Chapter 6

The Impact of National Militaries on Global Health

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Abstract

Historically, the movement of military personnel has had serious consequences on global health. From the decimation of native people in the western hemisphere through the introduction of smallpox to the cholera epidemic in Haiti, militaries and military operations have served to spread disease and facilitate the emergence or re-emergence of novel disease organisms. This chapter provides historical insight into these impacts and reviews the impacts of more recent military activities, especially, recent military operations, on the global burden of disease and health to include vector borne disease, infectious diseases, and emerging diseases across the globe. Emphasis will be placed on current military operations.

Keywords: military, disease, emerging disease, infectious, vector, tick, mosquito, sand fly, yellow fever, malaria

1. Introduction

Throughout early human history, people were relatively isolated from each other due to an inability to move large numbers of people large distances. This isolation precluded the importation of flora and fauna, including those which cause human disease [1]. However, as technology improved and population numbers increased, populations began to move, which resulted in the movement of regional diseases to non-endemic areas. Prior to this, the spread of disease was limited by how fast people could walk or beasts of burden such as oxen and horses could move. The unintended outcomes of this increased movement of people included an expansion of infectious diseases, movement of vectors to new areas and a subsequent importation of these related vector-borne diseases. Well known examples of this movement of disease includes the movement of the Black Death or plague from city to city in late 1300's, which killed an estimated

75 to 200 million people across Europe [2], the importation of smallpox to the America's in the fifteenth through nineteenth centuries [3] and cholera transported to the Baltics, Mexico and the United States by troops, ships and immigrants in the 1830's [4]. Examples of vector and vector borne-disease invasions facilitated by the movement of people include species of the *Aedes* mosquito, to include *Aedes aegypti* thought to have been brought to the Americas during the slave trade [5] and which is the primary vector of the recently introduced Zika virus in the western hemisphere, and *Aedes albopictus*, a competent vector of arboviruses such as West Nile virus, dengue and yellow fever, thought to have been introduced to the New World since 1930, and *Anopheles* species to include *Anopheles gambiae* which was the vector responsible for importing *Plasmodium falciparum* malaria from West Africa to South America in 1930 [4]. All are thought to have been brought from Africa and Asia to the Americas through the transport of goods and people by ships and airplanes. More recent examples include the introduction of the East Asian tick to New Jersey in the eastern United States [6].

Another aspect of increased mobilization is the speed at which diseases can be spread. While the speed of spread may be affected by the causative agent, there is no doubt mass global transport may increase the pace at which diseases can be spread. For example, the 1957 influenza pandemic which originated in China was able to spread from its epicenter to a global distribution within 6 months due to regular air travel across the globe [7]. Similarly, severe acute respiratory syndrome (SARS), a disease caused by a coronavirus, was able to spread from a single source in southern China to people in 26 different countries within the course of 3 months [8]. Intense monitoring and isolation of infected individuals may have reduced the transmission and avoided another large-scale pandemic. While both influenza and SARS are respiratory infections, the global spread of other types of diseases has been shown to have been facilitated by mass global transportation. One such disease is the Human Immunodeficiency Virus (HIV) and its associated disease Acquired Immune Deficiency Syndrome (AIDS). While genetic analyses indicate that HIV made the jump from chimpanzees to humans approximately 70 years ago [9] in western Africa, the disease started to spread in the 1970's and 1980's due to travel, especially of certain groups such as immigrants, mass goods transporters and military personnel. While the majority of HIV positive individuals still live in Africa, by 2016, an estimated 36.7 million people across 125 different countries were HIV positive. Due to movement of peoples, the disease increased from an estimated 10,000 to 300,000 cases to 36.7 million cases in only 35 years [10].

