Military Readiness: The Effect of the Coronavirus Disease 2019 (COVID-19) Pandemic on the United States Warfighting Platform

by

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Abstract

Military readiness stands as one of, if not the most important tenants of the current National Defense Strategy (The White House, 2022). It represents a critical state from which the nation is able to defend itself from any and all threats. Specific nations and terrorist organizations continue to pose a potential threat; however, the COVID-19 pandemic presents both direct and indirect threats to United States national security. Defining military readiness is a topic by itself. This can be examined in a number of different methods. For the present study, readiness is defined primarily as the general function of the United States to maintain an active state of military readiness such that it can deter and defend any and all threats to national security. The COVID-19 pandemic posed a tremendous impact on multiple infrastructures of both the United States and the world. Cumulative knowledge from previous pandemics offers a solid framework of knowledge; however, COVID-19 has proven to be novel both biologically and in its effect upon the global community. Its impact on military readiness warrants a watchful eye to ensure that the United States can endure and maintain essential military readiness despite the many effects of the pandemic. A problem/solution approach is utilized to incorporate available literature and subject matter experts to examine the threat and to explore possible solutions. Detailed examination demonstrates that existing knowledge and frameworks of previous pandemics, such as the H1N1 pandemic of 1918, offer a core base to work from. Furthermore, existing frameworks compiled from viral pandemics since this time also offer a host of resources. Despite the significant impact of the COVID-19 pandemic, the current study supports, through exhaustive literature review and discussion with multiple subject matter experts, that the United States military is in fact capable of maintaining military readiness amidst the current COVID-19 pandemic.

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Keywords: COVID-19, Coronavirus, military readiness, warfighting, vaccine

Preparación militar: El efecto de la pandemia de la enfermedad por coronavirus 2019 (COVID-19) en la plataforma de combate de los Estados Unidos

Resumen

La preparación militar se erige como uno de los inquilinos más importantes, si no el más importante, de la Estrategia de Defensa Nacional actual (La Casa Blanca, 2022). Representa un estado crítico desde el cual la nación puede defenderse de todas y cada una de las amenazas. Las naciones específicas y las organizaciones terroristas siguen representando una amenaza potencial; sin embargo, la pandemia de COVID-19 presenta amenazas directas e indirectas para la seguridad nacional de los Estados Unidos. Para el presente estudio, la preparación se define principalmente como la función general de los Estados Unidos para mantener un estado activo de preparación militar de modo que pueda disuadir y defender todas y cada una de las amenazas a la seguridad nacional. La pandemia de COVID-19 planteó un tremendo impacto en múltiples infraestructuras tanto de los Estados Unidos como del mundo. El conocimiento acumulado de pandemias anteriores ofrece un marco sólido de conocimiento; sin embargo, COVID-19 ha demostrado ser novedoso tanto biológicamente como en su efecto sobre la comunidad global. Su impacto en la preparación militar justifica una mirada atenta para garantizar que Estados Unidos pueda soportar y mantener la preparación militar esencial a pesar de los muchos efectos de la pandemia. Se utiliza un enfoque de problema/solución para incorporar la literatura disponible y expertos en la materia para examinar la amenaza y explorar posibles soluciones. Un examen detallado demuestra que el conocimiento y los marcos existentes de pandemias anteriores, como la pandemia H1N1 de 1918, ofrecen una base central para trabajar. Además, los marcos existentes compilados a partir de pandemias virales desde entonces también ofrecen una gran cantidad de recursos. A pesar del impacto significativo de la pandemia de COVID-19, el estudio actual respalda, a través de una revisión exhaustiva de la literatura y la discusión con múltiples expertos en la materia, que el ejército de los Estados Unidos es, de hecho, capaz de mantener la preparación militar en medio de la actual pandemia de COVID-19.

Palabras clave: COVID-19, Coronavirus, preparación militar, guerra, vacuna

军事戒备：2019 冠状病毒病 (COVID-19) 大流行对美国作战平台的影响

摘要

军事戒备即使不是当前最重要的国防战略，也是重要的国防战略之一（白宫，2022年）。它代表了一个国家能够抵御任何威胁的关键状态。个别国家和恐怖组织继续构成潜在威胁；不过，2019 冠状病毒病(COVID-19)大流行对美国国家安全构成直接和间接威胁。对于本研究，戒备状态主要被定义为美国为保持积极军事准备状态的一般功能，以便其能够阻止和防御国家安全所面临的任何威胁。COVID-19大流行对美国和全世界的多种基础设施造成了巨大影响。从以往大流行中积累的知识提供了坚实的知识框架；不过，COVID-19在生物学上和对国际社会的影响上都被证明是独特的。COVID-19对军事戒备的影响值得密切关注，以确保美国能够忍受并保持必要的军事戒备，尽管大流行造成了诸多影响。使用一项问题/解决方案措施来结合可用的文献和主题专家，用于分析威胁并探究可能的解决方案。详细分析表明，关于以往大流行病（例如1918年的H1N1型流感）的现有知识框架为相关研究提供了一个核心基础。此外，从此次病毒大流行中汇编的现有框架也提供了大量资源。尽管 COVID-19大流行产生了重大影响，但本研究通过详尽的文献综述和与多位主题专家的讨论后发现，美国军方实际上有能力在当前的COVID-19大流行中保持军事戒备状态。

关键词：2019 冠状病毒病，冠状病毒，军事戒备，作战，疫苗

Introduction

Military readiness is critical to the ability of a nation to defend itself from both foreign and domestic threats (The White House, 2022). It is simple in theory but complex in reality due to the diverse and numerous forces, in addition to the many capabilities of the military.[1] Modern warfare has changed dramatically from the Cold-War era whereby the United States was postured to counter a Soviet offensive, to the present with

threats from various countries, terrorism, and rogue individuals exploiting technological advances. The National Defense Strategy identifies four primary threats to the United States, including Russia, China, North Korea, and Iran, with the threat of terrorism an additional threat following the September 11, 2001 terrorist attacks. The current National Defense Strategy emphasizes the importance of military readiness as a critical tenant of preparedness (Mattis, 2018). In fact, the National Defense Strategy specifically notes three distinct strategies, to include the rebuilding of military readiness in the Joint Force arena as a top priority (Mattis, 2018).

The military services are comprised of key assets that include service members, vehicles, facilities, and weapons. Modern joint operations maximize the complexity of logistics to ensure that these forces must interact effectively (Joint Publication 3-0, 2018). This all requires continuous training to maintain effective military readiness. This interdependent network relies on the readiness of each individual component to function effectively as a system.

The novel coronavirus disease 2019 (COVID-19) imposed a tremendous burden on various global infrastructures and continues to do so at present. Its effect on the United States military has required multiple adaptations and poses a potential threat to the readiness state of the military. In reference to the National Defense Strategy's (2022) identified five primary threats, the addition of COVID-19 as a plausible sixth threat to U.S. national security warrants attention based on the direct effect of the pandemic itself as well as the indirect effects on various infrastructures and the other primary threats. Numerous functions of military service require frequent and prolonged interpersonal contact which imparts a challenge given the high transmissibility, unknown long-term effects, and work disability imposed by COVID-19. However, the military must overcome all threats to readiness in order to remain capable of defending the Nation.

This threat to military readiness is one of great concern and unknown duration. It emerged with little actionable warning yet prodigious force. The military has not encountered a biologic threat of this magnitude since the 1918 influenza pandemic (DiEuliis, 2020). Other pandemics of lesser scale such as the H1N1 influenza pandemic of 2009 or earlier avian flu pandemics did not have the global impact of COVID-19 (World Health Organization, 2017). Response to the present COVID-19 pandemic must assert control and continuity of military operations in order to maintain a defensive posture for the United States. This study aims to assess the readiness state of the United States military within an extended COVID-19 pandemic.

Analysis of this research question will incorporate a qualitative problem/solution framework to analyze both the short and long term effects of COVID-19 on United States military readiness (Ackerman, 2010). In accordance with this type of research framework, the problem of threatened military readiness from the COVID-19 pandemic will be examined and fol-

lowed by a discussion of collective solutions (Ackerman, 2010). A multitude of sources will be used to identify the pandemic threat and its effects on military readiness. Recommendations will be proposed and supported to best prepare and maintain readiness of the United States military in the face of the COVID-19 pandemic.

An expanded discussion of military readiness will set the stage within the background and significance section. Existing military doctrine, protocols, and policies will be reviewed and examined as to their efficacy toward the current COVID-19 pandemic. A review of past pandemics offers insight into the current threats imposed on infrastructures, specifically its impact on military readiness.

Once military readiness and the pandemic threat are reviewed, a discussion of both existing and potential solutions will be explored. Although previous pandemics can offer some guidance, the current COVID-19 pandemic is unique in many ways and presents novel issues. The COVID-19 pandemic has dominated the headlines of 2020 with widespread effects on financial, economic, political, social, health, and military platforms. Many of these infrastructures have struggled to function; however, the military is a critical infrastructure that must endure for the national security of the United States. The present research question thus investigates how the United States military readiness is prepared for an extended COVID-19 pandemic.

Background

Military Readiness

The term "readiness" is defined by the military in Joint Publication 1-02 as "the ability of military forces to fight and meet the demands of assigned missions (Joint PUblicatino 1-02, 2010)." Military readiness represents a critical component of the National Security Strategy as indicated by its presence as the first line of effort in the current National Defense Strategy (Mattis, 2018). The 2017 National Security Strategy stated that "The United States must retain a ready force capable of protecting the homeland while defending US interests. Readiness requires a renewed focus on training, logistics, and maintenance (The White House, 2018)." The nation's ability to generate and deploy a ready military force marks the core structural framework of national security (Junor, 2017). The composition of military readiness is complex with the inclusion of virtually every aspect of military force, ranging from the individual medical readiness (IMR) requirements of each service member, the weapon systems used to arm them, the training programs to teach them, and the logistical capabilities necessary to transport them.

The definition of military readiness can vary based on the audience; however, Betts, author of the sentinel book *Military Readiness*, proposes a comprehensive definition as "the relation between available time and needed capability (Betts, 1993)." Readiness is

composed of a multiplicity of layers and variables, making both fulfillment and analysis complex. Further, statistics on the various types of readiness (medical readiness as an example) are difficult to study in open publications as the data is typically not available in continuous or current form (Betts, 1993). In general terms, military readiness focuses on the relation of time to two ratios: 1) the affinity between the demand and supply for combat ability and 2) the relation between actual and potential capability (Betts, 1993). Betts also examines readiness at three levels, including the individual (and individual weapon system), the unit, and the larger theater force (Betts, 1992).

