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Population Health during Combat Operations

Matthew S. Goldberg, Project Leader Linda Wu Ethan W. Novak

October 2017 Approved for public release; distribution is unlimited. IDA Document NS D-8697 Log: H 17-000496

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About this Publication

This work was conducted by the Institute for Defense Analyses (IDA) under contract HQ0034-14-D-0001, independent research program (C7183), "Health during Combat Operations." The views, opinions, and findings should not be construed as representing the official position of either the Department of Defense or the sponsoring organization.

Acknowledgments

Thank you to Philip M. Lurie and Julie A. Pechacek for performing technical review of this document.

For More Information: Matthew S. Goldberg, Project Leader mgoldber@ida.org, (703) 578-2728

David J. Nicholls, Director, Cost Analysis and Research Division dnicholl@ida.org, (703) 575-4991

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IDA Document NS D-8697

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Executive Summary

Health Care Delivered in the Combat Theater

The recent wars in Iraq and Afghanistan have taken a heavy toll on the US military. During Operation Iraqi Freedom (OIF), which ended in August 2010, there were nearly 3,500 hostile deaths among US military personnel and 32,000 more wounded in action (WIA). During Operation Enduring Freedom (OEF, in and around Afghanistan), which ended in December 2014, there were more than 1,800 hostile deaths and about 20,000 were WIA.¹

The Institute for Defense Analyses (IDA) has conducted several studies that categorize the diagnoses and treatments of traumatic battle wounds in theater, the medical specialists that cared for those wounds, and the ability of military hospitals in the United States to train enough of those specialists.² However, less effort has gone toward estimating the numbers and types of military medical providers who must be deployed to ensure the health of the entire deployed military population. Treatment of disease and non-battle injury (DNBI) often requires different medical specialities than does the treatment of battle injuries.

The most severely ill or injured personnel are evacuated by military air transport to higher echelons of care if theater medical resources are not adequate to treat them. The first stop from either the Iraq or Afghanistan theater of operations is typically Landstuhl Regional Medical Center in Germany, continuing if necessary for definitive care to a facility in the continental United States, such as Walter Reed National Military Medical Center (Bethesda, MD) or San Antonio Military Medical Center (Joint Base San Antonio, TX).

Among all of the medical evacuations from the two theaters, only 18 percent of those from Iraq and 24 percent of those from Afghanistan were for battle injuries. The next three largest diagnosis categories (each accounting for at least 12 percent of medical evacuations

¹ Matthew S. Goldberg, "Casualty Rates of US Military Personnel during the Wars in Iraq and Afghanistan," *Defence and Peace Economics*, published online (in advance of print) January 20, 2016, doi: 10.1080/10242694.2015.1129816.

² John E. Whitley et al., "Medical Total Force Management," IDA Paper P-5047 (Alexandria, VA: Institute for Defense Analyses, May 2014); John E. Whitley et al., "Essential Medical Capabilities and Medical Readiness," IDA Paper NS P-5305 (Alexandria, VA: Institute for Defense Analyses, July 2016); and Philip M. Lurie et al., "Medical Readiness within Inpatient Platforms," IDA Paper P-8464 (Alexandria, VA: Institute for Defense Analyses, August 2017).

from both theaters and collectively more than 40 percent) were musculoskeletal disorders (mostly of the back or knee), non-battle injuries (mostly sprains and fractures of the extremities), and mental health disorders (the most frequent conditions being adjustment reactions, mood disorders, anxiety disorders, and post-traumatic stress disorder).

Female Service members have had an increasing role in the US military over the past two decades. In 1993, they were given the opportunity to fly fighter jets and serve on combat ships at sea. The Direct Ground Combat Definition and Assignment Rule—which prohibited women from being assigned to units whose primary mission was engaging in direct ground combat—was in effect through December 2015. However, because irregular warfare does not respect an established front line, female members who served in support roles were still at considerable risk for combat injuries and death—for example, while riding in vehicles that struck improvised explosive devices. About 110 female Service members were killed in action in Iraq and another 50 in Afghanistan; about 640 were wounded in action in Iraq and 380 in Afghanistan.