2. Historical impacts of military operations

While the preceding examples are broadly based and were influenced by the general movement of people and goods, military operations have directly or indirectly influenced the regional and global spread of diseases. When militaries invade new areas, they are exposed to new ecological habits, tend to cause the displacement of people including civilians and military personnel, and modify the local infrastructure, which may promote disease or disease re-emergence. For example, during the Siege of Caffa in 1346, members of the Mongol Tartar Army are thought to have introduced plague to the residents of Caffa, either intentionally

by the hurling of plague infected bodies over the walls, or unintentionally through rodent to rodent transmission. Infected residents and military personnel fleeing the city by boat are thought to have transmitted the disease to Mediterranean ports, where it rapidly spread throughout western Europe [11]. Evidence indicates smallpox was also instrumental in affecting outcomes during military campaigns in the New World. For example, because of the decimation of the native people due to the introduction of smallpox by the Spanish, Hernan Cortes was able to conquer the Aztec Empire and much of modern Mexico. Similarly, during the Pontiac Rebellion and the siege of Fort Pitt, Field Marshall Amherst and Colonel Henry Bouquet of the British Army are thought to have used smallpox inoculated goods such as blankets to transmit smallpox to the Native Americans to expatriate them from the territory [12]. While impossible to prove, this act and the incidental exposure of Native Americans in the area to smallpox may have been responsible for the deaths of up to 1.5 million people [13].

Other diseases, while not used to fight a war, have impacted the outcome of wars or even been used as a reason to start wars. The British defeat at the Battle of Cartagena in 1741 by the Spanish is thought to have been facilitated by the substantial loss of British sailors and troops to disease, particularly yellow fever. The British also lost a substantial number of soldiers to yellow fever during their peaceful occupation of Havana, Cuba during the Seven Years War, losing more men than they did in operations in North America during the same time [14]. Other armies were not immune to the impacts of yellow fever. From 1801 to 1803, Napoleon's largest expeditionary force was destroyed by yellow fever during the Haitian-French War, with over half of the deaths caused by yellow fever [15]. Beginning in 1894, the southern US began to experience an outbreak of yellow fever. The source was thought to be Cuban immigrants and fishermen operating in US waters. US government officials sought to curb the outbreak in the US by sending epidemiologists to Cuba to try and reduce a concurrent outbreak in Cuba. When the outbreak continued, the US officials approached Spain to address the outbreak. However, the Spanish response was to quash a rebellion occurring in Cuba at the time, increasing the cases of yellow fever. As a pretext to stop the outbreak, on April 25, 1898, the United States declared war on Spain. In the lead up to the war, US trainees located in camps in the southern US also contracted yellow fever, seriously impacting the US's ability to wage war. By 1900, US researchers had determined yellow fever was caused by the bite of a mosquito and by 1901, yellow fever had been eradicated from Cuba [16].

During the early part of the twentieth century, influenza was the primary disease influenced by the massive movement of people. The primary factor driving this mass movement of people was World War I. From July 1914 to November 1918, more than 70 million military personnel were mobilized in support of the war effort [17]. During this time, a new strain of the influenza virus, H1N1, began to circulate among troops in Europe and was carried across the globe as troops moved from Europe back to their home countries. The disease spread rapidly through militaries, especially among camps found across the United States. At its height, the admission rates among these camps was 361 per 1000 individuals. This infection of training camps provided a ready source of movement of the virus back to Europe as troops moved back and forth [18]. At the height of the infection, over 500 million people were infected globally, and 50 to 100 million people died, resulting in a global reduction in life expectancy of over 10 years [4].

3. Current military operations and emerging infectious diseases

In more modern times, military operations have resulted in the expansion in the geographic distribution of many diseases, including those of concern at the turn of the twentieth century. This includes influenza, cholera and other diseases of historical importance. Additionally, these military operations have expanded the geographic distribution of diseases either thought to have been eradicated in a region or the emergence of novel diseases. These diseases can be compartmentalized into vector borne diseases and infectious diseases.

3.1. Vector borne diseases

Vector borne diseases are those diseases which are transmitted when a person is bitten by an infected arthropod vector. These diseases are typically broken up into those transmitted by a mosquito, a tick or a fly, especially species of sand flies. Until World War I, the main cause of morbidity and mortality in military populations was infectious disease, not battle wounds. This trend reappeared during the Vietnam War. Among the main causes of disease were those caused by vectors, especially for diseases such as plague, yellow fever, malaria, louse borne typhus and louse borne relapsing fever [19].