The complexity of military readiness is indicated by a continuously increasing national defense budget. Harrison asserts that virtually every component of the annual defense budget relates to readiness in some manner, with a request of $740.5 billion for fiscal year 2021 and a projected five trillion-dollar budget over the next decade (Harrison, 2014; U.S. Department of Defense, 2020).

Betts articulates a need to understand readiness "for when, for what, and of what (Betts, 1993)." Readiness for "when" refers to the time interval, duration, potential for coexisting campaigns, and the potential for long-term sustainment. Readiness for "what" refers to what types of wars that the United States military must be prepared to engage, while readiness for "of what" relates to an understanding of which force components are required. Bett's paradigm of military readiness as a function of for when, what, and of what, is referenced by numerous scholars on this topic. Perhaps more succinct is his formulated definition of military readiness as the mix of speed and effectiveness that allows for satisfactory performance in combat (Betts, 1993). Former Principal Deputy Under Secretary of Defense for Personnel and Readiness, Dr. Laura Junor notes the ability to analyze readiness at nearly every level in the military, from the individual service member to the nation as a whole (Junor, 2017). Dr. Charles Tatum stated that readiness can thus be examined in a hierarchical system of simultaneously functioning levels (Tatum, 20020.[2] The Joint Chiefs of Staff maintain readiness within this multi-tiered system that includes strategic, operational, and tactical levels of military readiness (Chairman of the Joint Chiefs of Staff, 1998). For the purpose of this study, a broad definition of military readiness serves the purpose and may be defined as "the ability of the United States military forces to fight and meet the demands of the national military strategy (Junor, 2017)." This study will also examine military readiness primarily at the level of the service member since the analyzed threat is health-related.

The complexity of military readiness can be evaluated in relation to what the United States may face in the future – the reality is that no one can be certain. Readiness is unique in that it must be available in both potential and kinetic forms. Betts noted this as the relation between potential and actual capability (Betts, 1993). This may

also be viewed in related terms of deterrence and engagement. Difficult decisions with tremendous budgetary implications must be determined based on available intelligence of the threatscape. Equipping the United States to be ready for the future is a priority of the current National Defense Strategy (The White House, 2022). However, an examination of present readiness is difficult as there exists no perfect means of analysis. The National Research Council notes various quantitative measures of military (force) readiness such as personnel, recruiting, equipment, weapons, munitions, and materiel. However, there also exist many qualitative measures of readiness (leadership, morale, personal interactions, mission execution) that are difficult to quantify (National Research Council, 2017).

Measuring military readiness is a difficult task as it chases an ambiguous and variable definition of readiness. In a 2017 Congressional Research Report to Congress, Russell Rumbaugh noted that those who define readiness broadly see a crisis, whereas those who view readiness narrowly do not see a crisis (Rumbaugh, 2017). Harrison describes the measure of military readiness as a function of inputs and outputs, although these do not necessarily bear truly representative reflections of each other (Harrison, 2014). Harrison astutely identifies readiness inputs as proxy measures for the outputs (Harrison, 2014). Many readiness indicators have been described (trained personnel and functional equipment); however, the United States warrants readiness from a strategic perspective (Forrester et al., 2001). Forrester et al. note that the smaller military force of modern times may not allow straightforward statistical comparison with earlier data due to its reduced size and joint force direction (Forrester et al., 2001). Nevertheless, a number of variables have been utilized to attempt to track and compare military readiness. Some of these include the Department of Defense (DoD) Operation and Maintenance Budget estimates, military health spending, reenlistment and recruitment statistics, mission-capable rates, and sporadic (when released) IMR data (Forrester et al., 2001). However, this data is typically not released for years after its occurrence, making real-time monitoring difficult and likely not relevant to a given situation. This delicate balance underscores the complexity of matching a multi-billion dollar annual defense budget with military readiness goals. Gen Edward C. Meyer, former Army Chief of Staff, termed an imbalance of this system as a "hollow force (Forrester et al., 2001)." The Congressionally mandated readiness reporting essentials are listed in Table 1 (Government Accounting Office, 2013). While seemingly comprehensive, there are nearly infinite potential variables that warrant examination. Gen. (Ret.) Curtis Scaparrotti, a highly decorated senior General and former Director, Joint Staff, notes six primary components of force readiness: personnel, medical, force protection, intelligence, mobility and sustainment, and command and control/cyber (Scaparrotti et al., 2020).

Table 1. Readiness reporting requirements for Congress.

Reporting Requirement	Corresponding Resource Area
Personnel status, including the extent to which personnel are in positions outside of their specialty and/or above their grade	Personnel
Historical data and projected trends in personnel strength and status	
Recruit quality	
Borrowed manpower	
Personnel stability	
Personnel morale	
Recruiting status	
Training unit readiness and proficiency	Training
Training operations tempo	
Training funding	
Training commitments and deployments	
Deployed equipment	Equipment and Supplies
Equipment availability	
Availability of ordnance and spares	
Equipment that is not mission capable	Maintenance
Age of equipment	
Condition of non-pacing items	
Maintenance backlog	
Status of prepositioned equipment	
Overall readiness rating for units rated C-3 or below for the quarter and each month of the quarter by unit designation and level of organization	Overall Readiness Ratings
Resource areas that adversely affected the readiness rating for units rated C-3 or below	
Each readiness problem and deficiency identified using internal DOD assessments	
Planned remedial actions to address readiness problems and deficiencies	
Key indicators and other relevant information related to each identified problem and deficiency	
Readiness of the National Guard to support the National Response Plan in support of civil authorities	
Reasons why the unit received a readiness rating of C-3 or below	

There are various databases that collect data that may be used to examine readiness characteristics, such as the Defense Manpower Data Center (DMDC). This entity offers support to the Office of Personnel and Readiness (P&R) (Committee on Strengthening Data Science Methods for Department of Defense Personnel and Readiness Missions, 2017). Multiple methods exist for the DoD to report on the status of military readiness to Congress. Two primary mechanisms have been utilized for this reporting: the Status of Resources and Training System (SORTS) and the Defense Readiness Reporting System (DRRS) (Forrester et al., 2001; Trunkey et al., 2013). This reporting is classified and not subject to public examination and/or discussion. The more recent DRRS has advantages over the earlier SORTS system and

has become the primary mechanism used, although DRRS includes SORTS metrics (Trunkey et al., 2013). Current DRRS results provide a numeric rating based on a scale of zero to 100 (versus SORTS scale of one to four) (Trunkey et al., 2013). The DRRS includes commander assessment in assessing unit readiness; however, this has been criticized as it seems unlikely that commanders will be consistently critical of their own command (Trunkey et al., 2013). Continued improvements in the reporting of readiness data are exemplified by the Defense Logistics Agency's tool, the Service Readiness Dashboard. This tool offers real-time tracking of various components necessary to maintain a variety of equipment platforms (Reece, 2020). Key examples of this function include supply chain tracking of parts necessary to maintain various equipment and weapons systems such as a Chinook helicopter or an M1 tank (Reece, 2020).

The DoD provides quarterly military readiness reports to Congress (Table 1). These Quarterly Readiness Reports are classified and only address readiness inputs (no outputs) (Harrison, 2014). This current reporting system is circular in logic with its lack of output reporting. Budgetary constraints do not allow for the full, non-supervised financing of the United States military. However, modern technology allows for a previously impossible collection and analysis of metrics on these readiness characteristics. Implementation of quantitative metric analysis of military force characteristics is needed for more useful readiness measures (Harrison, 2014). Harrison summarizes the optimal formula for military readiness metrics as delivering the following: 1) measuring outputs (rather than only inputs), 2) linkage to military strategy, 3) quantifiable, and 4) focus on objective rather than subjective measures (Harrison, 2014).

A Congressional Budget Office study in 2011 determined that the DoD was not establishing a definitive association between readiness expenditures and actual military readiness (Congressional Budget Office, 2011). In defense of the complexity of this reporting, Betts noted that "good models of operational readiness are difficult to formulate because their subject is in large part an ecological phenomenon, a jumble of vectors whose interdependencies are hard to trace or isolate (Betts, 1993)."

New methods of readiness have been proposed. While beyond the scope of the current study, acknowledging the field of military readiness as a complex and dynamic system is a start. Current analysis is criticized as only evaluating inputs (Harrison, 2014). Linking readiness inputs and outputs would allow statistical analysis to yield more efficacious military readiness theories and models (Harrison, 2014). A proposed model to link military readiness inputs and outputs is depicted in Figure 1 (Harrison, 2014).

Tatum offers a different approach for a novel means to examine readiness (Tatum, 2002). This novel method of analysis utilizes structural equation modeling to harness the utility of measurement theory and causal

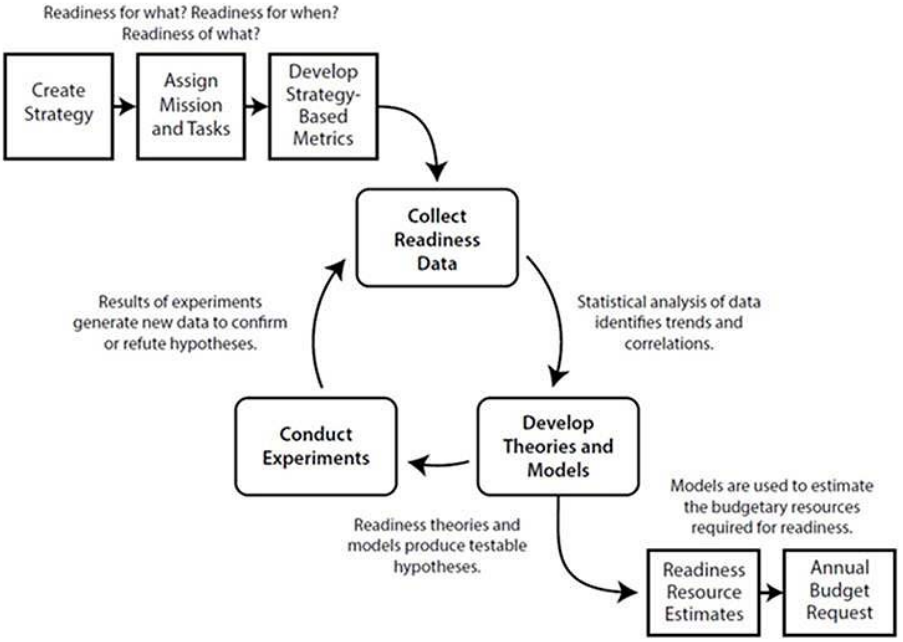


Figure 1. Proposed model for the linkage of both inputs and outputs of military readiness.