Female Service members were less likely than males to be wounded in Afghanistan and less likely to be evacuated from theater if wounded (comparable data for Iraq are not readily available). The combined effect is that the rate of evacuation from Afghanistan for battle injuries was 10.0 per 1,000 deployed troop-years for males but 1.3 per 1,000 for females. However, evacuation rates for certain types of DNBI were much higher for females than for males, pointing out the need for women's health providers to deploy in adequate numbers when the military population contains as many as 20,000 female members. For example, the evacuation rate for breast disorders was more than 27 times as high for females as for males, primarily driven by one specific diagnosis code for "lump or mass in breast." The evacuation rate for genitourinary disorders was 3.9 per 1,000 for females versus 1.4 per 1,000 for males. Further, in accordance with military policy, all pregnant service members are evacuated from the wartime theater: 103 evacuations from Afghanistan between October 2001 and December 2012, and 268 evacuations from Iraq between January 2003 and December 2011. Conversely, female Service members show significantly lower evacuation rates than males in several other categories such as nonbattle injuries and poisonings, and diagnoses involving the circulatory system.

The next tier of severity below evacuation consists of medical conditions classified as DNBI that did not require evacuation, but that required either inpatient or outpatient care within the theater, after which the patient was typically returned to duty. Regarding inpatient care, the 10 most frequent diagnostic groups accounted for 73 percent of all inpatient DNBI diagnoses in Iraq in 2007 (the year of the surge). Eight of the 10 most frequent diagnoses cluster into these three larger categories:

• Internal medicine: nonspecific chest pain, abdominal pain, appendicitis (34 percent).

- Non-combat wounds: skin infections; open wounds of extremities; open wounds of head, neck, and trunk (16 percent).
- Non-combat injuries: other injuries, fracture of lower limb (12 percent).

The breakout of DNBI that required inpatient care in Afghanistan during 2010 (the year of the surge in that theater) was similar, with the addition of burns to the category of non-combat wounds, and epilepsy/convulsions to the category of internal medicine.³

Turning to outpatient care, the 10 most frequent diagnostic groups accounted for 70 percent of all outpatient DNBI diagnoses in Iraq in 2007. Nine of the 10 most frequent diagnoses cluster into these three larger categories, which are not the same as the ones identified above for inpatient diagnoses:

- Non-surgical orthopedics/rheumatology: rehabilitation care, back problems, sprains and strains, non-traumatic joint disorders, connective tissue disease. (37 percent)
- Internal medicine: medical examination/evaluation, upper respiratory infections, immunizations and infectious disease (20 percent).
- Mental health: administrative/social (8 percent).⁴

The breakout of DNBI that required outpatient care in Afghanistan during 2010 is, again, similar.

Identified Areas of Concern

The evacuation data revealed women's health as an area of concern, and the DNBI treatment data reveal mental health and non-surgical orthopedics as additional areas. The requirement for orthopedic care is understandable in that many of the Service members who deployed to Iraq or Afghanistan were from the Reserves or National Guard, and tend to be older than members of the Active Components. Also, they carried heavy loads of equipment and body armor. Older reservists carrying that much weight over rugged terrain are especially prone to orthopedic injuries to the back, knees, and other areas of the body. The problems were particularly acute when compounded with areas of high altitude in Afghanistan: Bagram Airfield lies at an altitude of 1,480 meters (4,850 ft.), and the capital, Kabul, lies at an altitude of 1,800 meters (5,900 ft.).

³ Some medical evidence links seizures to high altitude. See, for example, Edward H. Maa, "How Do You Approach Seizures in the High Altitude Traveler?" *High Altitude Medicine and Biology*, March 2011, 12(1): 13–19.

⁴ Administrative/social diagnoses are assigned when a service member receives counseling for any of a wide range of issues including family and household problems, alcohol or drug abuse, or HIV.

Having identified these areas of concern, the next question is whether adequate number of providers deployed to Iraq and Afghanistan in the appropriate medical specialties. Again concentrating on Iraq in 2007 and Afghanistan in 2010, IDA compared the numbers of medical specialists who deployed to those two conflicts against the inventories in the Active and Reserve Components. Those tabulations, along with a review of published studies, suggest that the fraction of the inventory that deployed in those specialty areas may not have been adequate. Not quite five annual-equivalent women's health providers were deployed in 2007 to Iraq and only one was deployed in 2010 to Afghanistan. Those deployed providers represented less than 1 percent of the combined Active and Reserve inventory. Only 120 annual-equivalent mental health providers (including both enlisted and officer personnel) were deployed in 2007 to Iraq, and only 45 were deployed in 2010 to Afghanistan. Those totals represented between about 1 percent and 4 percent of the Active inventory of mental health providers and between 1 percent and 5 percent of the Reserve inventory. Finally, only 59 annual-equivalent orthopedic care providers (again including both enlisted and officer personnel) were deployed in 2007 to Iraq and only five were deployed in 2010 to Afghanistan. Those totals represented no more than 4 percent of the inventory levels in the orthopedic specialties.