3.2. Mosquito borne

Mosquito borne diseases can be caused by various agents such as viruses or protozoans. Historically, diseases such as malaria and yellow fever have negatively impacted military operations. Military personnel returning to the US from European, African and the Pacific theaters after World War II are thought to have drastically increased the incidence of malaria in the US [15]. By the end of the decade after the war, malaria was eradicated from the US, with the country being certified malaria free in 1969 [15]. Even though malaria was eradicated in the US, during the Korean War, military personnel returning from the conflict to the United States are thought to have imported malaria back to the US. For example, in 1952, Camp Fire girls attending summer camp in California contracted *Plasmodium vivax* brought to the region by returning Korean veterans. This was possible because of the latency period of *P. vivax*, which can approach 1 year in duration. Importation during this period caused the incidence of malaria to spike in the US, reaching a high of 7023 cases in 1952 [20]. This importation of malaria to the US by returning military personnel also occurred during the Vietnam War. From 1965 to 1968, the incidence of malaria increased in the US from 50 cases to a high of 2610 in 1968. Most of these cases were in US military personnel but in 1967, the number of civilian cases peaked at 157, an increase of 119 in only 8 years. At least once case of malaria was reported from each state during this time frame [21]. More recently, from 1981 through 1989, malaria was re-imported into the former USSR by troops returning from fighting in Afghanistan. During this period, over 7000 cases of malaria were reported in the USSR in personnel returning from the war. All cases were caused by *Plasmodium falciparum* and *P. vivax*, which were thought to have been eradicated in the USSR prior to the conflict. This importation of malaria caused the incidence to rise in the overall population, with cases reaching at least 420,000 in 1985 [22]. Finally, from

2003 to 2005, 423 US military personnel contracted malaria while deployed to the demilitarized zone (DMZ) in South Korea. The cases were primarily caused by *P. vivax*, however, approximately 20% of the cases were caused by *P. falciparum*. Additionally, cases were reported in military personnel deployed to Afghanistan, Liberia and Honduras. Of importance is the fact that within 45% of those diagnosed with malaria, the diagnosis occurred more than 240 days after the mid-point of their service in Korea [23]. This implies that these military personnel could serve as reservoirs to import malaria to the US or other countries to which they may be deployed. This is important because malaria has been considered eradicated from the United States, although the primary vector, Anopheles mosquitos, still occur, indicating that the movement of US military personnel around the globe could act as a method of reintroduction of malaria, much like happened in the USSR.

While it has been shown that malaria can and has been imported and reintroduced through military operations, it is by no means the only mosquito borne disease impacted by the global movement of military personnel. Once such disease is dengue and dengue hemorrhagic fever, both transmitted by several species of the *Aedes* mosquito type, primarily *Aedes aegypti* [24]. Historically, dengue has caused major illness in military personnel. Dengue was present in US troops in the Spanish-American War, during the conflict in Cuba to contain yellow fever, during World War II, the Vietnam War and during operations in Somalia. Troop movements during the conflict in Cuba are thought to have led to an outbreak of dengue in Texas as troops returned to the US from Cuba, resulting in over 6000 people being infected [25]. In the Philippines, dengue was second only to venereal diseases as the most common illness in US personnel stationed there at the start of the twentieth century [26]. During Operation Restore Hope in Somalia in 1992–1993, US personnel were shown to have contracted dengue, with 45% of those with an undefined fever having confirmed dengue through seroepidemiologic confirmation [27]. More recently, US personnel deployed to Haiti testing positive for dengue fever accounted for 25% of all hospital admissions within the first 6 weeks of the deployment [28]. While no recent cases of dengue in the US have been shown to have occurred because of the movement of military personnel, an outbreak of dengue in Australian troops during operations in East Timor highlighted the possibility for returning military personnel to import dengue to areas where it has been eradicated. During retrograde operations from East Timor, nine Australian military personnel were confirmed positive for dengue after their return to north Queensland. While no local transmission cases occurred, the potential for importation is possible due to the mosquito vectors being present. This is also true in the US, where species of *Aedes* mosquitoes are common throughout much of the US [29].

Other mosquito borne diseases shown to have the potential for importation by military personnel include chikungunya, West Nile and Rift Valley virus and lymphatic filariasis. A new variant of chikungunya has been shown to have been introduced to temperate regions such as the US, possibly by troop movements. This is important because this variant is associated with a new vector, *Aedes albopictus*, which possibly has a more cosmopolitan distribution that *Aedes aegypti*, the more common vector of chikungunya. Additionally, serological evidence supports the importation of lymphatic filariasis to Australia by an Australian soldier stationed in Timor [15]. These incidences highlight the potential for military personnel to import many mosquito borne diseases across the globe.

