICAL RISKS

Headlines in mainstream media proclaim loudly that the telewarrior is suffering. *“Drone pilot’s war not remote; Front-row seat means they’re always on the front lines”* (Chicago Tribune¹⁰¹), *“Remote Control Warriors Suffer War Stress* (Associated Press⁵⁷), *“The Ethical and Psychological Effects of Robotic Warfare”* (National Public Radio³⁸). These headlines point out that the nature of combat and the exposures these warriors currently experience are different than that of previous generations.

Industry-wide psychiatric disorders have been among the most common causes of work-related illness and work-loss;⁴³ such disorders are often related to environmental and professional isolation versus feelings of empowerment and belonging.⁵² Fatigue, and reduced non-work time activities contribute to feelings of isolation.¹⁰⁰

Relatively little is known of the psychological makeup of the telewarrior because of the heterogeneous population, so generalities would be imprudent. However, some data is known about specific subsets of

the telewarrior population that are linked to the operation of current UAS. These will be noted in subsequent discussions of psychological risks inherent in telewarfare.

In 2010, 100% of RQ-4 and 89% of MQ-1/9 pilots were over age 25, whereas half of the sensor operators and intelligence analysts were under 25, and almost none were older than age 40 in either group. Overall, among these populations the distribution of experiences was slightly “older” than the overall officer and enlisted make-up of the host installation. Similarly, RPA pilots were more likely to be married (75%) than their enlisted sensor operators and analysts (~50%), and were actually more likely to be married than officers installation-wide. A majority of RPA pilots had children at home, compared to 30-40% of enlisted members.¹⁴ Thus, in this snapshot RPA pilots were older and married with children. Sensor operators and intelligence analysts were markedly younger, unmarried and had no children at home.¹⁴

It is possible that this difference will change somewhat with direct training pipelines for RPA pilots. During the snapshot above, some MQ-1/9 pilots had been directly accessed after Undergraduate Pilot Training (UPT), and contemporary changes in the training pipeline will make such early direct training the norm rather than the exception.

Aside from demographic information, little is known of the psychological profile of *successful* RPA pilots versus their peers who are less tolerant of the UAS environment. Research into specific skill sets required for UAS operation tend to suggest that attention, spatial visualization and eye-hand coordination skills correlate most highly with success.⁶ Other services typically using SUAS found “piloting” or airmanship skills to have low correlation with UAS operational success, and thus have used primarily or totally enlisted controllers. In contrast, the Air Force determined that because of the size of UAS and the need for them to operate alongside and within the same airspace as manned aircraft officers, rated pilots were required. The initial RPA pilots were drawn directly from trained pilot pools; therefore the first set of aeromedical standards applied to newly-accessed/directly-trained RPA pilots were those of traditional aircrew. Recently, however, the Air Force relaxed screening standards for RPA pilots to enable a wider aperture for accession. Comparison of populations and their success provides the opportunity for characterization of essential personality and intelligence qualities required for UAS operations.

According to a study done at the Air Force Research Laboratory on measures of intelligence, screened RPA pilots with no prior aircraft experience matched the abilities of pilots with aircraft experience. In fact, the small sample tested exceeded the experienced pilot population in measures of reaction time, visual reasoning, and general efficiency. Non-screened RPA pilots accessed directly from the general population differed from the screened operators in that they were notably poorer in the areas of reaction time, visual reasoning, information processing accuracy and executive reasoning. The non-screened group had a 50% attrition rate versus <10% among those screened during RPA pilot training. Thus, the psychological and intelligence qualities of successful Air Force RPA pilots appear to more closely match their aircraft pilot peers than the general Air Force population.⁴²

Sensor operators have been perceived as particularly vulnerable to task saturation and psychological challenges due to their work. Characteristics felt to be of significance in qualifying successful sensor operators are similar to those of pilots. Key indicators for success include visual perception, postural endurance, physical reliability, high cognitive aptitude in coordination, attention/vigilance, spatial processing and analysis, and higher than average reasoning and visual spatial awareness. Researchers have found personality traits such as ability to maintain motivation as critical to success.⁷³

In two recent evaluations MQ-1/9 sensor operators were found to have significant personality differences as compared to civilian peers. As might be expected of a highly demanding career field, the most successful operators tended to be the most able to compartmentalize, and who had the most drive/perseverance and success-oriented characteristics.¹⁶ Psychologically, sensor operators were found to be statistically more skeptical/cynical and unwilling to trust; tended to be aggressive, competitive and tended to make decisions based on logic rather than emotion. And thus, this population was found to be statistically less insightful to emotions but to maintain a higher degree of control of their emotions (compartmentalization) than civilians.²⁰

A potential, theoretical consideration for future operators of the DCGS and UAS may be psychological make-up and motivations of the youthful recruits to the field. Current recruiting efforts focus on networked, video-gaming youth of today. This may be counterproductive as large-scale studies of high-utilization video game players strongly suggest a unique if not characteristic personality makeup that includes a tendency toward depersonalization and violence,^{3,37,55,53} impaired attentiveness and sustained vigilance,⁸⁷ and impaired interpersonal skills.^{23, 30} These individuals may, however, be culturally more able to develop meaningful cyber relationships and effective networking communities for personal support,³³ and appear more likely to be able to attend to multiple stimuli simultaneously.⁶²

OPERATIONAL STRESS AND POST-TRAUMATIC STRESS DISORDER

The issue of PTSD has become such a national concern related to combat in general that it has been the subject of considerable interest among political and medical leadership alike. In 2000 the definition of PTSD was redefined in the widely accepted Diagnostic and Statistical Manual IV² and has remained static since. Diagnostic criteria for PTSD include a history of exposure to a traumatic event meeting two criteria, and symptoms from each of three symptom clusters: intrusive recollections, avoidant/numbing symptoms, and hyper-arousal symptoms. Symptoms must have lasted more than a month, and the symptoms must cause clinically significant distress or impairment in social, occupational, or other important areas of functioning.

PTSD has become a signature illness of the past decades of wars, is one of the VA medical system's most common diagnoses,¹⁰² and is a focus of research and specific focused therapy. Although commonly associated with combat, PTSD is not a military-specific phenomenon. Anyone who has been in a mishap, witnessed one, or for that matter has watched a tragedy (e.g. the World Trade Center disaster) could develop PTSD as a result of the witnessed trauma.

There are several concerns about PTSD among UAS crews, especially sensor operators. Among the theoretical risks for PTSD described in the lay press is the ability and necessity for UAS teams to assess

the results of their attacks. One member relayed their experiences thus: “in a fighter jet you....drop a 500-lb bomb and then fly away, you don’t see what happens...but when a predator fires a missile you watch it all the way to impact, and ...it’s very vivid; it’s right there and personal. So it does stay in people’s minds for a long time.”⁵⁶ Author P.W. Singer asserts that “drone pilots actually have higher levels of PTSD...than those who are actually physically serving in the combat zone.”³⁸ As a result of these sensational claims and the very real and very different environment of the RPA pilot or sensor operator it is important to look at the present situation in an effort to anticipate what could be an emerging threat.

It is clear that telewarriors have a high level of clinically significant stress. Among telewarriors as defined by their unit, the utilization of mental health clinic services was nearly twice that of maintenance squadrons on the same installation.²² Similarly, subjective measures of operational stress were more than twice as high as that of a control group among all types of telewarriors, ranging from 36-48%.¹⁵ Among installation telewarriors mentioned above who reported for mental health services, nearly half had positive PTSD questionnaires as opposed to 10% or less in the same installation’s maintenance squadron. “Some of our members experience a very personal sense of guilt...guilt from not being able to do anything to prevent the loss they observed” stated one ISR leader who also reflected on members’ inability to access counseling services due to lack of Mental Health provider clearance or access to services.⁴⁴ In spite of this, it appears that PTSD itself may actually be a relatively rare phenomenon among telewarriors.