Additional research is called for to develop the requirement for a deployed medical force capable of ensuring the health of a deployed military population that, at its peak, exceeded 100,000 Service members in and around Afghanistan and 200,000 in Iraq. The requirement should be sized to meet medical practice norms for both the average number of ill or injured Service members treated by each deployed medical provider, and the population served ("panel size") for each such provider.

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The recent wars in Iraq and Afghanistan have taken a heavy toll on the US military. During Operation Iraqi Freedom (OIF), which ended in August 2010, there were nearly 3,500 hostile deaths among US military personnel and 32,000 more wounded in action (WIA). During Operation Enduring Freedom (OEF, in and around Afghanistan), which ended in December 2014, there were more than 1,800 hostile deaths and about 20,000 were WIA.¹

The Institute for Defense Analyses (IDA) has conducted several studies that categorize the diagnoses and treatments of traumatic battle wounds in theater, the medical specialists that cared for those wounds, and the ability of military hospitals in the United States to train enough of those specialists.² However, less effort has gone toward estimating the numbers and types of military medical providers who must be deployed to ensure the health of the entire deployed military population. Treatment of disease and non-battle injury (DNBI) often requires different medical specialities than does the treatment of battle injuries.

This document identifies and quantifies three tiers of DNBI that occurred during the periods of peak activity ("surges") in the recent conflicts in Afghanistan and Iraq, in decreasing order of severity:

- Medical conditions that required the Service member to be evacuated from the theater of operations;
- Medical conditions that did not require evacuation but that required inpatient care within the theater; and
- Medical conditions that required neither evacuation nor inpatient care, but that required outpatient care at a Role 2 medical facility (i.e., a forward surgical station) or higher.

¹ Matthew S. Goldberg, "Casualty Rates of US Military Personnel during the Wars in Iraq and Afghanistan," *Defence and Peace Economics*, published online (in advance of print) January 20, 2016, doi: 10.1080/10242694.2015.1129816.

² John E. Whitley et al., "Medical Total Force Management," IDA Paper P-5047 (Alexandria, VA: Institute for Defense Analyses, May 2014); John E. Whitley et al., "Essential Medical Capabilities and Medical Readiness," IDA Paper NS P-5305 (Alexandria, VA: Institute for Defense Analyses, July 2016); and Philip M. Lurie et al., "Medical Readiness within Inpatient Platforms," IDA Paper P-8464 (Alexandria, VA: Institute for Defense Analyses, August 2017).

Three areas of particular concern are identified: women's health, mental health, and non-battle injuries that require orthopedic treatment. This document tabulates the numbers of providers with the corresponding specialties who deployed to Iraq and Afghanistan, and compares them to inventories of medical specialists in the Active and Reserve Components. Those tabulations, along with a review of published studies, suggest that the fraction of the inventory that deployed in those specialty areas may not have been adequate. Additional research is called for to develop the requirement for a deployed medical force capable of ensuring the health of a deployed military population that, at its peak, exceeded 100,000 Service members in and around Afghanistan and 200,000 in Iraq.

2. Medical Treatment of US Military Personnel Deployed to Iraq and Afghanistan

A. Classification of US Military Casualties

The Department of Defense (DoD) defines a "casualty" as a Service member who is lost to his or her unit as a result of death, wounding, or injury.³ DoD further classifies a casualty as "hostile" if it is sustained during a combat mission, or on the way to or from a combat mission if directly related to that mission. This definition includes friendly-fire incidents (US Service members wounded or killed mistakenly by US or allied forces) but excludes injuries or deaths due to the natural elements, self-inflicted wounds, or combat fatigue.⁴

DoD distinguishes among three types of hostile casualties, depending on whether the injured Service member survived and, if not, the location where he or she died:

- Killed in action (KIA), if the service member died immediately on the battlefield;
- Died of wounds (DOW), if the Service member survived the injury on the battlefield but died after being admitted to a forward surgical station or a combat support hospital;⁵
- Wounded in action (WIA), if the Service member survived his or her injuries beyond the initial hospital admission.

In practice, KIAs and DOWs are usually combined into a single category, without regard to the location of death. Service members who are declared WIA, and who later die because of the attenuated life expectancy associated with their wounds (whether or not under the care of either DoD medical facilities or those of the Department of Veterans Affairs), are *not* retrospectively reclassified as DOW.