3.3. Tick borne

Ticks are ectoparasites, meaning they feed on their hosts on the skin or body surface. They are known to be vectors for several viral and bacterial diseases including ehrlichiosis, tularemia, Rocky Mountain spotted fever, Lyme disease and many others [15]. Military personnel are at a high risk for tick borne diseases because of their increased time in rural, remote areas due to training and combat operations. For example, 11.9% of recruits in the Finnish Army were shown to be positive for antibodies against *Borrelia burgdorferi*, the causative agent of Lyme disease, while US armed forces show exposure exceeding those in the general US population [15]. The same outcomes occur for spotted fevers. During a training exercise in 1989 located in Arkansas and Virginia in the US, 15% of military personnel tested positive for *Rickettsia rickettsii*, the causative agent for Rocky Mountain spotted fever. These cases occurred in troops from states where the disease was not found, indicating they were novel cases which had the potential to be carried back to the home states of the military personnel if not diagnosed and treated [15]. If ticks capable of being a competent vector occur in those states, the geographic range of the disease would be increased. The same disease has been shown to be common in British military personnel deployed to Afghanistan with as many as 4.9% seroconverting for exposure to *Rickettsia* spp. and 2.7% converting after their deployment to Afghanistan. This implies that it may be possible for these personnel to carry the disease to the United Kingdom [30].

Ticks are also the primary vector for Crimean-Congo hemorrhagic fever (CCHF), a disease caused by an arbovirus in the *Bunyaviridae* family. CCHF is spread from host mammals such as rodents and small mammals to humans through the bite of *Hyalomma* tick species [31]. CCHF has been shown to be present in Afghanistan, where military operations, led by the North Atlantic Treaty Organization (NATO), have been occurring since 2003, where the risk for CCHF exposure is high. US military personnel deployed to Afghanistan are at risk for contracting CCHF, with one US military member contracting the disease in Afghanistan, which ultimately led to his death [30]. Evidence exists which indicates CCHF can be imported to new geographic regions via the movement of individuals coming from areas endemic for the disease. In 2012, health care providers in the United Kingdom confirmed a case of CCHF in an individual returning from Afghanistan [32]. Because *Hyalomma* ticks are common across Europe, introduction of the arbovirus by military personnel and an expansion of the geographic distribution of the disease are of potential concern to public health organizations.

3.4. Sand flies

Sand flies include species of flies found in several different Genera. Of concern are those of the Genera *Phlebotomus* and *Lutzomyia*, both of which can transmit the parasites of the *Leishmania* type [15]. This parasite is responsible for leishmaniasis, a disease with two main forms in humans, cutaneous and visceral. As an emerging vector borne disease, much research into the life history, distribution and potential for range expansion has been conducted regarding the vector, the sand fly [33]. Sand flies are crepuscular, with the highest infection rates occurring at dusk and dawn [34]. The organisms responsible for causing leishmaniasis are found in over 90 countries, including those with current military activity. Of note are military operations occurring in Afghanistan and formerly in Iraq [34] where genetic sequencing has confirmed the

parasite in areas where NATO troops are operating [35]. Rates of infection in military personnel can be high. During operations in Afghanistan and Iraq, it is estimated that at least 1300 US military personnel have contracted leishmaniasis [36], an incidence higher than that seen in US military personnel in World War II [34]. British, Dutch and German forces have also experienced leishmania infections while deployed to Afghanistan [15]. Additionally, 45% of all cases of leishmaniasis seen in the United Kingdom in 2011 were in British military personnel who had conducted training in Belize [37]. Little research has been conducted on the capacity for sand fly species in non-endemic areas to transmit the disease, however, Claborn et al. were able to show that species of sand flies in the genus *Lutzomyia* found in the US may be capable of serving as vectors for Old World, temperate adapted species of *Leishmania* types [36]. This implies that military personnel could serve as a reservoir to expand the geographic range of Old World types to the New World if endemic sand flies received the parasite from an infected individual.

Sand flies are also competent vectors for an arboviral infection caused by serotypes of the Phlebovirus. This infection, often called sand fly fever or pappataci, is considered a disease of military importance, affecting military personnel deployed to the Middle East and the Mediterranean. During World War II, sand fly fever was of serious concern to allied forces, with over 19,000 cases reported. Outbreaks have been reported in allied forces deployed to Afghanistan, although at numbers far fewer than for leishmaniasis [15]. Of British military personnel deployed to Afghanistan, only 4.8% were shown to have seroconverted. However, local populations show high rates of seroconversion, indicating the risk to military personnel operating in these areas, and the subsequent risk of importation to other countries remains high [15].