In a recent detailed look at telewarriors, Chappelle and McDonald have identified the causes of stress among telewarriors.¹⁴ Their findings, specific to PTSD and using very specific PTSD survey tools, are instructional. They found that among both RPA pilots and RPA sensor operators the overall incidence of PTSD was 4% for active duty and half that for ANG/Reserve crews. Intelligence analysts and mission intelligence coordinators likewise had a 3% prevalence rate. For comparison, the non-combatant surveillance-only RPA and non-ISR control groups had a 1-2% prevalence rate, all of which are consistent with or below the general civilian population reported prevalence rates. They are also consistent with or less than reported rates of PTSD among Desert Storm veterans (as high as 5-7%⁷⁶ and as low as 2.1%).²⁹ Returning OIF/OEF soldiers have reported 12-17% PTSD prevalence rates using this tool.⁸⁵ Apparent outliers were Global Hawk sensor operators who were unique in having deployed into the kinetic combat operations theater, potentially reflecting a high correlation of the perception of personal risk with subsequent PTSD. Screening using methodologies such as those in this recent study are much more sensitive than self reporting. Thus, they may actually over-estimate the prevalence of PTSD relative to self-reported or mental health care-seeking samples.⁹⁹ They are, however, generally consistent with current and past conflicts.

The very high rates of stress, but low incidence of PTSD may reflect the cross-over between PTSD and fatigue. Among the most common symptoms of PTSD are short-term sleep disturbance and anxiety.⁹⁹ Some have reported that much of what has been attributed to PTSD following extended deployments is actually more attributable to fatigue than combat.³⁶ Certainly the 24/7/365 combat environment of the telewarrior would qualify as an “extended deployment.” On-site interviews and detailed studies seem to support the theory that the psychological and emotional issues of today’s telewarriors seem to be

more related to fatigue, shift work and isolation than to combat experiences, and that PTSD is actually a rare finding among telewarriors.

Sources of operational stress are plentiful, but may be correlated most highly with fatigue and shift work. The continuous battle rhythm has been discussed above and is a recurrent theme in several sections of this paper. Indeed, there seems to be a strong correlation between hours worked per week and the incidence of “clinical distress” as defined by objective measures in all telewarriors.¹⁵ Moreover, certain cultural and personality traits may make individuals more susceptible to trauma. Individuals who feel an integral part of a larger team or unit, especially with high morale and leadership direction and who have control of their fate are more resistant to combat related stress than those who are new to a unit or who feel un-empowered or lack control. Though sensor operators and analysts frequently have to directly view the products of their work, a more common complaint among analysts is that they have too little or no feedback on the success or failure of their work.⁶⁵

The future risks of PTSD as a diagnosis are difficult to assess. In the near term many of today’s youth are actually self-inoculating for video horrors and may actually be quite resistant to personalization of telewarfare,³ as increased exposure seems to dehumanize victims seen on video or images.³⁶ However, as distal environments become more immersive, the likelihood of individual trauma among telewarriors may increase.

Non-psychologists have ample opportunity to recognize and evaluate stress and stress-related illness in the primary care environment. Workers who have stressful work environments are more likely to have heightened inflammatory responses⁷⁴ and subsequent physical complaints as manifestations of their stress.⁴⁷ Due to high levels of perceived or real barriers to mental health services,⁴⁵ the primary care physician may commonly expect to see stress manifest itself in non-psychological primary care presentations.

MITIGATION STRATEGIES

Prevention:

Stress Inoculation: A large body of literature suggests the value of stress inoculation in the prevention of PTSD,⁵ driving combat preparedness, training, and desensitization therapies used throughout the DoD today. The Army’s comprehensive soldier fitness initiative, based on five dimensions of health (physical, social, emotional, spiritual and family) addresses development of resilience in a proactive fashion.¹³ Though programmatically geared toward soldiers in a kinetic battleground, similar programmatic approaches to prevention could have application to the telewarrior. Partnering with leadership, the AFMS should consider developing specific training for telewarriors and insertion of that training strategically during each phase of formal initial and recurrency training.

In some studies 90-95% of military members seek some medical care each year, usually in a primary care clinical environment. Recognition and treatment of “post-war” stresses in the primary care arena is more effective and less intrusive than large scale screening and selection of individuals who have already developed pathologic responses such as PTSD.²⁸ Thus, effective services at the primary care level may enhance early identification of trauma and prevention of PTSD.

Leader Training: It is likely many non-medical leaders are not trained to recognize and manage normal and abnormal responses to shock and stress. The AFMS could partner with leadership to develop psychological first responder and higher level of counseling expertise among ISR team/mid-level leaders aimed at providing immediate intervention and recognizing pathology, versus normal combat stress reactions within the compartmented operation. Curriculum could be included in aircrew physiology training and could form the basis for additional levels of training.

Policy and Guidance: Access to mental health and other counseling services is sharply restricted based on security clearance and access guidance. Moreover, in the absence of specific guidance, members typically assume that a visit to a psychologist will threaten their security clearance and career. Policy, guidance and community norms may have a profound effect on behavior, as suggested by differential prevalence of secretive and abnormal behaviors.

The Personnel Reliability Program (PRP) is a security program guided by almost totally proscriptive guidance; any abnormality is cause for immediate disqualification. Among the PRP community, prevalence of suicide is elevated.¹⁰² For SCI workers, which typically include telewarriors, there is little guidance and a cloak of secrecy. The rate of spousal abuse and interpersonal conflict seems to be more prevalent among these workers.¹⁰² Many telewarriors are both PRP and SCI, and thus may fall within both categories.¹¹ There is no intent to state or imply a cause-and-effect relationship, but guidance developed should permit discussion and intervention without violating codes of secrecy or creating the spectre of certain career impact.

MITIGATION STRATEGIES

The AFMS should work toward development of TS/SCI and long-duration warfare specific guidance with security operations leaders to develop meaningful guidance for management of adjustment disorders and stress reactions within the structure of security clearances and operations, and develop valid practice guidelines for return to duties. While effective practice guidelines that include scientifically validated procedures for return to duties are standard practice, there is essentially no guidance for management of ill or injured telewarriors. There is no defined “waiver process,” nor is there standardized evaluation and follow-up guidance. Aside from the sometimes capricious Disability Evaluation System and a vague security clearance process, there is no written process to qualify or disqualify an Airman for the career field. In a manner similar to development of cardiac or head injury standards for aviators, scientifically-validated waiver methodology for telewarriors represents a gap in policy and medical capability. The AFMS should also consider the establishment of secure clinical/counseling facilities, such as on-site or regionally-centered satellite clinics within the DCGS hub facilities.

Optimization:

Team Hardening: Effective kinetic military training has been a challenge throughout history, and in fact the most highly trained teams have become legendary for their high morale. It has often been reported that experienced and “battle-hardened” forces such as these have typically low rates of psychiatric combat losses despite intense combat. In a manner similar to Survival Evasion and Resistance training,

the AFMS could partner with leadership to develop challenging but psychiatrically safe maximal team challenges for telewarriors.

Selection: There are clearly personality and social factors that affect an individual's resilience to combat stress and the personalization that leads to PTSD. Many of those are known, but no active method to reliably assess an individual's readiness or capability to handle stress is commonly used as a selection tool. The AFMS has a role in designing and advocating for selection standards that maximize resilience in the unique telewarfare environment.