Other deaths and injuries—not the direct result of hostilities—come about from causes such as motor vehicle or industrial accidents (e.g., falls), homicides, or suicides.

³ "Defense Casualty Analysis System," Defense Manpower Data Center (DMDC), www.dmdc.osd.mil /dcas/pages/faq.xhtml.

⁴ Department of Defense, "DoD Dictionary of Military and Associated Terms (as updated through June 2017)," www.dtic.mil/doctrine/dod_dictionary.

⁵ A forward surgical station is also known as a Role 2 medical facility, and a combat support hospital is also known as a Role 3 medical facility.

DoD includes non-hostile deaths in its official casualty reports, depicted as the inner dashed rectangle in Figure 1. The final category is non-hostile, non-fatal, disease and non-battle injury; tabulations of DNBI are not included in the casualty reports but are available from other DoD sources. As is the case with hostile injuries, non-fatal DNBI that results in premature death is *not* reclassified as fatal DNBI.



Figure 1. Classification of US Military Casualties, Injuries, and Disease

The literature suggests that DNBI has led to more hospitalizations and personnel lost than combat injuries during all major US conflicts from the American Revolution through the Gulf War.⁶ Therefore, DNBI will be a major focus of the current research.

Both non-hostile deaths and DNBI occurred in Iraq and Afghanistan at higher rates than would be expected in peacetime among military populations the same size as those deployed to the wartime theaters. During OIF between March 2003 and August 2010, there

⁶ S. F. Taylor, R. H. Lutz, and J. A. Millward, "Disease and Nonbattle Injury Related to Peacekeeping Operations in South America: Summary Patient Care Statistics for CABANAS 2000," *Military Medicine* 166, No. 12 (December 2001): 1059–61, https://www.ncbi.nlm.nih.gov/pubmed/11778404; S. F. Paparello et al., "Diarrheal and Respiratory Disease aboard the Hospital Ship, USNS Mercy T-AH-19, during Operation Desert Shield," *Military Medicine* 158, No. 6 (June 1993): 392–5, accessible through DTIC at http://www.dtic.mil/dtic/tr/fulltext/u2/a268438.pdf; G. C. Cook, "Influence of Diarrheal Disease on Military and Naval Campaigns," *Journal of the Royal Society of Medicine* 94, No. 2 (February 2001): 95–7, doi: 10.1177/014107680109400217; G. W. Beebe and M. E. DeBakey, *Battle Casualties: Incidence, Mortality, and Logistic Considerations* (Springfield, IL: Charles C. Thomas, 1952); and L. A. Palinkas and P. Coben, "Disease and Nonbattle Injuries among U.S. Marines in Vietnam," *Military Medicine* 153, No. 3 (March 1988):150–5.

were 3,479 hostile deaths and 929 non-hostile deaths; the latter were 21 percent of total deaths among US military personnel. Goldberg (2016) estimated that there would have been only 711 non-hostile deaths at the peacetime military death rate of 53.0 per 100,000 people per year, so there were 218 "excess deaths" (in the epidemiological sense of the term).⁷ Similarly, during OEF between October 2001 and December 2014, there were 1,836 hostile deaths and 510 non-hostile deaths; the latter were 22 percent of the total. Goldberg (2016) estimated that there would have been only 313 non-hostile deaths at the peacetime death rate, implying 197 excess deaths.

In much the same way as non-hostile death rates, it is easy to imagine DNBI rates being elevated in wartime. Conditions are austere: Bagram Airfield, Afghanistan lies at an altitude of 1,480 meters (4,850 ft.); the capital of Afghanistan, Kabul, lies at an altitude of 1,800 meters (5,900 ft.); and some remote portions of the country rise to more than 6,100 meters (20,000 ft.—at or above the service ceilings of US Army helicopters). Army studies have documented a lack of physical performance starting at 4,000 ft., and effects on cognitive performance (in addition to headache, nausea, dizziness, and shortness of breath) at 8,000 ft.⁸

In addition, many of the Service members who deployed to recent combat operations were from the Reserves or National Guard, and tend to be older than members of the Active Components. One study estimated the median ages as 24 years for regular Active Duty members deployed to Afghanistan or Iraq, 30 years for members of the National Guard, and 31 years for Reservists.⁹ Another study, using data from 2003, estimated that Army riflemen in Afghanistan carried an average equipment load of 63 lbs.¹⁰ Older Reservists carrying that much weight are especially prone to orthopedic injuries to the back, knees, and other areas of the body. In Afghanistan between October 2001 and December 2012, members of the Reserves or National Guard accounted for 20.6 percent of the military population (measured in troop-years, the equivalent of a single soldier serving for a period of a year) but a somewhat disproportionate 24.6 percent of medical evacuations (for all causes, combat-related or not) to Europe or back to the United States.¹¹

⁷ Goldberg, "Casualty Rates of US Military Personnel."