3.5. Infectious disease

In the context of this discussion, infectious diseases are those that are spread by means other than vectors. These can include emerging infectious diseases, which are those that are entirely new to a population or geographic region or that have been re-introduced. The conditions that favor this emergence are often encountered during military conflict, increasing the risk of the disease not only to the civilian populace, but to military personnel mobilized to these areas. The emergence of these infectious diseases can often be a two-way street, meaning military personnel may bring diseases with them or local diseases may be transported by military personnel to their home countries or regions. For example, Lassa fever, an often-fatal viral disease, was imported to Germany from Sierra Leone in 2006 while a case was imported to the US from Liberia in 2004. Additionally, cases were imported to the Netherlands in 2000 and the United Kingdom in 2003 by military personnel returning from peace keeping missions. In both countries, war had displaced large numbers of people with aid workers and military personnel moving in and out on a regular basis [38].

3.6. Respiratory diseases

Influenza remains a disease of serious concern for military personnel. As militaries from various countries are mobilized to more and more places, the risks of an influenza pandemic increase. Even with higher vaccination rates, military personnel show high rates of infection and seroconversion. For example, in 2011, 30.1% of US military personnel seroconverted for

influenza, even though the US Department of Defense requires mandatory vaccination of all military personnel. A new variant of influenza (H3N2 A/Wuhan) was the primary causative agent for an acute outbreak of influenza aboard a US Navy vessel in 1995–1996. During the outbreak, over 95% of the crew had received the influenza vaccine for that year. Even with this high vaccination rate, 232 crew members contracted the flu. The source of the outbreak was a single sailor who had vacationed in North Carolina prior to the ship sailing [39]. Even with high vaccination rates, the high rate of infection occurred because of the new variant of the virus which was not included in the vaccine. This underscores the capability of highly mobile military personnel to serve as conduits for a rapid spread of novel diseases. This potential for rapid expansion and emergence of novel strains was apparent in 1976 when a Private David Lewis died of influenza while training at Fort Dix, New Jersey. Post mortem examinations revealed he had died from a novel strain of swine flu, prompting the Centers for Disease Control and Prevention and the President of the United States, Gerald Ford, to declare an emergency and mandate a 100% vaccination rate. Ultimately, an epidemic did not occur, however it highlighted the potential for a new global influenza pandemic [40].

Other respiratory diseases shown to be capable of mobilization and transmission by military personnel include pneumonia, pharyngitis and acute rheumatic fever, pertussis and tuberculosis. Of grave concern is the appearance of bacterial resistant strains of the causative agents for these diseases. Many of these strains are not endemic to the country of origin for the military personnel. For examples, *Streptococcus pneumoniae* epidemics in military personnel became rare by the 1980's, due to the use of antibiotics in treatment. However, multi-drug resistant strains reported in civilian populations globally have caused outbreaks among US military personnel. The rate of drug resistant forms has increased to over 70% in Korea, with US military personnel and their families contracting these strains. Additionally, US ship's crews in the Mediterranean have experienced outbreaks of resistant pneumonia while operating off the coast of Italy [41]. Increases in the prevalence of resistant *Streptococcus pyogenes* have also been noted in US military personnel, even though these strains typically only occur in Europe and Japan, both regions with an active US military presence [41]. These strains are rare in US civilian populations but may be introduced by military personnel if not actively monitored and controlled. In 1997, Fort Jackson, South Carolina experienced an outbreak of adenovirus type-4 among its basic trainees. Because graduating basic trainees typically move directly from basic training to their advanced schools at other installations, they may serve as a conduit for disease expansion. One such graduate from Ft. Jackson was shipped to Fort Gordon, Georgia. Because of an unusually long incubation period of 58 days, this graduate introduced adenovirus type-4 to Ft. Gordon, which then experienced its own installation wide outbreak [42]. This example highlights the ability of military personnel to transfer infectious diseases from location to location and introduce it to the local population. Alternatively, French soldiers typically do not receive vaccinations against *Bordella pertussis* as an adult. While deployed in support of International Security Assistance Forces in Afghanistan in 2006 and 2007, French soldiers were exposed to the pertussis bacteria. By the end of the pertussis outbreak, the cumulative attack rate among French soldiers reached 20%, illustrating the potential for military personnel from other countries to be exposed to novel infectious agents, especially when they have no native resistance to the causative agent [43]. Because of its public health significance, tuberculosis remains a global disease of concern as multi-drug