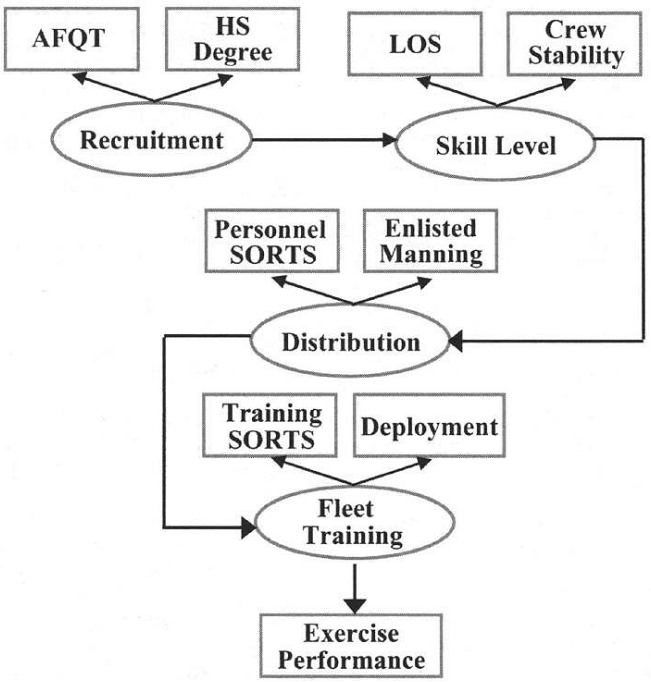


Figure 2. Structural equation modeling of Naval readiness by Tatum.

modeling to introduce more mathematical principles into this otherwise ambiguous study (Tatum, 2002). Figure 2 depicts this model of readiness as based on performance measures rooted in recruitment and skill level and the potential relationships of subsequent effects (Tatum, 2002). For example, Tatum found that recruitment and skill level were closely associated with a correlation coefficient of 0.97. This model uniquely transformed otherwise qualitative reporting into more strict quantitative reporting (Tatum, 2002).

There exist a multitude of ways to define military readiness. Similarly, numerous methods may be utilized to track and monitor readiness. The present study aims examine current U.S. military readiness with specific focus on effects rendered by the COVID-19 viral pandemic.

Biological Threats

Any biologic threat, whether natural or engineered, poses a potential risk to the national security of the United States. Biological threats have included specific entity or organism-specific diseases such as botulism, plague, viral hemorrhagic fevers, ricin, and anthrax to name a few examples. A pandemic represents a global outbreak of a disease (World Health Organization, 2020). This may be of variable infectious origin; however, viral pandemics (versus other etiologic agents [i.e. bacterial]) have proven to be among the most infectious and widespread. The United States (and world) have experienced multiple pandemics in the past. Viral pandemics of related practical historic relevance include the 1918 pandemic (H1N1 influenza virus), the 1957 pandemic (H2N2 influenza virus), the 1968 pandemic (H3N2 influenza virus), and the 2009 pandemic (H1N1 pdm09 virus) (Centers for Disease Control and Prevention, 2020). Among these, the 1918 (H1N1) pandemic is commonly referenced due to its global impact in addition to its wartime effect on the military. This influenza virus-fueled pandemic afflicted approximately one quarter of the US Army and nearly 40% of the Navy (Byerly, 2010). Globally, approximately 50 million people died from the H1N1 virus in 1918 (Short et al., 2018). Multiple waves of the highly infectious influenza virus swept through various large training camps in the spring of 1918, with passage among unknowingly infected troops en route to France (Byerly, 2010). Medical officers quickly recognized the viral origin and advised on avoidance of overcrowding of troops. However, the common necessity for service members to work within close proximity made (and continues to at present) avoidance of overcrowding difficult. Numerous familiar actions were implemented in efforts to combat the virus, such as social distancing, limitations on travel, and quarantine. Of note, the Great Lakes Naval Training Station (Rockford, Illinois) offered masks to its personnel; however, only 96 of 674 (14%) utilized these coverings (Byerly, 2010). Perhaps this lack of compliance was related to the poor outcomes of this pandemic.

Discussion of each of these pandemics individually is beyond the

scope of this study; however, increasing knowledge from each of these global events has fueled scientific and medical knowledge to increase preparedness. Rapid detection, identification, surveillance, education, treatment, and prevention remain mainstays of management and are only improved with technological advances. The advent and improvement of gene sequencing have proven useful for nearly all categories. Technological advances such as reverse transcription-polymerase chain reaction (RT-PCR) testing allows for the detection of viral ribonucleic acid (RNA) and/or nucleic acids in respiratory specimens with both high sensitivity and specificity (Centers for Disease Control and Prevention, 2020). Many of these clinical tests allow results within 15 minutes and with sensitivity ranging (depending on the test and sequence identified) up to 100% (Centers for Disease Control and Prevention, 2020).

The severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is the causative virus of coronavirus disease (COVID-19) (World Health Organization, 2020; Coronaviridae Study Group of the International Committee on Taxonomy of Viruses, 2020). As of January 2023, there were 666,785,614 cumulative global cases, with 101,646,108 (15% of global) cases in the United States (Figure 3) (Johns Hopkins University and Medicine, 2023).

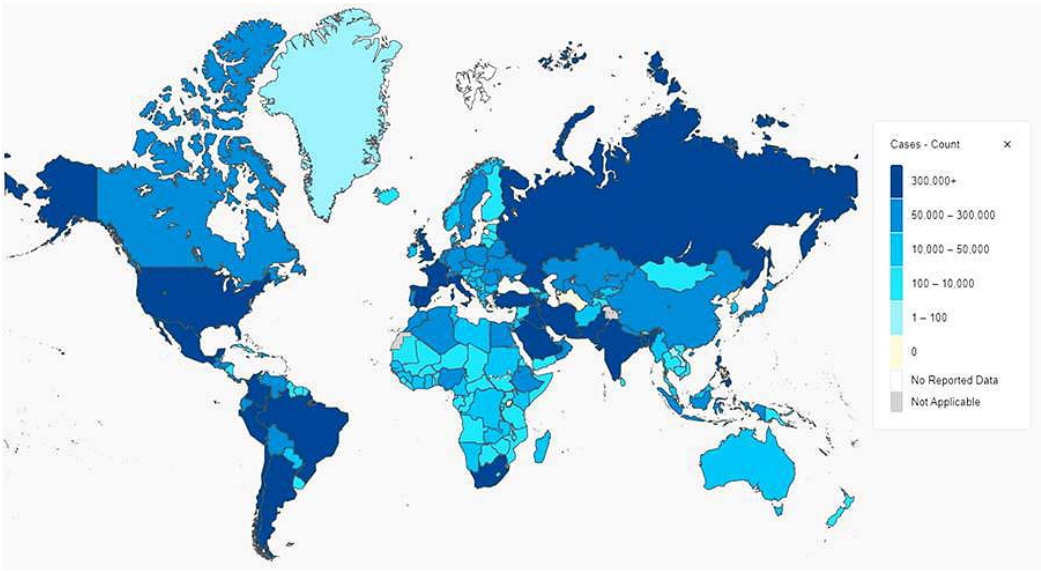


Figure 3. Global map of confirmed COVID-19 infections as of October 2020 (Johns Hopkins University and Medicine, 2023).

There have been 1,099,860 deaths in the United States as of January 2023 (Johns Hopkins University and Medicine, 2023). The United States military has reported 453,456 cases with 96 deaths (.02%) as of January, 2023 (U.S. Department of Defense, 2023). COVID-19 is characterized by high in-

fectivity and a relatively high mortality rate. Coronaviruses are not new and in fact, have been previously recognized as a potential threat (Jeffery et al., 2009). Viral transmission occurs primarily person-to-person via respiratory droplet and close contact. The potential for fomite transmission is also considered a source (Harapan et al., 2020). The phenomenon of asymptomatic transmission is of particular concern for the military, wherein a large population of potential carriers can transfer the virus unintentionally to both military and civilian individuals. The mean incubation time for COVID-19 is approximately five days but may last up to 24 days (Harapan, 2020).

The basic reproductive number (R_0) of a biologic agent defines the average number of infections that can ensue from a single infected individual (transmissibility) (Harapan, 2020). The R_0 of COVID-19 is estimated to approach 3.28, which denotes a high transmission rate (Viceconte et al., 2020). There are multiple reports with calculated R_0 values both above and below this number, including a recent report by Sanche et al. measuring the median COVID-19 R_0 value at 5.7 (Sanche et al., 2020). A comparison of recent viral pandemics and their corresponding R_0 values is depicted in Table 2. As noted, this is of particular concern in the military population where close contact is a standard in everyday training and living. While the implementation of social distancing and the use of face coverings is an effective means of reducing risk, it becomes difficult to maintain standard military training and operations under these restrictions.

Table 2. Global pandemics and estimated basic reproductive number (R_0) (World Health Organization, 2017).

Pandemic	Year	Virus	Estimated R_0	Estimated Case Fatality Rate
"Spanish Flu"	1918	H1N1	1.2 to 3.0	2 to 3%
"Asian Flu"	1957	H2N2 (avian)	1.5	< 0.2%
"Hong Kong Flu"	1968	H3N2 (avian)	1.3 to 1.6	< 0.2%
"Influenza A"	2009	H1N1 (swine)	1.1 to 1.8	0.02%
"COVID-19"	2020	SARS-CoV-2	1.5 to 6.68	2.9%[5]

The range and higher suspected R_0 of COVID-19 warrant a watchful eye as its transmissibility and clinical severity are greater than that of previous pandemics (Figure 4). The continued and expected emergence of novel COVID-19 variants will continue just as any new and existing viral disease. A biological threat such as a pandemic imposes a health threat to both civilians and military personnel in addition to its effects on infrastructure. A pandemic by virtue of its global impact will expectedly affect social, political, economic, financial, healthcare, industrial, and military infrastructures. The

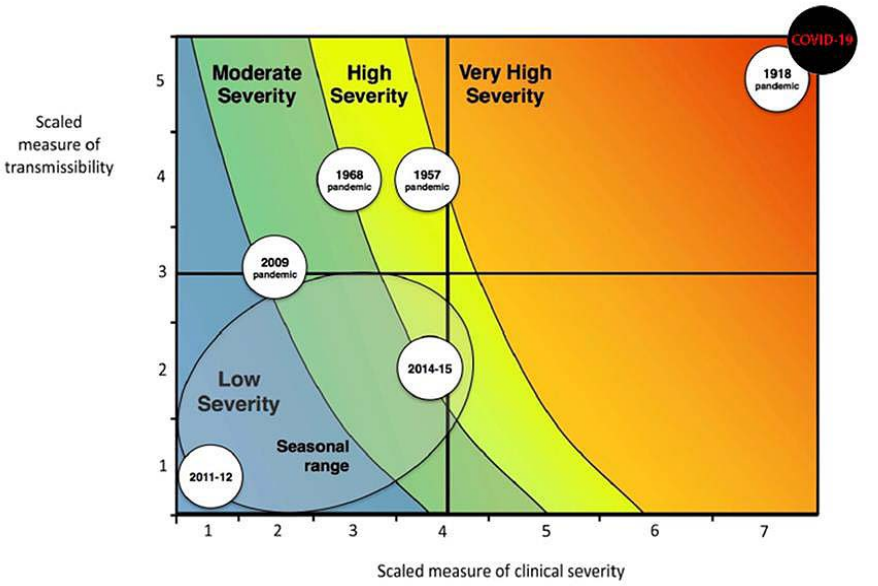


Figure 4. Transmissibility and clinical severity of major past pandemics (U.S. Department of Health and Human Services, 2017).