Training: As with aviation, a cadre of specifically trained primary care physicians, extenders, technicians and behaviorists could be established to support this unique and growing tip-of-the-spear mission. The recommendation of the assembled panel was for supporting installations to have one or more specifically trained, uniquely identified, physician(s) attached to the ISR unit by name (similar to a Squadron Medical Element). The group furthermore preferred a "second term" flight surgeon as the substrate for the initial cadre for support. In order to include all combatant telewarriors in such an operational support clinic, we suggest establishing a multidisciplinary, potentially flight surgeon-led, clinic of sufficient stability to permit specific training and security clearances for serving medical personnel. Thus the construct of such a clinical environment could include a mix of specifically trained operational physician/flight surgeon(s) and a mix of military or civilian family physicians and supporting behaviorists. Essential sub elements of this include:

- TS/SCI clearance for all members of the team
- Specific focused training on missions supported, potentially including RPA School (flight surgeons), and some analyst training (non-flight surgeons)
- Specific career path in support of telewarfare operations once established

Diagnosis/Treatment and Rehabilitation

Identification of Cases: Assignment of a personal psychologist to each telewarrior is not necessary, but the "go to the mental health clinic" paradigm may be overly restrictive. A recurring theme in after-action reports from both active duty, ANG and Reserve units reflect concern regarding access and clearance. Optimally the AFMS should consider specific training for empowered primary care physicians and leaders to identify those most at risk, and intervene early. To do so will require specific healthcare providers to have the access and security clearances to visit and discuss issues of concern within secure confines, and to assist with early intervention.

Diagnosis and Treatment of Combat Stress and PTSD: The principles of treatment for telewarriors are likely to be no different than for battlefield combatants (e.g. "3 hots and a cot".) Thus it is counterproductive to threaten a security clearance or remove access for extended periods due to a mental health visit. It is important that the AFMS and security officials develop written guidance and methodology to return telewarriors to work as soon as feasible. Use of anonymous virtual services such as the DoD's National Center for Telehealth and Technology (<http://t2health.org>) efforts or more personally identifiable telecounseling venues may be useful among digitally savvy and connected warriors if fears of threat to their clearances could be mitigated. Partnership with the chaplaincy has

proven to be highly successful as well. In units with specially cleared chaplains within the workplace, members have anecdotally found considerable solace in the confidentiality provided by the chaplaincy.

SPECIFIC ISSUES WITH ANG:

ANG EIP units often have little or no access to military healthcare between employment periods. Yet, the symptoms of true PTSD by definition manifest 30 or more days after the event. The AFMS must address the ongoing medical care of EIP and other combat Guardsmen during their non-Title 10 periods, and should work with state officials to establish properly cleared, specifically trained telewarrior support capabilities.

SOCIAL ISOLATION

Individuals who are detached or isolated from peers, friends or family are at much higher risk of psychological distress and suicide.^{19, 35, 52, 78, 83} The psychological health benefits of extracurricular activities and strong community bonding are abundantly demonstrated in the near-linear correlation between higher non-work activity level and better sleep, as well as recovery between work periods and lower chronic maladaptive symptoms.¹⁰⁰ Those workers who begin to give up social activities in favor of work are at much higher risk of work-related stress and thus lost work time. Disruption in this balance measured in work-life balance, personal life impact, stress, financial concerns and job-employee-company characteristics have been found to correlate highly with “presenteeism” and “absenteeism” (both counterproductive work practices.) In many industries, including the USAF, data useful to identify at-risk individuals is available but not routinely analyzed.¹

Among telewarriors, shift work, continuous 24/7 operations, and a secure secretive environment and culture are the rule. The installation’s “combined club” is hardly an acceptable venue for intelligence analysts to celebrate or mourn the day’s operation. Even spouses and families are not let into the secret world of the telewarrior. Thus, the telewarrior is in many ways isolated from even his own family and friends and has little venue to seek social support. These factors may contribute to Dr. Chappelle’s findings that among MQ1/9 operators nearly half report worsening relations with their own family.¹⁴

Among Sensitive Compartmented Information (SCI) populations that typically characterize telewarriors, partner abuse is more commonly reported than among other groups. Similarly, at mental health clinic intake, SCI personnel are significantly more emotionally ill than non-SCI individuals, suggesting a delay in seeking care.¹¹ We can surmise that these could be manifestations of compartmentalization and “pent-up” stress that can’t even be shared with families. Whereas in most flying units families have an active social network and are intimately connected to the mission, telewarrior families are excluded by design. Thus the commonly yelled argument “*you just don’t understand...*” may actually be literal rather than metaphorical for the telewarrior.

Families play an important role in the development and maintenance of resilience. Overall greater involvement of families in the missions and professional life of the warrior are effective means of protecting the warrior and the families from the stresses of warfare and extended separation. Specific programmatic approaches to enhancing family resilience have demonstrated promise in reducing psychological and behavioral impacts of deployment and may bear consideration for the telewarrior who is commuting to the war zone daily.⁸¹

Shift work is in itself isolating. Although many telewarriors attempt to keep some form of family and social life, continuous rotating schedules make it nearly impossible to reliably participate in sports, church, family or community events. Telewarriors that work hard to balance those factors often do so at the expense of good sleep/shift hygiene, potentially worsening fatigue already inherent in the continued shift-work operations.

Among intelligence operators the workplace is culturally designed to be professionally isolating, including the darkened workspaces. The intelligence culture features a high degree of individualism and less partnering and crew resource management style activity than some other professions. It has been likened in some ways to medicine, where individual practitioners talk, but are loath to develop trusting relationships and communicate freely about their professional issues.⁵⁰ Within the DCGS a worldwide “chat” environment may be the best professional support a telewarrior has, and recently, like in medicine, a more teaming environment has emerged. Although depersonalized, if social context is permitted, the networked virtual environment has been found to be an effective social support structure for some.⁵⁸ However, “strictly business” rules and varying teams can limit its usefulness as a support capability. The secure virtual environment could offer opportunities for supporting medical teams.

MITIGATION STRATEGIES

Prevention:

As with shift-work modification, the AFMS has a role in helping leaders create strategies to permit quality social time and develop a culture of open discussion among telewarriors. This can and should include working with leaders to develop methods to involve families in the workplace and mission. Strategies to involve medical providers in the preventive care of potentially isolated workforce are crucial. One innovative method to be considered may include leveraging communications technology to permit direct linkage of medical personnel and telewarriors virtually in a secure environment

Telemedicine for Telewarriors: The “flight line clinic” concept can be further expanded to include wide use of telehealthcare and extenders in the workplace. Especially in ANG facilities, it is impractical, even on a combat footing, to establish 24/7 MTF-like services to support operations. However, it may be feasible to utilize Independent Duty Medical Technicians (IDMTs), Physician Assistants (PAs) or Nurse Practitioners (NPs) to provide on-site services with reach-back to a regional-supporting telewarfare specialist. The highly digital globally networked DCGS could be an ideal environment to establish a networked medical operation that provides on-site workplace support at low risk and low cost. Working with ISR leadership, reach-back medical capability could be achieved by establishing regional telewarfare satellite clinical capabilities within the secure confines of the physical structures of the largest AD hubs, wherein the supporting medical staff could confer with forward extenders and even offer counseling in the virtual environment. The DoD’s National Center for Technology and Telehealth show promise, and could be a foundation for telehealth relationships behind the security barriers.

The nearest analogue to on-site support has been successful insertion of chaplains into the DCGS environment. Having “cleared” chaplains on site has been cited as a highly successful model for management of stress and personal conflict.⁴⁴ Further partnership with the chaplaincy to develop

integrated training that includes additional familiarization with shift work and combat-related problems management and inclusion of the chaplain into the telehealth system could lead to an effective extender-type relationship in some cases.

Diagnosis:

Data may exist in a number of databases to identify those most at risk of pathologic isolation and its stress reactions. The AFMS should leverage questionnaire, health and survey data routinely collected and “eyes on target” approaches to proactively identify those individuals of concern.

IMAGE DISSONANCE

The three unique populations of today’s RPA pilots offer an interesting glimpse of image dissonance. With the exception of directly-accessed RPA pilots today, all Air Force Large and Medium RPA pilots joined the Air Force and devoted thousands of hours of their lives to place air between them and earth – to fly. Their personal image, social norms and behavioral patterns were formulated on the premise that they are pilots. Having “been placed” in a UAS unit for many is a dysphoric experience, as they are permitted to continue to be valuable members of the team, but in the eyes of many in their own community, and perhaps to themselves, they are second-class citizens.¹² One panel member reflected that the pilots referred to Creech AFB as the “leper colony” both due to its remoteness and due to the “outcast” feeling of the pilots. Many were promised they would be placed back into major weapon systems after a brief detour in RPAs, but operational needs have not permitted their return to actual flying. Some fear their skills may attrit beyond reasonable recovery.