resistant strains have developed in many parts of the world [44]. Military activities, due to their cramped living and operating conditions, provide a prime habitat for TB outbreaks to occur. Additionally, because military personnel, especially naval personnel, are often exposed to novel or resistant strains while in contact with the resident population where they embark, they are at risk for contracting and spreading TB. In 1987, the seroconversion rate for the crew of the USS Saipan was 24.5% [45], which was a decrease from the 48% seroconversion rate of the USS Richard Byrd in 1966. Because of these declining seroconversion rates, it was thought that adequate control measures had been developed, mitigating the risk of TB on ships. However, in 1998, the US Navy experienced an outbreak of TB aboard a large Navy amphibious ship. Of the approximately 1000 crew members on board, 21 members developed active TB and 447 were positive for the Mantoux tuberculin skin test (TST). All were thought to be new cases [45]. A second outbreak occurred in 2006 aboard the aircraft carrier, USS Ronald Reagan. During this outbreak, a sailor born in the Republic of the Philippines, who was diagnosed with latent tuberculosis infection (LTBI), converted to active TB. Of the approximately 4000 personnel on the ship, 134 had a new TST result, most likely from the recent transmission of tuberculosis from the index case [46]. Additionally, over 1300 civilians were allowed on the ship as it returned to its home port in San Diego, California. Of these, only one exhibited a new positive result. Of more importance, the Navy was unable to locate 33 sailors who may have been exposed due to separation from the Navy. In this instance, the ultimate source of the outbreak was a foreign-born sailor who converted to active TB, meaning the source of the bacteria was not the US, although US personnel potentially brought the strain back to the US.

3.7. Gastrointestinal disorders

While respiratory diseases are of major concern, diseases of the gut and intestines may occur at a much greater incidence. Diseases such as norovirus, salmonella, *E. coli* and others are the second most leading cause of global disease burden [47]. Historically, diseases such as cholera, dysentery and typhoid, caused by *Salmonella enterica*, have caused serious disease morbidity and mortality for military personnel, often by transmission from the local environment to incoming military personnel. However, these diseases have also moved among these same personnel. For example, during the Spanish-American War of 1898, typhoid affected more than 24,000 US military personnel training at camps in preparation for mobilization. This outbreak was used by MAJ Walter Reed to determine the origin of typhoid in the camps and the development of controls to reduce its impact on military operations [48].

Many of the causative agents, especially bacterial agents, are showing resistance to antimicrobial therapy [49]. This resistivity varies geographically, as does the primary causative agent. In the US and other parts of the world, ETEC or enterotoxigenic *Escherichia coli* accounts for the majority of traveler's diarrhea. However, in Thailand, the primary agent is *Campylobacter* species. Of note is the resistance of this particular strain to quinolones and other antibiotics in Thailand. Military personnel deployed to in Thailand in 1987 and 1990 showed resistance up to 11% of the time, resulting in relapse of the disease. By 1995, resistance had increased to 84%. Because resistance is high, relapse is also high [49]. One potential outcome of this resistance and relapse is the introduction of this novel strain into other parts of the world as deployed personnel return to their country of origin. This has the potential to change the

geographic distribution of this resistant strain of *Campylobacter* from regional to global. Other bacteria responsible for diarrhea have also shown resistance in deployed military personnel. During Operation Desert Storm, US military forces suffered from high rates of gastrointestinal infections. Of 432 US military personnel reporting with gastroenteritis, 17% were found to be infected with antibiotic resistant *E. coli*, 54% of *Shigella sonnei* infections were resistant as were many other causative agents [50].