Table 3. COVID-19 impact on DoD employees (updated January 2023).

	Cases	Hospitalized	Deaths
Military	453,456	2,741	96
Civilian	167,988	2,489	417
Dependent	72,867	579	36
Contractor	46,222	778	141
Total	740,942	6,587	690

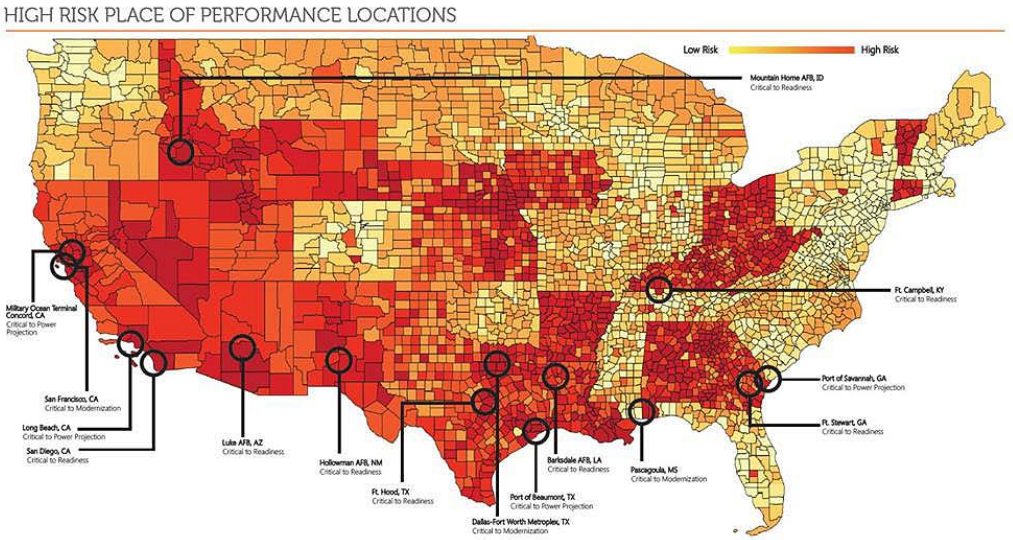


Figure 5. COVID-19 impact on DoD installations (Govini, 2020).

DoD maintains a monthly update of COVID-19 impact statistics on DoD employees to include military service members (Table 3) (U.S. Department of Defense, 2023). The aforementioned fatality rate of 0.2% among military personnel is noteworthy considering the close proximity of a large proportion of service members. An analysis on the predicted readiness impact that COVID-19 has on multiple military installations is show in Figure 5. This map identifies areas where the medical infrastructure is not ideally positioned to function due to poor preparation and/or capacity. Despite this potential malpositioning of medical infrastructure, the U.S. military remained at full capability and had minimal medical impact from the COVID-19 pandemic with reference to military deaths.

A number of mathematical models have been employed to analyze and attempt to predict future patterns of the COVID-19 pandemic (Schramm et al., 2020). These models have been used in previous pandemics for both preparedness and response purposes (Wu et al., 2011). Kucharski et al. employed multiple mathematical predictive models to better understand and predict the transmission and R_0 of COVID-19 (Kucharski et al., 2020). This study concluded that a decline in R_0 within specific geographic areas coincided with travel control measures (Kucharski et al., 2020). Most modeling studies focus on specific characteristics of a pathogen; however, Feighner et al. (2009) reviewed these modeling applications with military readiness in mind. This study consisted of a roundtable forum of global participants of pandemic modeling. Collective recommendations included the following: 1) awareness of nations who participated in global infectious disease modeling (as well as those who did not participate), 2) better collaboration between intra national organizations, and 3) better collaboration globally between nations (Feighner, 2009). The Models of Infectious Disease Agent Study (MIDAS) group has served as a networking hub for many of these participants (Feighner, 2009; Models of Infectious Disease Agent Study, 2020). The Armed Forces Health Surveillance Center, Global Emerging Infections Surveillance and Response System (AFHSC-GEIS) is tasked with continuous global surveillance for emerging infectious diseases that could pose a threat to the United States military (Russell et al., 2011).

Military readiness establishes the ability of the military to be ready, responsive, and agile. Any threat to this readiness poses a national security threat to the nation. The COVID-19 pandemic presents a threat to U.S. military readiness, specifically on service members, training capabilities, transportation abilities, and social and economic stressors.

Current Threat of Coronavirus 2019 (COVID-19) on Military Readiness

The COVID-19 pandemic threatens to have lasting effects on United States military readiness. Physicians study the multi-targeted effects of disease on the human body through the biopsychosocial model, which examines biologic,

psychologic, and social manifestations (Engel, 1977). A similar approach may be utilized to analyze the direct biological (health), social, and psychological effects of the COVID-19 pandemic, in addition to indirect effects such as economic, financial, and political repercussions. As per the previous discussion on defining readiness, the underlying functional necessity of the United States military readiness remains the effective maintenance of readiness standards set forth by the National Defense Strategy (Mattis, 2018).

Examination of how the COVID-19 pandemic affects military readiness identifies threats to military recruiting, training, operations, equipment procurement and maintenance, industry supply chain, budgetary effects, military health, and the overall psychological impact of the service member. These will be individually reviewed beginning with recruiting.

The United States military ended the draft and implemented the current all-volunteer force in 1971 (Rostker, 2006). An increasing proportion of the American population is unfit for military service based on various health markers such as obesity (Cawley, 2012). This existing unfavorable trend compounded with the evolving threat imposed by the COVID-19 pandemic cause reason for concern. However, the effects on recruiting are complex and may not be as simple as an upward or downward trend. An estimated eight percent increase in enlistment immediately after the terrorist attacks on September 11, 2001 was seen with a lasting effect until 2005 (Daniel, 2020). Military recruitment works to combat attrition; however, the COVID-19 pandemic imparts a direct effect on the health of service members and a potential indirect effect on the general motivation to remain in the military or to join (Esper, 2020). This is in addition to other direct and indirect effects of a pandemic.

Training for the vast majority of military duties requires an element of interpersonal contact. This becomes problematic in the face of the COVID-19 pandemic with respect to both prevention and transmission of the virus. Temporary closures of many military training schools occurred with the initial wave of the pandemic. However, most schools have opened with modified protocols to allow safe training in the midst of the pandemic. Any pause in this otherwise continuous training of future service members poses a significant threat to the United States military readiness. Maj Gen Andrea Tullos noted that the Air Force was "at about 90% of traditional capacity" for basic training throughput as of July 2020 (Lopez, 2020). However, she further stated that the Air Force is "at 100% production for what the Air Force is asking us to produce for the end of this year (Lopez, 2020)." While firm data does not exist as this would offer adversaries unwanted information, military capacity has seemingly continued to increase to full capacity at present. There have been periodic mask mandates; however, this has resulted in minimal to no effect other than at the individual level.

Military operations (both domestic and international) are impacted with regard to available service members, travel logistics, prioritization of importance, risk of infection, and politico-social interactions with host and/or collaborating nations. Less than careful social interactions that might predispose to viral transmission of any service member within a specific group or team that could in turn lead to widespread infection of that group or additional individuals. Many personnel scheduled to return home from deployments were delayed as a result of the coronavirus, such as with the recent overseas stop movement order affecting approximately 90,000 service members in March (U.S. Department of Defense, 2020). Limitations at present are less, less documented, and mainly related to travel restrictions imposed by destination countries. Travel restrictions and adaptations have also been necessary to reduce potential exposure. Defense Secretary Dr. Mark Esper noted that the DoD must continue global military operations due to both existing situations and new ones arising from the added impact of the pandemic (Vergun, 2020).

Military mobility represents a critical component of readiness, particularly in overseas locations. Functional mobility requires a coordinated effort between service members, equipment, maintenance, and logistics operations. This also necessitates a stable and permissible geopolitical environment (Scaparrotti, 2020). Four core areas are emphasized in the functional ability of international mobility that is particularly sensitive amidst a global pandemic: 1) infrastructure development and stability, 2) strategic air and sealift, 3) command and control, and 4) legal and diplomatic policies and procedures (Scaparrotti, 2020). International representation and involvement in organizations such as the North Atlantic Treaty Organization (NATO) afford cooperative logistics and support to assist mobility among other functions (North Atlantic Treaty Organization, 2020). Recent transatlantic cooperation among NATO allies in response to the COVID-19 pandemic has afforded mutual benefit to involved nations. A host of successes from this collaborative effort includes the return of family members to their home countries despite border closures, distribution of protective medical equipment in time of shortfalls, identification and support of partner countries in greatest need of assistance, a collaboration of rules, laws, and security, and an overall sharing of best practices on navigating through the pandemic (North Atlantic Treaty Organization, 2020).

The supply chain that supports the United States military derives procurement from an array of civilian and military sources. The entire nation, including the military, has witnessed delays in virtually every product (key examples include personal protective equipment and sanitizer) as a result of COVID-19. Any delay in military acquisition represents a threat to military readiness and thus national security. President Donald Trump authorized Executive Order 13922 in an effort to expand the domestic supply chain in support of strategic resources necessary

to respond to the COVID-19 outbreak (Executive Order 13922, 2020). Subsequent executive orders have largely sought to evaluate supply chain status via task forces (Executive Order 14017). The pandemic actually shed light on many DoD supply chain vulnerabilities, leading to productive changes that include bringing many contracts back to the US (Lopez, 2020).