Similarly, many analysts cross-train from airborne career fields to DCGS roles. Knowledgeable panelists reflected that in their experience airborne intelligence assets identify themselves more as aviators than they do analysts. Thus “relegation” to ground-based operations and loss of the aviation-centered culture could be a factor for some of them as well.

SENSORY DEPRIVATION/BOREDOM

A commonly stated problem for telewarriors was boredom, and possibly even sensory deprivation. In fact traditional warfare has long been characterized as long periods of boredom punctuated by moments of sheer terror. Realistically today’s telewarrior is not engaged in a battle all of the time, or probably even a majority of the time. For many their day may be primarily surveillance of a static objects or “listening to static,” in the case of a linguist. Objectively, individuals placed in a low stimulus environment rapidly develop measureable difficulty concentrating and a loss of motivation that persists even after removed from the environment.⁷⁵

Boredom in the telewarrior environment, though, brings with it the need for continued high vigilance and ability to snap to a quick decision based on information gleaned from a secondary source (aircraft data, etc.). Absent the sympathetic stimulation of being potentially under fire, combatants in the virtual world may not have the prompts for vigilance that their “boots on the ground” counterparts do. This can be especially problematic for long-duration UAS operations.

The risk of lapses in vigilance in the telewarfare environment is significant. Studies suggest maximum duration of sustained effective vigilance is about four hours. However, to relieve telewarriors for

frequent useful breaks requires additional staff and creates the need for hand-off of controls (especially in UAS operations), which creates risk. As a result, telewarriors may find themselves in a high vigilance role for extended durations even while fatigued or bored.⁸⁹

MITIGATION STRATEGIES

Optimization:

Selection of Telewarriors: Rudimentary biomarkers for fatigue have been developed, and there is an apparent genetic basis for fatigue resilience and maintenance of vigilance. The AFMS should consider work to develop testing methodology and/or biomarkers for vigilance, alertness and fatigue resistance.¹⁰²

Vigilance Tracking: The AFMS, working with developmental agencies, has skills to permit development and optimization of vigilance tracking and alerting technologies. Such technology is already used widely in the automotive industry and seems a logical fit in the telewarrior workplace.

BURNOUT/ COMBAT FATIGUE

A major contemporary issue of telewarfare is “burnout”, which can be viewed primarily as a manifestation of several factors, including workplace demands, cumulative fatigue, as well as social and professional isolation. It may not be in and of itself pathologic. However, as long as telewarfare systems rely on 24/7/365 surge operations, compounded by the issues above, it seems likely that this will be a long-term issue.

Among those surveyed, 53% of active duty and 52% of ANG crews attributed their symptoms of fatigue and “burnout” to shift work, with a small minority citing PTSD or exposure to combat as the source of stress. Thus the contemporary situation is that “burnout” is probably the single highest contributor to combat stress responses among telewarriors. Nearly a third of active-duty predator pilots, DCGS analysts, and Global Hawk sensor operators reported burnout in one study. Across the board ANG crews had much lower levels of burnout and lower levels of occupational stress.⁷³

Some of this disparity may reflect the nature and maturity of ANG DCGS and UAS crews. In general ANG operators have been re-roled from flying units, and as is often the case, are older and more seasoned. ANG shift work practices in one state differed sharply from those of their AD counterparts by using more traditional 8-hour shifts and more reconstitution time, which could contribute to lower rates of stress. Furthermore, a stable, supportive unit structure may provide stability lacking in some ADAF DCGS activities. However, as the senior former pilots and flying crew members depart, introduction of a younger workforce into the ANG milieu could reduce some of this current difference.⁶⁵

SUPPORT FOR THREATS AT HOME/FAMILIES UNDER ATTACK

Telewarriors are combatants. Political leadership has made it clear in public forums that in today’s kinetic environment combatants are targetable and those who harbor combatants may themselves be at risk. Although there is relative security in physically placing telewarriors far behind the kinetic front line there can be little long-term comfort in their security from virtual or actual attack. Moreover, a high percentage of these combatants go home at night to their families, not a secure barracks.

It seems logical, therefore, that the DoD should have legitimate concerns for the security of telewarfare combatants. Telewarriors known to the adversary could be subject to individually targeted cyber attack capable of emotionally, financially or administratively crippling them. Moreover, especially among ANG members whose duties have been widely publicized in their communities, their homes and their families are publically known, making it is entirely possible for families to be threatened along with the active duty member. The intelligence community has long kept identities and roles of operatives a closely guarded secret, and US Code Title 50 provides broad authority to do so. However, today's telewarriors are not all covered under Title 50 and have actually often been made into a media spectacle in our recruiting zeal and YouTube world.

The AFMS role is anticipatory. The question of families in CONUS becoming collateral victims may well be a question of "when" rather than "if." The AFMS should consider a family support model that includes ANG and AFRC telewarrior families under threat. The Israeli Defense Force considers them such high value targets that some families are required to be housed on installations. The Air Force may have to consider similar arrangements or other protective guidance, and if so, AFMS support would need to be tailored to the same.

NEXT STEPS - DOTMLPF

Should the AFMS determine by policy that telewarriors and their battlespace should be prioritized for specific research, focused selection, prevention and clinical services, the following DOTMLPF discussion may serve as a useful starting point. Obviously, specific resourcing models and milestones must be established and considerable strategic and near-term resourcing planning required that exceed the focus of this manuscript.

The specific construct proposed in this document includes dedicated clinical and preventive services: hub clinics at major ISR centers designed to be manned 24/7 and to have secure telemedicine connectivity with "forward" DCGS sites in real time. "Forward" sites manned by extenders or Total Force providers would have instant reach-back to behavioral health or aeromedical/clinical specialists at the hub, who have sufficient clearance.

Additionally, we propose selection and optimization research specific to emerging environments of telewarriors, including human interfaces with robotics, AI and global-networked combat operations. The AFMS must clearly identify roles and responsibilities in the selection of Airmen, and specifically in the selection of telewarriors. Given that policy directives would guide prioritization of research into these areas, out-years funding must be set aside to do so. This should be worked alongside SAF/AQ and AF/A1 entities to ensure lack of redundancy and coordinated leadership.

Doctrine

Embracing the telewarfare battlespace as an AFMS priority requires the establishment of policy, specific direction, priorities and vectors. Policy must provide sufficient latitude for research and innovation to assess emerging environments and support the warrior. Doctrine based on best practices will follow

policy by several years because no such policy or normative practices currently exist. Thus, initial policy will be required to set in motion a chain of events to enter this arena:

- Establish AFMS roles, direction, boundaries and resources for telewarrior prevention and optimization research that includes development of scientifically-based, reproducible selection standards to prevent illness and injury and optimize performance.
- Working with SAF/AQ and AF/A1, clearly define AFMS role and responsibilities in selection and optimization research.
- Establish expectations for steady-state clinical support of telewarrior operations, including on-site and reach-back capabilities, focused clinics and minimum provider training.
- Establish policy for alignment of telewarrior clinics, forward satellites and physical location of main-base activities (MTF or within secure ISR group confines.)
- Establish policy for MTF 24/7 support of telecombat operations, including expectations for deployed-in-place medical teams as appropriate.
- Develop policy for the support of ANG EIP members both on current Title 10 orders and post-deployment to ensure continuity of care and access to qualified, cleared medical teams. Forward, embedded medical extenders could provide valuable access for these members.
- Develop policy for “deployed or employed in place” provider teams of primary care and behaviorists. They should be segregated administratively and functionally from productivity measures and should be provided sufficient stability to support extended duration operations 24/7 as though deployed to any other AOR. Using three globally-distributed AFMS-staffed ISR clinic nodes, it should be possible to provide 24/7 virtual medical operations without requiring 24/7 clinical operations to do so.