Other diseases, while not specifically resistant, have shown a propensity for expansion of its geographic distribution through military operations. Cholera was historically contained to the Indian subcontinent but was brought to other areas of the globe through shipping and trade, including the slave trade. However, the first cholera pandemic occurred from 1817 to 1823, caused by the movement of British troops and camp followers in the Indian subcontinent and abroad. A similar pattern occurred during the Crimean War [51]. Asiatic cholera was first introduced to the US by immigrants arriving at seaports. While rare up until the mid-1800s, cholera rapidly expanded in the US, partially by the movement of troops westward. This westward expansion of military forces, and subsequent expansion of cholera, resulted in outbreaks among civilian populations who would not otherwise have been exposed [52]. More recently, humanitarian military operations resulted in the introduction of cholera to an area where it had not been endemic. In 2010, a catastrophic earthquake struck Haiti, effectively destroying its infrastructure. In response, the United Nations mobilized peace keeping forces to aid in security and recovery. By October 2010, Haiti began to see cholera cases appear in the local populace. As of July 2015, almost 750,000 cases of cholera had occurred on Haiti, resulting in almost 9000 deaths [53]. Genotyping of the cholera strain indicate the source was from South Asia, particularly the Bangladesh and Indian subcontinent. During the peacekeeping operations, the United Nations sent military personnel from Nepal to support the operation. Based on the genotyping, and the peacekeepers present, it was concluded that the source of the outbreak was the Nepalese military personnel who had set their camp up along a river bank that served as a source of domestic water for the Haitians [54]. The resulting outbreak was the largest cholera outbreak to ever occur. It was not until December of 2016 that the UN Secretary-General, Ban Ki-Moon, acknowledged the UN's role in the disaster. This episode drastically illustrates the potential for military forces to import diseases to areas where they are deployed and the scope of the potential outcome when this occurs.

3.8. Other bacterial infections

One final note involves organisms that are normally not pathogenic, but have the potential to become so, especially when individuals are exposed to a novel strain. *Acinetobacter baumannii* are common bacteria found in the soil, on skin and other surfaces, particularly artificial surfaces. Recently, *Acinetobacter baumannii* has emerged as an important pathogen in hospital settings, resulting in nosocomial infections in patients with an associated increase in morbidity, morality and health care costs. Since operations began in Iraq, the incidence of infection by *Acinetobacter baumannii* in US military personnel has increased [55]. While *Acinetobacter baumannii* is not unique to Iraq or Afghanistan, multi-drug resistant forms, until recently, were relatively rare in the US [56]. Molecular genotyping of the multidrug resistant forms found on US personnel, indicate a subtype found in the Middle East as the primary infectious agent

in wounds sustained in combat operations in the region. Because *Acinetobacter baumannii* survive extended periods of up to 4 months, medical devices may be a source for nosocomial infections [57]. Similar patterns of initial and nosocomial infection have been seen in United Kingdom military personnel injured in Iraq and Afghanistan. The most common strain found in wounded personnel of the US and the UK is isolates of the T strain. This strain is associated with the Middle East, particularly Iraq [58]. The movement of these military patients has resulted in the international transfer of multidrug resistant *Acinetobacter baumannii* strains into other European countries as well as into the US [59]. These same strains are now found in the US. Similar strains have been independently found in injured soldiers being returned to Canada. This is significant because in Canada, unlike in the US, military wounded are cared for in civilian hospitals, not military hospitals. This increases the risk of the T strain of *Acinetobacter baumannii* becoming established in the civilian health care system in Canada, thereby increasing the risk for nosocomial infections [60].

4. Conclusions

The introduction of novel diseases is a hot topic not only in the United States, but also in Europe, South America and globally [61]. This has become more important as these diseases have re-emerged and spread. Within the last 20 years alone, the increased number of military operations has resulted in a marked increase in the movement of personnel and equipment. As military forces are increasingly mobilized globally in combat and peace keeping roles, the risks of increasing the distribution of emerging infectious diseases will also increase. Detection and control of these emerging diseases will be a major challenge, not only for those countries where military operations are occurring, but also in the countries providing personnel and equipment for these operations [38]. As the disruption of impacted societies increases due to military operations, it is reasonable to expect the emergence or re-emergence of diseases will increase. While increasing military deployments and operations may increase the risk and rate of the spread of infections and emerging diseases, these same militaries can improve surveillance by partnering with local governments and officials to improve their capacity and capabilities. These mutual engagements could potentially reduce the time for detection of an epidemic of global significance. While detection and control of emerging disease is the major challenge facing humans today, partnered engagements may serve to reduce the risk. Going forward, militaries may need to expand their role in post-disaster assistance, surveillance and other activities that could possibly expand the public health capacity of the civilian populations.

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