The COVID-19 pandemic has also demonstrated tremendous financial impact on United States budget allocations, with $2.3 trillion in expenditures to fund emergency relief (non-military) packages (Cordesman, 2020). This unexpected cost places a tremendous burden on an already growing budget and increasing deficit. Cordesman provides an in-depth analysis of the coronavirus effects on the fiscal year 2021 budget (Cordesman, 2020). In short, he contests that decisions will need to balance expenditures between national security and civil spending (Cordesman, 2020). The U.S. Census (2022) published a detailed report on the economic impact of the COVID-19 pandemic. Data was categorized in numerous means (quarterly revenue, merchant wholesalers' monthly sales, retail and food service monthly sales, etc.), offering specific information about each but less about the overall portfolio. However, a dramatic drop in all reported categories was noted (U.S. Census, 2022). Post-coronavirus budgetary determinations must essentially plan for a sixth entity (COVID-19) to defend the nation against, in addition to the National Security Strategy's existing notation of Russia, China, North Korea, and Iran (Mattis, 2018).

The direct health impact of the coronavirus on military service members is portrayed in Table 1, with over 450,000 service members infected, over 2,500 hospitalized, and 96 deaths (U.S. Department of Health, 2023). The direct health effect on the individual service member represents a threat to the very building blocks of the United States military based on the health and fitness for duty of each individual (Panetta, 2017). Panetta et al. note that "if the brave men and women who work in the Defense Department are not fully prepared to face emerging threats, then no amount of money or other incentive will be enough to recruit and retain the highly talented workforce the military needs to succeed in the future (Panetta, 2017)." In an interview with Col Louis Perino, the State Air Surgeon of the Georgia Air National Guard, he stated (Perino, 2020):

> The COVID pandemic has had significant impacts, in multiple dimensions, on the Air National Guard Medical Service (ANGMS). The ANGMS provides 1) IMR to ensure that all members are medically qualified and ready to accomplish their in-garrison and deployed missions, and 2) ready medics able to support contingency operations at home and around the world.

Individual medical readiness is a necessary component for all service members to be functional in their duty status and deployable. IMR consists of six core requirements: 1) periodic health assessment, 2) dental readiness,

3) readiness laboratory studies, 4) immunizations, 5) individual medical equipment, and 6) deployment limiting conditions (Air Force Instruction 10-250, 2014). A deficiency (without waiverable response) of any of these categories renders a service member non-deployable. The effect of military health on readiness spans every aspect of the military and threatens the potential for debilitating consequences. The insertion of COVID-19 into the context of IMR emphasizes the potential impact on the individual building blocks (service members) of the US military.

The asymptomatic transmission of COVID-19 among personnel is of particular concern in the military. Payne et al. reported that 60% of the 382 service members aboard the USS Roosevelt tested positive for antibodies to COVID-19 (Payne, 2020). Despite the high infection rate aboard the USS Roosevelt, the majority of sailors never developed any symptoms of infection. This was attributed to the resilience of young, healthy service members (Kasper et al., 2020). The presence of positive antibodies informs of previous exposure and potential immunity to a specific pathogen. The explicit danger of asymptomatic transmission among a population such as aboard the USS Roosevelt is apparent. An infectious entity with a high reproductive value (R_o) such as COVID-19 poses a high risk in any population (relevant example being a military base) whereby rapid transmission of disease is possible and probable. Continuous updates to reflect the most recent knowledge are demonstrated in various DoD level publications such as the Force Health Protection Guidance for Coronavirus 2019 (U.S. Department of Defense, 2020).

A broader perspective of the effect of the COVID-19 pandemic on the United States military includes the psychological impact. Pandemics are natural to the course of history; however, the COVID-19 pandemic is a source of fear and anxiety (Cronk, 2020; Military Health System Communication Office, 2020). Both the presence of and working within the pandemic adds an increased risk of psychological distress for service members (Guo et al., 2020).

Overall, the United States military has demonstrated resilience to the COVID-19 pandemic and remains ready to fight (Lopez, 2020). Despite the many threats to military readiness, the United States military maintains effective measures to remain ready. This is largely due to rigid implementation of widespread practices such as social distancing and the use of face coverings, in addition to other more specific measures more specific to the military. A detailed discussion of these methods used to combat the COVID-19 will ensue in the solutions section of this study.

Current Management of a Pandemic

The COVID-19 pandemic presents a new threat; however, viral pandemics are not unfamiliar. In fact, the United States has endured viral (mostly influenza) pandemics in the past and collected a vast array of protocols for this purpose. Preparedness is an art that is maximized by few. It is summarized by former Health and Human Services

Secretary, under President George W. Bush, Mike Leavitt, stating that "In advance of a pandemic, anything you say sounds alarmist. After a pandemic starts, everything you've done is inadequate (Diamond, 2020)."

The COVID-19 pandemic has caused global devastation to multiple global infrastructures; however, it was not without prior realization. The virus family *Coronaviridae* consists of 7 coronavirus types that can infect humans. The most recent SARS-CoV-2 is responsible for COVID-19. Two other types (MERS-CoV and SARS-CoV) are responsible for the Middle East Respiratory Syndrome (MERS) and severe acute respiratory syndrome (SARS), respectively (Coronaviridae Study Group of the International Committee on Taxonomy of Viruses, 2023). Both SARS and MERS resulted in pandemics although of a much smaller magnitude than COVID-19.

Past experience with the SARS and MERS pandemics, the H1N1 pandemic, and other viral and bacterial pandemics offer expansive knowledge that can be harnessed and utilized for the present and future. Medical readiness is similar to (and a component of) military readiness in that plans must be formulated in the present for unknown threats in the future. The reality is that, despite the novelty and panic experienced with COVID-19, the United States does have knowledge, experience, and protocols to deal with a viral pandemic. These include the Department of Defense (DoD) Implementation Plan for Pandemic Influenza, The National Strategy for Pandemic Influenza, the Centers for Disease Control and Prevention (CDC) Response Framework, the Department of Health and Human Services (DHHS) Pandemic Influenza Plan, and a multitude of published, peer-reviewed, scientific articles (Department of Homeland Security, 2006; U.S. Department of Defense, 2006). The DoD Implementation Plan for Pandemic Influenza (2006) is a core example of this retention of knowledge (U.S, Department of Defense, 2006). This national strategy provides three primary foundations: preparedness and communication, surveillance and detection, and response and containment. Priority actions of this strategy resonate with the current COVID-19 pandemic (Table 4).

Perusal of the planning assumptions demonstrate the validity and utility of expected events. For example, the plan notes expected initial infection to occur outside of the United States, statistical measures that are within reach of the COVID-19 pandemic, and vaccine expectations, among numerous other repeatable findings (U.S. Department of Defense, 2006). The Department of Homeland Security has a similar guide for pandemic influenza (Department of Homeland Security, 2006). The CDC *Updated Preparedness and Response Framework for Influenza Pandemics* offers a broad guide that remains relevant to the current COVID-19 pandemic (Holloway et al., 2014). Maj Gen C.H. White stated that "Good judgment comes from experience. Experience comes from bad judgment (Watson, 1943)." This quote emphasizes the col-

Table 4. Priority actions identified by the 2006 DoD Implementation Plan for Pandemic Influenza.

Advance International Cooperation
Build International Capacity
Ensure Rapid Responses
Ensure Early Warning and Situational Awareness
Establish a Border and Transportation Strategy
Establish Screening Protocols and Implementation Agreements
Ensure Effective Risk Communication
Provide Guidance on Maximizing Surge Capacity with Available Resources
Provide Comprehensive Guidance on Community Shielding
Provide Clear Guidance for the Private Sector and Institutions
Develop Rapid Diagnostics
Establish Stockpiles of Vaccine and Antivirals
Advance Technology and Production Capacity for Influenza Vaccine

lective strength of historical experience. This CDC publication incorporates pertinent information from and replaces the federal government stages from the 2006 National Strategy for Pandemic Influenza (Department of Homeland Security, 2006). While each pandemic is unique, a common core strategy remains. Within this document, the CDC defines eight domains of effort that are mandatory to respond effectively to a pandemic: incident management, surveillance and epidemiology, laboratory, community mitigation, medical care and countermeasures, vaccine, risk communications, and state/local coordination (Holloway et al., 2014). Written primarily in the context of the civilian world, extension of its application to the military realm is relevant as well. This CDC publication outlines six intervals (two pre-pandemic and four pandemic) to include the following: 1) investigation of cases, 2) awareness of potential ongoing transmission, 3) initiation of a pandemic wave, 4) acceleration of a pandemic wave, 5) deceleration of a pandemic wave, and 6) preparation for future waves of the pandemic (Figure 6).[3] This revised framework from the CDC incorporates the most useful components of all prior frameworks and includes newer tools such as the Influenza Risk Assessment Tool (Trock et al., 2012) and the Pandemic Severity Assessment Framework (Reed et al., 2013). It is designed to incorporate the most useful information from previous frameworks, to coordinate with updated World Health Organization (WHO) pandemic phases (Figure 7), and to incorporate newer tools that will assist in decision-making (Holloway et al., 2014).

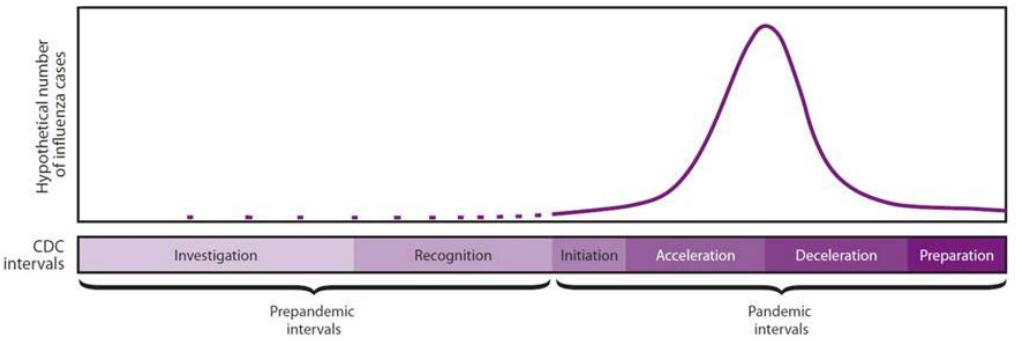


Figure 6. Six intervals of pandemic (investigation, recognition, initiation, acceleration, deceleration, preparation) as defined by the CDC.