Organization

Full implementation of these recommendations would require expansion of the scope and purview of the operational medicine/aerospace medicine activities of several MTFs. It would add not only responsibility and specific training requirements, but will also drive research and organizational realignments:

- Establish telewarrior health activity either within expanded flight medicine clinic (already tasked for UAS personnel support) or at ISR-based secure locations as free-standing entities.
- Organizationally align supporting personnel, including forward-based extenders and dedicated behaviorists within the resulting construct.
- Organize and staff consultative and research activity for telewarriors. Options include leveraging existing 711 HPW assets or establishing an activity de novo at a major ISR center.

Training

The expert panel assembled to create these recommendations and those who authored the scientific literature on the subject were 100% self-taught. With the exception of a brief introduction of material specific to UAS operator and sensor operator health and administrative management in the Aerospace Medicine Primary, and a slightly more expansive discussion in the Residency in Aerospace Medicine,

there is no focused training on the subject of telewarfare or medical support and optimization of the telewarrior. We recommend consideration of formal training and a subsequent career pathway for supporting medics:

- Develop specific training course for supporting primary care physicians and staff that includes diagnosis and management of disorders described above.
- Secure mission training for key supporting medical personnel sufficient to permit human factors analysis and mission awareness (e.g. UAS training for flight surgeons, intel or sensor operator training for supporting physicians, psychologists, extenders).
- Develop specific training for operational psychologists.

Materiel

Materiel requirements will be determined by the clinical support construct chosen. If satellite or secure clinics are desired, a materiel tail will follow. Likewise, should a consultation and research activity outside existing organizations be desired, materiel solutions will be needed. Should either of the latter solutions be chosen, agreements with the host unit must be brokered for space and facility support. A key materiel solution, however, is a secure telemedicine capability of sufficient robustness to provide for DCGS-wide health discussions while ensuring HIPAA and clinical standards of personal privacy.

Leadership

The most likely organizational construct will be to initially align these organizations within the aerospace medicine activity. Thus leadership can remain in its current configuration.

Manpower

Always the “long pole in the tent,” manpower for such innovation will be problematic and must necessarily be non-traditional. Support of telewarriors is 24/7 and by definition at “home.” Thus it is counterproductive to formulate a plan for their support using assets that deploy frequently. Moreover, a very large percentage of today’s telewarriors are Total Force members not geographically near ADAF MTFs or other support. Therefore, manpower solutions for telewarrior support should either include sufficient civilian, Total Force and non-deploying staff or should, by policy, consider supporting medical providers deployed in place. A percentage of the resources to support telewarriors already exists in the MTF, however, it is likely that insufficient providers and behaviorists exist to support the clinical needs of the Population at Risk (PAR) *and* support mission needs on site. Utilizing non-physician extenders, enlisted medical personnel, and civilian or contract support could extend the range of reach-back clinics.

Providers selected to support these missions must have adequate clearance to engage in the mission and work with telewarriors in a non-threatening fashion. These providers/extenders should be specifically trained and identified for this duty and expected to remain in place or within the career field for several years. Other cadre for inclusion in an ISR human resources team hub would likely include properly cleared behaviorists, and could include the cleared chaplain and enlisted support staff.

Selection or use of second-term flight surgeons will require a policy discussion geared toward expanding the flight medicine pipeline and splitting out a select group of flight surgeons or occupational medicine (potentially not flight qualified) providers specifically for telewarfare support.

- Establish a PAR-based manpower model for main-base 24/7 primary care and behavioral medicine support at key telewarrior sites.
- Establish a care station support model utilizing extenders for smaller, “forward” sites, including Total Force contributions.
- Develop a cadre of specifically identified, TS/SCI-cleared, career providers and behaviorists to support telewarfare operations.
- Consider specific selection of second-term flight surgeons, occupational medicine, primary care and behavioral medicine ADAF, civilians and contractors for initial cadre.
- Establish administrative rule sets, including AFSC or Suffix to enable career field management to ensure continuity within the telewarfare communities and utilization to support combat operations therein.

Facilities

Facility requirements will flow from the chosen course of action. Should the AFMS choose to pursue on-site, secure clinics and aid stations, a chain of events including negotiations for real estate will follow. Near-term solutions are more likely to be MTF-based internal reorganizations, though this will not necessarily provide for a secure environment. Long-term solutions may, however, include a series of “forward”-based “tele-flightline” clinics and main-base clinics in ISR hubs. Three ISR hubs could be placed strategically around the globe to provide 24/7 telehealth support, but without requiring 24/7 staffing in each clinic.

- Identify and develop ISR – telewarfare global clinical hubs designed to be continuously staffed with telewarfare medical personnel capable of providing continuous reach-back.
- Working with ISR leaders and Total Force enterprises, develop, equip and resource small limited service facilities in “forward” units with 24/7 reach-back to hub facilities.

FUTURE DIRECTIONS:

The next two decades will see increasing reliance on AI and remote non-human activities. Keeping a human in the loop will require high levels of *distrust* of the system to truly keep the human involved. It seems likely though that systems will be designed to engender a high level of *trust*. All systems to date have been designed in such a fashion that the human actually has less and less control (e.g. computer software upgrades.) Moreover, AI systems “think” and provide objective decision support much more rapidly than humans, and thus will have to be down-regulated to wait for the human. It seems likely, then, that humans will be a transient feature “in the system” as AI systems will be so fast and so reliable that humans will have little choice but to “consent” nearly all the time.

The implications of truly autonomous AI systems are well beyond the scope of this paper, but call to question the extended future of telewarfare. Baron Von Clausewitz described the immutable nature of

war as death and destruction, suggesting that only when the pain becomes too great will wars end. Critics of robotic or automated warfare point at today's stand-off warfare ("drone attacks") to assert that we have already become too cavalier and willing to wage war when nothing personal is at stake. Indeed, it is possible that we could be nearing a point when "war" could be between technological powers using only attacks on banking/manufacturing/communications cyberspace.

Cyber warfare is another emerging battlefield with similar stresses in some domains, and has direct parallel activities within or alongside almost all traditional Air Force roles.⁹⁰ However, employment of cyber warriors typically has little or no direct exposure to the kinetic battlefield³² and is guided by overarching employment methodologies with stresses unique to that battlespace.⁸ Thus, in a war fought only in cyberspace or between automated systems, war would no longer rely on the immutable constants.⁶⁶

For any of this to happen, though, the role of humans and machines must reverse, and with that role reversal the human interface must adapt. Throughout history and to present day, engineers have always designed systems intended to be operated by humans. Seats that fit the pilot, joysticks that are intuitive, displays that man can read are types of systems design we generally accept as needed for effective human operation. Similar to automated aircraft that no longer need a custom fit pilot seat and oxygen supply, AI systems will require little "operator interface". The human is likely to be presented with very little, highly filtered information, and thus will have to adapt to a trust-based relationship with the AI system. Whereas the operator of today's battlefield robot scans the battlefield through robot lenses, puts a cursor on a target, and remotely presses a "fire" button; tomorrow's soldier may get a text picture that says "found a bad guy – can I kill it? Press or say 1 to kill, 2 to cancel" or more likely just a picture text that says "look what I killed." User responses will likely be to some degree generational. As noted previously, experimentally there are three subsets of individuals based on their acceptance of AI ("consenters", "dissenters", and "indecisives.")^{21,25} Many assume that video game players would make good UAS operators; however, when studied, in general high-time video game users perform poorly on tests of cognition, but better on tasks of tracking, hand-eye coordination and simulated landing tasks.⁶⁴ They are also more likely to be in the "consenter" population which would suggest they are more likely to "trust" AI systems and to consent without question to AI decisions than traditional pilots.

Much of the research in the US regarding human performance in UAS has been performed in civilian universities under DoD or private industry sponsorship. This trend continues to grow though an overall structured architecture to assimilate knowledge and guide development is elusive. Even individual units have developed relationships with local universities aimed at more rapidly developing technology and training solutions.⁹⁵

The AFMS role is to understand this fundamental shift and to work within the Human Systems Engineering community to develop systems that can reliably communicate risk to humans for reliable decision making. Furthermore, future psychologists and primary care physicians must understand the work environment well enough to recognize and discuss reactions to errors of omission ("I should've stopped it") and the psychological issues of loss of control inherent in such an environment.

SUMMARY

This paper specifically focused on the individuals engaged in telewarfare, and the tools and workplaces that constitute the modern and future battlespace. Considerations of cyber warfare and cyberspace, space and missile operations and other remote combatant environments were beyond the scope of this document.

An occupational analysis of risks, mitigation strategies and barriers was assembled using available open source literature and a panel of select experts. This led to the development of broad strategic suggestions designed to form a foundation for future support of telewarfare operations.

Risks to telewarriors are mostly related to long-term extended combat operations and shift work fatigue, but initial reports of high levels of PTSD appear to be incorrect. Unique security requirements for telewarriors prevent effective clinical and preventive care in some areas. This is because relatively few medical personnel are properly cleared to enter the workplace or discuss workplace stresses. Telewarriors must maintain extended periods of vigilance despite long work hours, shift work and boredom. As systems become more automated, telewarriors are likely to be required to control multiple systems and consent to operations with incomplete data. Thus, trust relationships with AI technology may become a psychologically significant facet.

Specific selection and retention guidance reflecting current and future technology for telewarriors is a gap. Current selection methodology is based on standard measures of physical and intellectual ability. Early research into UAS operations has demonstrated specific capabilities required for successful operations, but no such research is known to exist for other telewarrior specialties. Selection methodology does not yet incorporate genetic, psychological or physiological markers of success for most telewarriors.

To address these known and emerging risks, a series of broad goals was introduced. These broad goals were grouped into three essential recommendations:

- 1) Establish specific research activities, develop selection and retention standards based on scientifically-based factors, and develop a waiver authority and process for telewarriors.
- 2) Develop compartmented, specially trained and specifically staffed/constructed care teams and facilities for global support of telewarriors using a hub and spoke construct.
- 3) Restructure supporting installation MTF for the continuous, priority support of combat operations and telewarriors.

The resulting hub and spoke support for telewarriors, specific research and selection methodology, and Total Force construct of specifically trained teams with sufficient access to directly support the mission should sound familiar. It is the 2011 reincarnation of early aeromedical support to aviators and similar support for astronauts. To begin discussion, a broad DOTMLPF construct is introduced and potential policy and execution vectors proposed.

The AFMS once again stands on the brink of a new chapter in warfare and technology. As it has in the past, technology, without defined standards or direction, is racing ahead. Humans are working diligently to leverage the technologies to their advantage, but often with little regard to health, safety or well being. As with aviation and space exploration, these new technologies are now and will continue to claim casualties without sound, well-disciplined science and a cadre of medical providers to help meld technology and medical art into optimized aeromedical – perhaps “tele-aeromedical” – knowledge.

The information in this paper is of a general nature and none is classified. The recommendations represent the opinions of the author and those of the supporting team of experts who helped construct it. It does not represent official policy of the Surgeon General or of the US Air Force.

APPENDIX A

TOOLS OF THE INDUSTRY

Driving forces behind the explosive growth of the ISR “industry” are the rapid advancement in robotics, and the rapid advances in computing and real-time secure communication capabilities. It is within this industry that AI is likely to find its earliest large-scale application.

UNMANNED AERIAL SYSTEMS (UAS) PAST, PRESENT, AND FUTURE

Unmanned Aerial Systems have been in use since WWII. Small WWII unmanned surveillance drones and later Vietnam-era larger reconnaissance drones were used in roles viewed as particularly “Dull, Dirty or Dangerous”. The US used unmanned B-17s and F6F’s to fly into “Dirty” radioactive clouds during the cold war, and drones have long been used for targeting and research purposes. During Vietnam, statistically the most dangerous aerial mission was the manned reconnaissance mission. Though unmanned vehicles such as the AQM-34 Firebee were utilized, they were incapable of real-time targeting and data collection, necessitating the continued use of manned platforms.

During the Balkan Wars the US first began to conduct large-scale combat operations directly from USAF main bases (Aviano, Whiteman.) These missions brought with them a new set of risks and human factors, not the least of which was fatigue from continuous operations and from long global missions. This, combined with the inherently dangerous need for continuous real-time surveillance, led to development of long-duration, real-time surveillance technology to minimize exposure and danger to aircrew. Satellites were thought to be the solution but the enormous expense, limited numbers and difficulty moving them for real-time targeting limited their tactical utility.⁶⁹ These limitations persisted through the first Persian Gulf conflict.

UAS have probably been the single most publicized area of rapid growth in the DoD. Over the past 6 years, USAF utilization has increased 1200%.^{4, 34} The ambitious 2005 Joint UAS roadmap outlined objectives for joint development and interoperability, and described a coordinated logistics and development process that would lead to unmanned aerial systems standardization. To date those objectives have not been fully achieved. However, the value of UAS in humanitarian responses,⁴⁰ border security, and even domestic law enforcement has been demonstrated, driving even more development and acquisition. The roadmap also lays out expectations for near real-time (<3 minutes) metadata-derived targeting capability. This latter expectation has largely been met and exceeded, but doing so now places Airmen that were once well-removed from the battlefield literally, though virtually, in the heat of battle.

In the USAF the vehicles are referred to as RPA. However, in DoD parlance the term UAS refers to the entire system within which the RPA resides. Both terms are used in this document. Current operational UAS in the USAF inventory are grouped into Small, Medium and Large categories based on their maximum gross weight at takeoff in a manner akin to manned aircraft classifications. This classification scheme is currently useful as well to describe the overarching construct in human support, but as technology and automation increase, they may become less predictive of human-machine interface

needs. Most of the Air Force vision for UAS described herein (unless otherwise noted) is derived from the USAF Unmanned Aircraft Systems Flight Plan 2009-2047.⁴¹

Small UAS (SUAS): As a general rule the SUAS are hand or catapult-launched, remote-controlled aircraft up to small private aircraft-sized systems that provide tactical, over-the-hill orbiting surveillance for tactical units. These types of aircraft are used in the Air Force for installation and perimeter security, and for reconnaissance for tactical operations primarily by security forces and special operations units. They are all currently designed to be operated by a single operator who also receives real-time video downloads and may also act as the sensor operator. The aircraft are manually launched and “landed,” but fly their orbits based on pre-assigned GPS coordinates, all by a single operator. Operators for these systems are typically enlisted members of the tactical unit who have received additional training in the operation of the systems or are contractors embedded in the tactical unit. The operators of SUAS typically maintain and troubleshoot the equipment without additional maintenance staff.

Medium UAS (MUAS): Medium UAS in the Air Force include the venerable RQ/MQ-1 Predator and its big brother the MQ-9 Reaper. These RPA’s use hardened airfields for launch and recovery similar to their piloted counterparts. An on-station pilot and crew safely guide the aircraft in through taxi, landing and take-off operations. These often forward-deployed crews are called the Launch and Recovery Element (LRE). The Predator system was acquired and pressed into service as an advanced technology demonstrator project. It did not, therefore, go through extensive development and testing that would have included human systems integration performance parameters. Thus first-generation Predators became legendary in aeromedical circles for poor human factors design, some of which continue to contribute to very high loss rates. Both AFMS and Line of the Air Force (LAF)-funded researchers have been active in the redesign and fielding of improved human interfaces for subsequent “blocks” of aircraft. Nonetheless, human factors (especially cognitive errors and technological environment – e.g. misinterpretation of data) remain by far the predominant cause (79%) of unmanned aircraft mishaps.⁹⁴

Similar MUAS have been fielded by all services and several militaries around the globe. Most are similar in crew requirements, depending on payload and systems. A two-man pilot and sensor operator team is typically employed for routine operations. In the USAF the LRE is collocated with and in Line of Sight (LOS) communication with the aircraft, and is typically forward deployed for launch and recovery operations. A second crew manages the aircraft during its surveillance orbits, typically from a CONUS installation (primarily Creech AFB at this time). There is a team of on-site mechanics to maintain and prepare the aircraft, and there is a team of “back enders” in aircrew parlance who direct the mission, analyze and process the data, and recommend solutions based on their data. Further discussion of these crew roles follows. Because of the long duration of these flights each “front end” crew is augmented to provide sufficient continuous round-the-clock coverage yielding a net of at least four crews per control team at each location.