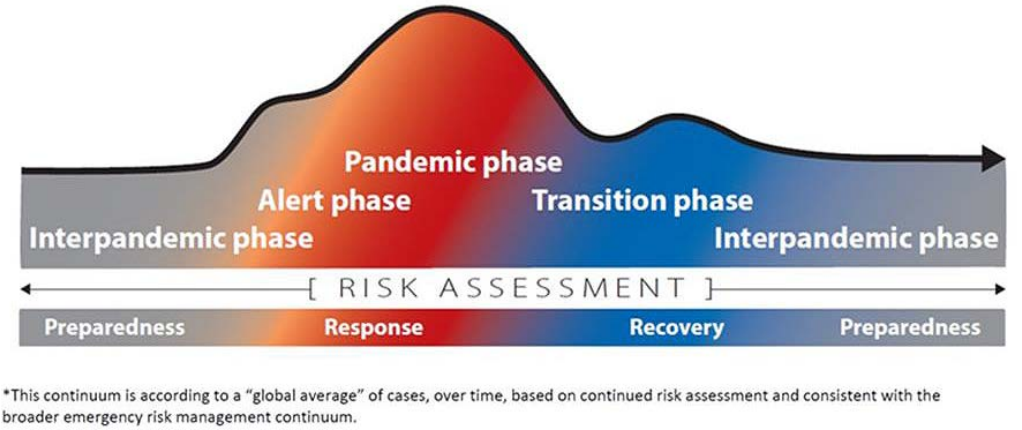


Figure 7. WHO definition of phases of a pandemic.

The WHO pandemic phases serve a broader definition and included interpandemic, alert, pandemic, and transition phases (World Health Organization, 2017). Although these frameworks consistently mention influenza, their basis as a viral pandemic still serves as a maintenance outline and framework for any type of pandemic, especially those of viral origin.

The updated 2017 Department of Health and Human Services Pandemic Influenza Plan coincides with the CDC framework and is applicable to the COVID-19 pandemic (U.S. Department of Health and Human Services, 2017). Relation to these existing sources and protocols will be used later to extrapolate suggested methods for the current COVID-19 pandemic in the Recommendations section. Perhaps the most important point is that there exists a wealth of information and resources, much of which dates back to the 1918 Influenza pandemic that remains relevant. The causative virus, its R_0 value, and its impact on the various infrastructures may change; however, the overall framework from which the United States responds changes little.

Criteria and Alternative Solutions to Maintain Readiness Amidst the Covid-19 Pandemic

Establishing criteria for optimal solutions for maintaining United States military readiness amidst the COVID-19 pandemic must be grounded in and balanced between the health and safety of military service members and both the needs and capabilities of national security. This tedious balance of conflicting goals is present for the military as it directly affects national security yet is susceptible to harm by the pandemic. The ethics of military readiness becomes apparent upon examining this contrast. The risk that service members take during wartime is expected; however, this risk during times of peace is less discussed (Pfaff, 2020). Pfaff (2020) notes that a military's true value is deterrence and thus peacetime does, in fact, mandate some degree of risk and sacrifice. Pfaff (2020) comments that "To the extent that readiness is a means of deterrence, then readiness, as well, should be worth some sacrifice." This philosophy readily applies to current military status with the coronavirus pandemic present. Numerous missions both on the homeland and overseas must carry on to ensure the safety and stability of our nation.

Optimal criteria for solutions that preserve military readiness would ideally allow maximum force readiness with the least amount of risk to service members, all with the least cost possible. Much debate exists on whether current military readiness is optimal; however, this was present long before the COVID-19 pandemic (Betts, 1993). On one hand, an adequate supply of personnel and equipment might predict military readiness; however, this does not account for strategic or operational readiness (Forrester et al., 2001). Furthermore, modern trends of more specialized units with advanced technology often translate to requiring less manpower than previous military generations, thus making quantitative comparisons difficult. Nevertheless, comparison can be performed from different measures, such as budgetary methods, reports presented to Congress, and the methods discussed earlier such as the Status of Resources and Training System (SORTS) reporting. However, one might also look at the larger picture that reveals the proven ability of the United States to maintain and withstand current events and attacks. Former Defense Secretary Mark Esper offered multiple examples, including counterterrorism missions in Africa, the Middle East, and Afghanistan, continued monitoring of North Korean weapons tests, maintenance of a defensive posture in Iraq, confrontation of Russian bombers within US air space, continued monitoring and deterrence of Iran, counter-narcotics operations by US Southern Command, continued efforts with NATO in Europe, and a continued advancement of US space operations (Vergun, 2020). Acting Secretary of Defense, Lloyd J. Austin, III, emphasized the need to continually assess the U.S. military global force posture to ensure that our nation is prepared for any and all threats (U.S. Department

of Defense, 2021). Thus, the question of military readiness in the face of the COVID-19 pandemic is one of optimization and sustainment over an unknown pandemic duration. Combatting a viral pathogen is unique in that technology has been less effective than with other pathogens, particularly with treatment. Nevertheless, historical data and experience exist to offer useful actions. Optimal methods and protocols from a multitude of governmental organizations, peer-reviewed scientific research, and the successes of various nations will be compiled to offer a practical strategy to combat the COVID-19 to maintain United States military readiness.

Research Analysis

The present study is concerned with the impact of a pandemic on the military infrastructure, namely military readiness. Military readiness equates to capability. Betts offers a multitude of definitions for various types of readiness, with net military readiness (the focus of this study) equaling speed multiplied by effectiveness (Betts, 1993). A pandemic threatens military readiness in an infinite number of means. Despite a multitude of definitions of readiness, the primary function of U.S. military readiness is the ability to maintain an active state of military readiness in order to deter and defend any threat to national security.

The problem is that the novel coronavirus (COVID-19) pandemic has affected the world with far-reaching effects, impacting conventional health, economic, social, and political systems. The military is no exception and must overcome any effects of this pandemic to maintain essential readiness to both preserve and protect our nation.

The presence of and magnitude of the problem of military readiness in the face of COVID-19 is difficult to define in terms for numerous reasons, including the fact that it is essentially occurring in real-time, and there is limited historical data to analyze. The answer to this question is as nebulous as the concept of military readiness before the pandemic. There are differing views although these are largely non-scientific polls and not definitively reliable. A poll by *Military Times* surveyed 1,507 active-duty personnel on their opinion on the effect of COVID-19 on military readiness (Hane, 2020). Approximately 20% of surveyed troops believed that military readiness had been greatly reduced by the pandemic (Hane, 2020). In contrast, Deputy Defense Secretary David L. Norquist proclaimed "To those who wish us harm, make no mistake: even with the challenges that this disease has brought to our shores, the Department of Defense stands ready to meet any threat and defend our nation (Lopez, 2020)." He further stated that "Over the last four years, we have rebuilt our military from the negative effects of sequestration. We have more people, more advanced equipment, more munitions and are better trained. If our adversaries think this is our moment of weakness, they are dangerously wrong (Lopez, 2020)." Similarly, Air Force Gen. John E. Hyten (Vice Chairman of the Joint Chiefs of Staff) stated that military readiness is where it needs

to be (Lopez, 2020). Gen. Hyten further noted that a potential concern relates to a prolonged reduction in military recruiting and basic training; however, this has not demonstrated a negative impact at this point, proclaiming that at present "our readiness is still full up (Lopez, 2020)."

In an interview with Col (ret.) Mark Cancian (USMCR current senior advisor with the Center for Strategic and International Studies), he noted that the military took a series of early steps in a concerted effort to retain military readiness. Asked his opinion of the maximum duration that the United States military could sustain readiness under the current COVID-19 pandemic precautions and restrictions, Colonel (ret.) Cancian submitted that the services could likely endure for six to 12 months before seeing true readiness issues (Cancian, 2020). Colonel Cancian estimated that cessation of basic training yields an estimated two percent loss of strength each month (Hicks, 2020).

Dr. Michael Wallace, a retired military officer and current director of the Emergency and Security Studies program at Tulane University discussed the effect of the COVID-19 pandemic on military readiness. He noted three specific areas of impact: "how do you respond, who should respond, and the direct repercussion on morale (Wallace, 2020)." His first point is emphasized by the U.S.S. Roosevelt – this major carrier battle group was rendered incapacitated for 55 days due to a COVID-19 outbreak infecting over one-quarter of its crew (LaGrone, 2020). This situation was unexpected and resulted in paralysis of one of ten US carriers (U.S. Navy, 2020). The reduction of forces on a single carrier is devastating; however, consider the results of cessation of the otherwise continuous training pipeline of military recruits, pilots, and so forth. Dr. Wallace's second point emphasized who is best equipped to respond to a pandemic. He notes that the military is not definitively designed to handle a pandemic; however, there likely is no perfect organization for such a tasking. His final point pointed out the extreme blow to morale in both the civilian and military populations (Wallace, 2020). Quarantine and lock-downs of military installations carry far-reaching effects on military members and their families

Analysis of Potential Solutions

A review of the literature demonstrates relevant information and protocols based on prior experience with other pandemics (Holloway et al., 2014). Although previous literature and resources are not specific to a coronavirus-related pandemic, they remain relevant and a solid base to build on. A multitude of novel practices involving a conglomeration of scientific, psychologic, and social strategies have been uniquely applied to the current pandemic. In reference to the aforementioned biopsychosocial model in medicine, the current coronavirus pandemic can be approached in the most complete manner from multiple perspectives. Current employed and proposed solutions to combat COVID-19 have attacked it from med-

ical, psychological, and social realms to best counter the virus. Analysis of the current strategy is unique in that there exists increasing history (over 2 years) of data to analyze and extrapolate. After over 2 years of political, personal, and legal conflict, the Pentagon recently dropped the COVID-19 vaccine mandate for U.S. military (Politico, 2023). This news is unprecedented given the recent dismissal of over 8,000 service members over this very issue (Politico, 2023). Thus, examination of strategies and solutions in the current study is largely related to current methods, most of which incorporate proven approaches of prior pandemics. Additionally, interviews with multiple content material experts were accomplished to assist in determining in interpretation of the situation. Thus, a brief listing of solutions will be rendered in this section and expanded upon within the recommendations section.

The medical and scientific realm builds upon a myriad of peer-reviewed literature, data sets, protocols, and experience based on past pandemics. While the current COVID-19 pandemic is caused by a novel virus, the course of this pandemic is largely characteristic of a typical viral pandemic and thus much of the expected cycle is predictable. The DoD has extensive experience and protocols with pandemics and has the added benefit of rapid communication combined with a strict chain of command. Proven areas of interest and success include detection, surveillance, prevention, medical care, and development of a vaccine.