Large UAS (LUAS): The only currently fielded LUAS in the Air Force are the RQ4A and RQ4B Global Hawk systems. These 737-sized turbofan-powered aircraft are capable of extremely long duration, high altitude continuous surveillance operations. These heavily laden platforms can acquire and transmit vast amounts of intelligence and reconnaissance information in real time to a wide variety of

users/analysts. Global Hawk operates from fixed airfields and requires an LRE at the airfield. The “front end” crew consists of a pilot in the LRE and a pilot, sensor operator and at least two other crewmen (communications technician and QC manager) back in CONUS in the Mission Control Element (MCE). Once airborne, most Global Hawk control is performed by MCE, primarily at Beale AFB. As with Predator, each station is manned 24/7.

FUTURE TECHNOLOGY DIRECTIONS:

The Air Force has charted a course that codifies the long-term strategy of the DoD toward increasingly autonomous systems and for increasing data capabilities that further push the boundaries on both extremes of size and capability.

SUAS Future: Among SUAS the trend will be smaller, lighter, more tactical systems designed to penetrate and disrupt operations or provide personal protection on a local scale. SUAS future scenarios could include heretofore UAS non-user communities, thus creating the likelihood of additional career fields becoming involved in their employment and operation. Nano/Micro UAS could become part of the deployed member’s personal equipment. If properly automated, potential applications are almost limitless and should not be limited to reconnaissance capability.

Man-portable UAS will achieve a greater tactical role, including an offensive capability over time. Potentially becoming a reusable stand-off weapon, the current role of pilot/sensor operator/maintainer will necessarily evolve. These are the airborne equivalents of the Army robotic weapons already fielded. Ground-based systems already fielded are not automated, and require operator/“shooters” to control them. Whether small tactical UAS will also require operators to employ weapons or whether they will be fully automated systems is not published at this time. A final group of SUAS are air-launched systems. These will likely be controlled by a single controller either aboard an aircraft or on the ground, and include recoverable and expendable assets. As with man-portable systems they are currently envisioned as either surveillance or offensive tools.

LUAS Future: Within the LUAS categories are contained some of the most revolutionary visioning from a human factors and weapon systems support standpoint. Near-term priorities are for enhanced high bandwidth, long-duration continuous surveillance that will build on the current Global Hawk-like platforms. However, within reach but not-yet-fielded Large UAS are envisioned that could eventually replace most, if not all, manned reconnaissance platforms (e.g. AWACS, JSTARS) potentially fundamentally changing entire career fields from Airborne assets to ground-based assets. In fact, the Air Force is fielding a large airship UAS platform for persistent surveillance capabilities within the coming year.

Furthermore, LUAS visioning plans for an out-years common unmanned heavy lift capability. Such a vehicle could fill tanker and transport roles (including aeromedical evacuation), further redefining the roles of aircrew. Obviously design of such a system is years in the future and if it is to perform a medical airlift role it will have to be carefully designed to accommodate such a mission. All services are similarly developing or planning to develop autonomous medical airlift capability. Such a mission using an autonomously operated aircraft highlights the requirements for Human Systems Integration to include

“trust” in the systems design and error analysis. There will likely be a time, possibly within the careers of some current young medics, when the *only* breathing aircrew on the aircraft will be medics.

Special Systems UAS: The Air Force’s UAS strategy also includes a number of long-term developmental projects for ultra-high altitude, hypersonic and special purpose vehicles. The AFMS significance of these technologies will most likely be from an occupational medicine and passenger safety standpoint should they evolve to passenger carrying capability. Additionally, of interest to medics is the active development of unmanned medical evacuation capabilities which range in concept from robotic rescuers on the ground,⁸⁴ unmanned helicopter type recovery systems,^{5, 96} and LUAS capable of aeromedical transport.⁸⁶

APPENDIX B

UAS AND ISR PERSONNEL

The breadth of the USAF ISR-type activity involves thousands of aircrew and non-aircrew who are routinely engaged in the collection and analysis of data. These are further defined as those who perform those tasks on-station and those who do so in a stand-off or reach-back role – e.g. telewarfare. Thus, pilots and “back end” crews of cryptolinguists, analysts and mission controllers flying in airborne command centers, AWACS or JSTARS would be considered to be on-site/deployed and thus not “telewarriors” for the purpose of this discussion. Similarly, U-2 missions and personnel do not meet the definition of telewarrior outlined above. However, these Airmen must be factored into this discussion, as it appears likely that many or all will eventually be reassigned to telewarrior roles as LUAS are developed that are capable of assuming the activities currently performed by on-station AWACS, JSTARS, U-2 and Airborne command post-type aircraft.

The USAF projects a net requirement for nearly 15,000 airmen specifically dedicated to the UAS-driven ISR mission, including 1600+ pilots, 1400+ sensor operators, 900 mission coordinators and 5000+ Processing, Analysis and Dissemination (PAD) airmen. Another 600 dedicated SUAS operators are also anticipated.⁴¹ This compares to the Air Force’s total inventory of ~11,000 rated officer aircrew and ~7000 enlisted aircrew, of whom over 2000 are dedicated to the “back end” ISR mission and thus logically could join the ranks of telewarriors in the next decades.⁴¹ These numbers do not include the large number of often forward-deployed contract, civilian and military maintainers in forward launch and recovery elements and at home station. A common fallacy is to assume that “unmanned” missions are less manpower intensive. In fact Predator “unmanned” missions require about 30 personnel to conduct the mission. Though many hours can be flown using a small number of pilots – the supporting resources are considerable. Currently the mix of personnel supporting Predator operations includes a large number of deployed contractors.²⁷

The net effect is that within the coming decades it is likely that the total number of telewarriors, including vehicle operators and analysts, will nearly match the total number of other rated aircrew including those in non-flying positions.⁹⁷

SUAS Operators: The USAF UAS Flight plan describes a notional career pathway for SUAS operators, and some work toward that end either as an AFSC or a “shred” has been pursued.⁴¹ Given that vision, approximately 600 are currently projected. However, at this time it appears conceptually that the SUAS operator will remain a tactical asset and will be present in the area of operations. Thus, though many of the concepts that follow may apply, SUAS operators are typically tactical combatants and will not be considered in the “Telewarrior” definition.

Thus, personnel who fulfill the definition of “telewarrior” outlined above typically fall within the Medium/Large UAS and ground-based ISR/DCGS missions. The disciplines primarily represent the RPA pilot, UAS Sensor operator, Mission Intelligence Coordinators, and the Intelligence Analysts (1NXXX) who make up the Processing, Analysis and Dissemination activity.

THE “FRONT ENDERS”

RPA Pilots: The Air Force plans to resource about 1500 RPA pilots in the near term. The RPA Pilot (18XXX) controls the RPA from a remote workstation. Workstations and RPA capabilities and thus pilot requirements vary widely. Predator and Reaper are fairly dependent on pilots with enough airman prowess to land it using a bore-sight camera view. Global Hawk, on the other hand, has auto take-off and land capability so the only time the Global Hawk pilot needs to touch the controls is when something goes wrong. This evolving role of piloting versus operating has inspired a decade of discussion and evolving decision on the training and career path for RPA pilots. Thus UAV pilots are currently a heterogeneous population of former mission pilots, UPT-only trained pilots, and directly accessed and trained RPA pilots without prior flying experience.

The RPA pilot career field 18XX was officially created in 2009 and currently only applies to medium and large UAS (Predator/Reaper and Global Hawk). The heterogeneity of this population is worth noting. The first and still majority of RPA pilots were prior fully mission-qualified aircraft pilots voluntarily or involuntarily assigned to UAS. Former combat fighter and airlift pilots tired of years of continuous deployments welcomed the time “at home”, but for others it was unwelcome. One author notes these pilots often respond to “what do you do?” inquiries with “I was a (F-16, C-5, etc.) pilot but I operate UAV’s now.”¹² The second group of pilot/operators earned their UAS wings straight out of Undergraduate Pilot Training with the promise that they would get their “operational system” later. This group trained and graduated from undergraduate pilot training having flown usually the T-6 and learned airmanship, formation flying, land and air navigation, propulsion systems, weather, etc. but found themselves at the height of their airmanship prowess in ground-based duties. There were reportedly not a great number of eager volunteers for UAV SUPT among the first few classes. Though some have transitioned back into traditional flying roles, most remain in the UAS role.

In 2009 the CSAF announced a direct track to become a RPA pilot and the Air Force subsequently coined the 18XX AFSC. This did not, however, end debate over the need for Airmanship skills previously thought to be so essential to the proper control of RPA’s. Several studies and evaluations have attempted to determine the essential skills required for and correlated with success as a UAS operator, and work is ongoing.⁴⁹ Although many of those studies are as yet unpublished or codified into regulation, a cogent set of skills that parallel those of pilots were found to be relevant.⁴² These first directly-accessed pilots complete Initial Flight Training at Pueblo, where they learn basic aircraft control and fundamentals of Airspace and Instrument operations, then undergo specialty training at Randolph AFB where they are further introduced to instrument flying and controlled airspace operations. They receive specialty UAS operations training at one of several newly-minted UAS schoolhouses, some at ANG locations, where they train primarily with simulators.

The career path for the RPA pilot is a bit fuzzy to the outsider and is clearly a work in progress still. Possible assignments for Active Duty RPA pilots have been limited, and in the case of Creech AFB not particularly popular. One seminar participant reflected that some term it the “leper colony,” both reflecting location and the sentiments of the pilots who desire to “slip the surly bonds.” As more control stations and schoolhouses are opened, more opportunities for relocation and advancement may follow.⁴⁹

UAS SENSOR OPERATORS (UAS SO)

Seated alongside the RPA pilot in the Predator and Reaper cab is an enlisted sensor operator (1UXX). This crew position was formally designated in 2009, and the Air Force has established a requirement for 1400+ of them. Over the past decade, prior to development of a dedicated job series, the right seat had been occupied typically by enlisted Airmen drawn from other intelligence disciplines.⁴¹ Sensor operators currently are direct accessions from Lackland BMT. Initial technical school through 3-level training is at Randolph AFB, with a follow-on to Creech AFB henceforth.

Sensor operators are expected to be familiar with mission instructions and rules of engagement. They pre-flight, operate, monitor and post-flight a variety of on-board sensing equipment. Although sensor operators train alongside pilots-in-training during part of their technical school, they are neither trained nor expected to manually fly the aircraft. As with RPA pilots, the current long-term career path for UAS sensor operators is limited to the geographic availability of airframes and schools.

UAS MISSION INTELLIGENCE COORDINATORS (MIC)

The MIC is a unique position dedicated to the armed MQ-1 and MQ-9 aircraft. There is not an analogue in the Global Hawk. As such, the Air Force's anticipated requirement is "only" for approximately 900. This crew position is currently filled by either an Intelligence Officer or by a 1NXXX Non-Commissioned Officer (NCO). The MIC job is to fuse data from multiple sources including the real-time data in the cab and to serve as the integrative "go between" from the operator positions and the supporting PAD/DCGS teams. There is currently no unique AFSC, specific training or career pathway for the MIC.

THE BACK-END

In aviator parlance "back-ender" denotes the crewmen who are conducting the mission but not flying the aircraft. Airborne "back-enders" in the ISR community include Airborne Cryptolinguists (1A8XX) and in Airborne Battle Management, Communications and Mission Specialists (1A3XX, 1A4XX, 1A5XX) who are managed as enlisted aircrew and do not fit the definition of telewarriors although they are engaged in ISR operations.

However, a large number of analysts, most from the 1NXXX career fields, directly support the ISR mission. They are directly engaged in the 24/7 combat operations from afar and are linked to or reliant on the sensors and operations of the UAS operations. Thus, they are the ground based analogue to the "back-end crew".

Analysts all fall into the Air Force 1NXXX career field, but each discipline has unique training and experiential requirements that make some very highly specialized. All intelligence analysts begin their technical training at Goodfellow AFB, but that is where the similarities end. 1N1XX imagery analysts are specially trained to use multiple sensor sources to find, fix, and track and target adversaries, as well as to identify patterns suggestive of longer term concerns. 1N2XX, 1N4XX and 1N5XX are all analysts who find meaningful data from a wide variety of radio, data, and other electromagnetic sources or within computers and computer networks. There is a great deal of similarity and cross-over between certain sensors analyst domains and those of cyberwarriors. Linguists (1N3XX) are among the most difficult enlisted AFSC's to source. Extremely long training requirements and need for languages not commonly taught in US schools or society make this one of the harder to fill AFSC's and a source of continuous

“gap,” even with a robust entry level pipeline. The *Air Force UAS Flight Path* sets the requirement for “back enders” to support the UAS mission at a total of about 5500. Over the past two years the Air Force has made training of these assets a priority, thus it is a fairly young workforce.

The DCGS groups are typically organized into Processing, Analysis (or Exploitation) and Dissemination (PAD or PED) teams or cells at their location. Common teams include DCGS Analysis and Reporting Teams (DART), Imagery Intelligence (IMINT), Full-Motion Video (FMV), Signals intelligence (SIGINT), Measurement and Signatures Intelligence (MASINT), and corollary mission planning activities.¹⁰ The groups tend to be fairly large (500 or so Airmen), mostly enlisted workforce under the purview of NCO leadership. There are often relatively few and often junior officers. Although the lead time and technical school training is long and intense, the majority of training for these Airmen is within the unit. “On the job” upgrade training and proficiency demonstration is performed in-unit as the levels of classification and nature of work make centralized recurrency training difficult.

The Air Force deploys intelligence officers to forward joint commands at division level as ISR Liaison Officers. These officers act as a direct conduit and interface between the tactical joint force commands and supporting ISR agencies. Though highly valued, there are relatively few highly qualified ISR officers and high operations tempo can rapidly attrit those resources.

DCGS and PAD operations are almost exclusively performed in highly secure environments. Analysts and officers must have Top Secret (TS), Sensitive Compartmented Information (SCI) or above clearances. Thus, the selection process leading up to entry into the career field is significant, and personal behavior, activities, contacts and even family relationships and conduct are closely scrutinized before and during employment in the career field. Airmen who are decertified or “lose their clearance” are no longer qualified to perform their duties in the Air Force, and face retraining or separation. Thus any perceived threat to their continued suitability for highly classified work is a very real concern. Similarly, the materials that the analysts hear, see or know are all protected regardless of source. It is nearly impossible to draw a line between what is “OK” to talk about and what is not. Even though a particular event is on CNN, the analyst may have deeper knowledge than is reported or may have contributed with pride or disappointment to the event. Sometimes the press reports on speculation alone, in which case even a casual comment by someone “in the know” could serve as “unnamed officials confirmed.” Thus, and correctly so, members engaged in ISR activities are generally unwilling and unable to discuss work *at all* with their family, friends, medical teams or anyone physically or occupationally outside their cloistered world.

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