The psychological and social components of military readiness are somewhat unique from past pandemics given the advances of modern communication. This can have both positive and negative effects. Both the medical and the psychological aspects of a viral pandemic impose a strong impact on service members and their families who are exposed and/or affected by COVID-19. This includes both the direct effect of those involved in COVID-19 missions as well as indirect effects represented by families of service members. New cases of depression, post-traumatic stress disorders, anxiety, and suicide have already been reported (Jones et al., 2020).

Recommendations

Betts, one of the foremost authorities on military readiness, stated in an interview that:

> The pandemic is certainly bound to reduce military readiness by some amount, measured against optimal standards, if only because some number of personnel will be incapacitated. The importance of the reduction in readiness must depend on (1) the number of such incapacitated personnel, (2) the duration of their illness, (3) whether affected personnel do or do not happen to be concentrated in particular functional areas that might disproportionately increase the impact of infection, and (4) the comparable degradation of readiness in military

> forces of potential enemies. The fourth means that 'net' readiness, more than deviations from ideal absolute standards, is the most important measure of concern for the military effects of the pandemic.[4]

This realistic view of the pandemic impact accounts for the National Defense Strategy goals, with particular attention to the net readiness in comparison to rival nations.

An exhaustive strategy for the United States to combat the COVID-19 pandemic requires one that addresses all infrastructure components. These collective frameworks function in synchronicity much like the organs of the human body. Failure of one leads to diminished function or death of another organ, and possibly the entire body. The biopsychosocial model in medicine attempts to account for this anatomical dependence on various infrastructures (Engel, 1977). This model can be used to serve as a guide in outlining the morbidity of the COVID-19 pandemic on US military readiness.

The first part (biologic) in the current strategy refers to the medical and scientific components of the pandemic. This accounts for a large portion and is influenced greatly by the cumulative knowledge gained from past pandemics. Different pandemic vary in biologic agent, R_0, morbidity and mortality characteristics; however, there also remain a great deal that does not change. The underlying framework is present with gaps in the defining attributes of each new pandemic. For example, Table 2 offers a comparison of past pandemics, noting the causative agent and the R_0 values.

The DoD Implementation Plan for Pandemic Influenza (U.S. Department of Defense, 2006), DHS Guide for Critical Infrastructure ad Key Resources (Pandemic Influenza) (Department of Homeland Security, 2006), and the DHHS 2017 Pandemic Influenza Plan (U.S. Department of Health and Human Services, (20147) serve as relevant and established guidelines to frame current responses to the coronavirus pandemic. These guidelines establish best practices and protocols from the H1N1 influenza pandemic, much of which can be related to the current threat.

The article entitled "Impact of the 2009 Influenza (H1N1) Pandemic on the United States Military Health Care System" by Jeffery et al. offers an analytic view of the real impact seen on the medical infrastructure (Jeffery, 2013). In an interview with Jeffery, she noted several points relevant to the current pandemic (Jeffery, 2020). She stated that the United States was fortunate with the H1N1 pandemic in comparison to the COVID-19 pandemic – by this, she emphasized that "if H1N1 spread like COVID-19, then we would have outstripped our capacity particularly with pediatric patients."

Jeffery compared the logistics of military responsiveness to that of civilians, except that the increased control within the military allows better navigation of this pandemic. Lack of control within the civilian sector marks widespread and often unaccounted travel,

thus yielding increased transmission (Jeffery, 2020). Additionally, Jeffery discussed the hindering role of politics in healthcare delivery as evidenced by the distribution of the H1N1 vaccine which was initially in limited supply. Political conflict, media involvement, and daily counts of H1N1 infections and deaths served to add additional fear and anxiety among the public, with the resultant upsetting of a previously paid-in-advance order to the Centers for Disease Control and Prevention for full military vaccination. The result was that part of the military order was diverted to civilians which caused nearly a 3-month lag in fully vaccinating active duty personnel, risking military readiness.

Regarding the vaccination process during the peak of the COVID-19 pandemic, Jeffery stated that she did not think there was a chance that the military would have immediate access to a COVID-19 vaccine if the process used for H1N1 vaccination distribution was repeated. However, she added that the Army was involved with vaccine development, and the military could be called upon to help nationally distribute a vaccine – such involvement could signal that the military vaccination is essential to maintain military readiness and national security. She also emphasized the need to decentralize vaccination distribution centers in the military; for the H1N1, all vaccines came from one distribution center which can create a bottleneck in rapid response situations (Jeffery, 2020).

Former U.S. Army Reserve Command Surgeon, Colonel (ret.) Sharon McKiernan is well versed in both medical and military readiness. In an interview with Col McKiernan, she noted the potential impact the COVID-19 pandemic can have, such as extra time and locations, needed for quarantine prior to and after training or missions, temporary duty (TDY) or permanent change of stations (McKiernan, 2020). The disease also has implications for individual medical readiness, especially for those with complications such as myocarditis and the long-term medical impact of the current pandemic is yet to be seen.

As to the duration that the US military can endure the pauses and impacts associated with the pandemic, Col (ret.) McKiernan felt that this depends on how proactive and responsive the organization is. One example of the successful mitigation of the pandemic has been the diligence of following protocols in the South Korean peninsula. Col (ret.) McKiernan commented that South Korea possesses a wealth of information based on previous experience with the MERS pandemic, which translates well to combatting the virus that causes COVID-19 (McKiernan, 2020). Extreme diligence to protocols and testing has yielded excellent mitigation against the pandemic. Col (ret.) McKiernan emphasized the benefit of cooperation with local health officials and transparency in this situation that allow service members to avoid locations at risk ((McKiernan, 2020). The degree of effort will likely dictate the success of the U.S. military in efforts to continue through the current and future pandemics.

Col (ret.) McKiernan's experience and discussion of the successful mitigation of COVID-19 in South Korea by diligent utilization of protocols, screening, testing, and reporting serve an example to be repeated. As noted, much of this success relates to previous MERS pandemic experience, including cooperative measures between the US military and the Korean Disease Control and Prevention Agency (KDCA). Specifically, she affirmed the power of transparency in battling COVID-19 (McKiernan, 2020). This is exemplified by publicly available information presented by United States Forces Korea in the form of a website COVID-19 Hotspot Tracker (Figure 8) (USFK COVID-19 Information, 2023). This map identifies regional cases, open and closed areas, open and closed hospitals, areas that are designated open and safe, restricted movement areas, and health protection condition levels (HPCON) via geographic boundaries (USFK COVID-19 Information, 2023).

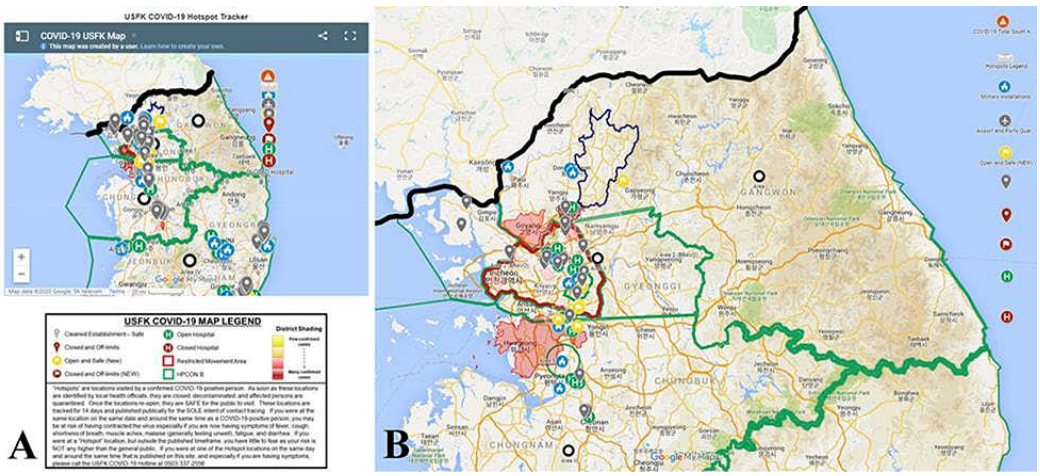


Figure 8. United States Forces Korea COVID-19 Hotspot Tracker (A). Magnified view illustrating the district shading representative of the number of confirmed cases at the peak of the COVID-19 pandemic (shades of yellow to red) (B).

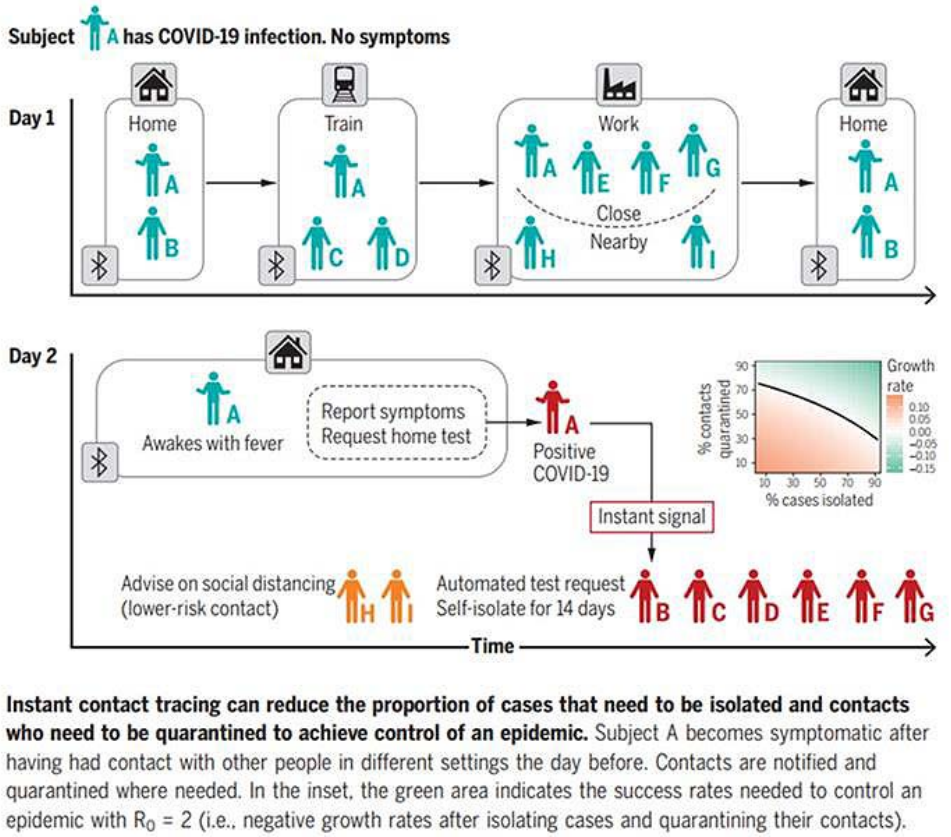
The coordinated efforts of the United States military and the KDCA demonstrate the importance of global cooperation. On one hand, COVID-19 in essence adds another enemy of the nation per the National Defense Strategy construct; however, this elusive threat chooses no sides and can infiltrate the entire world and its infrastructures. A cooperative front must be attained or else the pandemic will prolong longer than necessary. The scientific and medical communities have demonstrated such cooperative measures. Nearly any peer-reviewed journal article related to COVID-19 is available without subscription or cost. Although this may seem minor, the open support of scientific literature (over 4,000 articles by April 2020 and nearly 33,000 articles at present) across the globe only helps the cause. International collaboration aided

the development of an effective vaccine for COVID-19, as will be important for future pandemics. Such partnerships such as the "Coalition for Epidemic Preparedness Innovations" and the "Research Collaboration for Infectious Disease Preparedness" are examples of such entities established by the WHO (Momtazmanesh et al., 2020). Sharing of the genomic sequence of COVID-19 among international scientists allowed researchers the opportunity to begin working on vaccines while communicating across the globe with colleagues. Additionally, the globally collaborative Solidarity trial helped find effective treatment for COVID-19, with trials held in 52 countries, 2,000 researchers, and approximately 14,200 patients involved thus far (World Health Organization, 2023).

The implementation of previously used tactics in viral pandemics has been deemed useful and employed in the current coronavirus pandemic as well. These included social distancing, the use of face coverings, and quarantine (Byerly, 2010). The use of social distancing was common as six-foot spacing recommendations were present throughout public areas. Facial coverings such as masks were a part of everyday life, and common in geographic locales where viral illnesses are common. These simple yet relevant methods to reduce transmission were used even in the 1918 H1N1 influenza pandemic (Byerly, 2010). The utilization of quarantine was also used to quell the 1918 H1N1 pandemic. Commander John Mallory imposed a quarantine on Camp Upton's 30,000 occupants during this pandemic. The acting Army Surgeon General Charles Richard recommended a one-week quarantine for all troops prior to leaving for any destination. This familiar concept carries the detriment of reducing the active pool of available service members (Byerly, 2010). The use of quarantine was implemented routinely for service members and families who either test positive or are deemed in need of quarantine secondary to contact tracing (Figure 10) (Ferretti et al., 2020). This figure demonstrates the impact of a high R_0 value as well as the importance of contact tracing.

Advances in technology have afforded both the civilian sector and the military an added weapon to combat COVID-19's impact. The ability of many professions (both civilian and military) to work remotely and utilize virtual platforms to accomplish at least components if not all of job/mission taskings has allowed a great deal of work to continue that otherwise would be halted. The use of telemedicine allowed military physicians and medical personnel to continue to care for service members remotely. The use of remote login and virtual private networks allows for the secure accession and maintenance of privacy for service member military health records. This has proven to be of tremendous benefit for maintaining mission readiness.

The CDC *Updated Preparedness and Response Framework for Influenza Pandemics* outlines a series of mandatory medical steps that must occur within the CDC (pre-pandemic and pandemic) intervals (Figure 6) (Holloway et al., 2014). These steps include incident



Instant contact tracing can reduce the proportion of cases that need to be isolated and contacts who need to be quarantined to achieve control of an epidemic. Subject A becomes symptomatic after having had contact with other people in different settings the day before. Contacts are notified and quarantined where needed. In the inset, the green area indicates the success rates needed to control an epidemic with $R_0 = 2$ (i.e., negative growth rates after isolating cases and quarantining their contacts).

Figure 10. Contact tracing of asymptomatic individual with COVID-19 (Ferretti et al., 2020).

management, surveillance and epidemiology, laboratory studies, community mitigation, medical care and countermeasures, development and deployment of a vaccine, risk communication, state/federal coordination, and global coordination (Holloway et al., 2014).

In an interview with Dr. Diane DiEuliis, a senior research fellow at the National Defense University, she agreed with the fact that the DoD was fortunate that COVID-19 did not have the mortality impact on military service members like the H1N1 pandemic in 1918 (Dieuliis, 2020). In fact, there have only been 96 deaths of service members to date from COVID-19 (U.S. Department of Defense, 2023). Thus, from a medical and readiness perspective, Dr. DiEuliis stressed the fact that the virus affected morbidity but not mortality as much as previous pandemics. She noted that testing is a key component, including the apparent delay in developing a rapid test to use within the military (DiEuliis, 2023). Certainly, the fact that COVID-19 is a novel virus marks difficulty in the development and testing of new screening tests. Currently, there existed two primary methods of testing for COVID-19 during the peak of the pandemic: antigen testing

screens for active infection and antibody testing (both IgM [acute] and IgG [latent]) identify passive immunity to COVID-19.

Thus, a common theme among the medical, scientific, and military experts interviewed was the low mortality of COVID-19 among military service personnel, the largely unknown chronic sequela of infection, and also the variably temporary reduction in the availability of service members identified either by a positive test result or a significant exposure, thus resulting in either hospitalization and/or quarantine. The resultant effect resonates with Bett's explanation of net military readiness, whereby there are simply fewer service members available for duty (Betts, 2020).

Dr. Laura Junor is the Former Principal Deputy Under Secretary of Defense for Personnel and Readiness and currently serves as the Director of the Institute for National Strategic Studies at the National Defense University. In a dialogue with Dr. Junor, she highlighted production theory in view of the COVID-19 impact on military readiness (Junor, 2020). She stated that "it takes time to build military capability (Junor, 2020)." With reference to her sentinel article *Managing Military Readiness*, she summarized by noting that force readiness would likely not be dangerously impacted by COVID-19, particularly since (as others have noted) the younger and healthier population of the military is more resilient as evidenced by only eight deaths thus far. In congruence with Betts, Junor recognizes numerous global challengers to the United States and the fact that "the US prides ourselves in overmatch that comes from superior-tech, a professional force, and exceptional training (Junor, 2020)."

The psychological component of the COVID-19 pandemic was (and continues to be) widespread. The prevalence of depression, anxiety, and post-traumatic stress disorder is known to be a significant threat to the health and readiness of military service members (Greenberg et al, 2012). Despite the debilitating and lasting effects of these mental health effects, little attention has been given to this topic (Guo et al., 2020). While a non-military sample population, Twenge and Joiner reported that U.S. adults were three times more likely to screen positive for depressive and/or anxiety disorders in 2020 as compared to 2019 (Twenge & Joiner, 2020). The DoD Quarterly Suicide Report revealed an increased number of suicides for U.S. military service members in 2020 (as compared to prior years). This number dropped in 2021 and continued to decrease in 2022 (Orvis, 2023).

The social component of the COVID-19 pandemic is multifactorial and can be used to represent the various other components such as social, political, economic, and financial infrastructures. Each of these affects others to include the psychological and medical (biological) components. Thus, the pandemic truly affects individuals and infrastructure systems in a similar fashion.

Conclusions

The defining of military readiness is a difficult tasking. Numerous variables are interdependent and include a host of qualitative and quantitative inputs as well as both potential (deterrence) and kinetic (engagement) requirements. The United States (and the world for that matter) is fortunate to have the benefit of a wealth of previous experience to call upon. All previous pandemics offer some amount of applicable information that can be used for the present COVID-19 pandemic. This knowledge has largely been harvested and stored in multiple accessible protocols governed by various governmental organizations to include the Centers for Disease Control, the Department of Homeland Security, and the Department of Defense to name a few.

Military readiness is a critical component of the US defensive posture as highlighted by the National Defense Strategy (Mattis, 2018). The National Defense Strategy warns of four nations who pose a potential threat (Russia, China, North Korea, and Iran) in addition to the increasing threat of terrorism (The White House, 2022). The presence of the COVID-19 pandemic imposes an additional threat to the US due to the magnitude of its direct and indirect effects. It also introduces additional strains in the deterrence and reaction to these aforementioned threats. Adversaries may take advantage of the COVID-19 pandemic with a variety of active or passive attacks.

The US has learned and taken note of previous pandemics. The novel biologic and medical characteristics of COVID-19 have hindered resolution of this pandemic; however, the global community makes strides every day to combat this virus. Despite the high transmissibility and novel features of COVID-19, the US military has demonstrated preparedness, leadership, and strategies to combat COVID-19. The fact that only eight service members have died from COVID-19 points to the fact that effective methods are being used and that the issue of morbidity (rather than mortality) is most pertinent to military readiness in the face of COVID-19 (U.S Department of Defense, 2020). The military population is more resilient than the civilian population as a whole. This is primarily a function of the overall young and required health status of military service members. Those who have medically disqualifying conditions that might impair his/her ability to ward off a viral infection would often restrict such members from remaining in the military anyway.

A number of effective strategies (both old and new) have proven useful in the military strategy to combat the COVID-19 pandemic. These include the implementation of social distancing, the use of facial coverings/masks, travel limitations, temporary cessation of deployments and exercises, quarantine of infected (and exposed) individuals are useful and represent largely old methods. Modern advances in testing (antigen and antibody testing), contact tracing, and the utilization of virtual platforms (telemedicine, virtual training simulators, online educational

platforms) represent newer methods to maintain readiness in the face of the pandemic.

The collaboration of civilian and military organizations has proven critical to effectively respond in a pandemic (Lane & Schoomaker, 2020). Similarly, the same cooperation among nations helps to advance medical and scientific knowledge in efforts to discover treatments and vaccines.

The optimization of previously accumulated protocols from past pandemics, implementation of technological advances in detection of the virus, a hierarchical leadership command structure, and force that exhibits both flexibility and resilience all serve to promote a military capable of enduring the COVID-19 pandemic. Despite initial pauses in training, exercises, and functions, the US military has largely returned to full function amidst the current pandemic. Adjustments have been necessary but have led to creative methods to allow function.

In an interview with former Deputy Commander in Chief of United States Forces in Europe, Lt. Gen (ret.) Sam Wetzel (predecessor to General Colin Powell) offered his take on the pandemic: "In my opinion, the impact of readiness will be in the training area – many schools won't be able to complete due to the coronavirus. The result of this training impact will be in the active field." He was also asked how long he believed the United States can sustain an appropriate degree of military readiness amidst the COVID-19 pandemic. Lt. Gen (ret.) Wetzel affirmed without hesitation: "We will be ready (Wetzel, 2020)."

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