⁸ Rob Anastasio, "Army Studies High-Altitude Health Effects," January 5, 2010, www.army.mil/article /32487/army-studies-high-altitude-health-effects/.

⁹ Christopher Skeehan et al., "Nonbattle Injury Among Deployed Troops: An Epidemiologic Study," *Military Medicine* 174, No. 12 (December 2009): 1256–62, doi: 10.7205/MILMED-D-02-6008.

¹⁰ Lt. Col. Charles Dean (US Army), "The Modern Warrior's Combat Load," November 20, 2003, presentation, https://www.slideshare.net/James8981/call-combat-load-presentation1. The combat load of 63 lbs. represents 36 percent of the body weight of a typical 175-lb. soldier.

¹¹ Armed Forces Health Surveillance Center, "Medical Evacuations from Afghanistan during Operation Enduring Freedom, Active and Reserve Components, U.S. Armed Forces, 7 October 2001-31

B. Reasons for Medical Evacuations

Ill or injured personnel are evacuated by military air transport to higher echelons of care if theater medical resources are not adequate to treat them. The first stop from either the Iraq or Afghanistan theater of operation would typically be Landstuhl Regional Medical Center (LRMC), located near Ramstein Air Base, Germany. LRMC is a Role 4 medical facility, at which wounds, injuries, or illnesses are further assessed and treated. Patients with less severe medical conditions may be able to return to the combat zone. Those with more severe conditions are evacuated for definitive care to a Role 5 facility in the continental United States, typically either Walter Reed National Military Medical Center (Bethesda, MD) or San Antonio Military Medical Center (Joint Base San Antonio, TX).

Two studies by the Armed Forces Health Surveillance Center comprehensively tabulated medical evacuations from OEF in Afghanistan, and from OIF and Operation New Dawn (OND) in Iraq.¹² Battle injuries were the largest single cause, accounting for the plurality of medical evacuations from both theaters: 8,944, or 17.7 percent of evacuations from OIF/OND through December 2011; and 5,647, or 23.8 percent of evacuations from OEF through December 2012 (see Table 1).

December 2012," *Medical Surveillance Monthly Report* 20, No. 6 (June 2013): 2–8, www.afhsc.mil /documents/pubs/msmrs/2013/v20_n06.pdf.

¹² Ibid.; and Armed Forces Health Surveillance Center, "Medical Evacuations from Operation Iraqi Freedom/Operation New Dawn, Active and Reserve Components, U.S. Armed Forces, 2003-2011," *Medical Surveillance Monthly Report* 19, No. 2 (February 2012): 18–21, www.afhsc.mil/documents /pubs/msmrs/2012/v19_n02.pdf. Operation New Dawn was the successor to OIF, and ran from September 1, 2010 through December 15, 2011.

Diagnostic	OIF/OND, Jan 2003–Dec 2011			OEF, Oct 2001–Dec 2012		
(ICD-9-CM)	Number	Percentage	Rank	Number	Percentage	Rank
Battle injuries	8,944	17.7%	1	5,647	23.8%	1
Musculoskeletal system	8,257	16.3%	2	3,427	14.4%	2
Non-battle injuries and poisonings	7,542	14.9%	3	3,398	14.3%	3
Mental health disorders	5,892	11.6%	4	2,850	12.0%	4
Signs, symptoms, or ill-defined	5 005	40.00/	F	0.050	0.5%	F
conditions	5,065	10.0%	5	2,250	9.5%	Э
Digestive system	2,592	5.1%	7	1,124	4.7%	6
Nervous system	2,684	5.3%	6	1,105	4.7%	7
Genitourinary system (except						
breast disorders)	1,794	3.5%	8	1,028	4.3%	8
Circulatory system	1,512	3.0%	9	735	3.1%	9
Cumulative percentage		87.5%			90.9%	

 Table 1. Most Common Diagnostic Categories for Medical Evacuations

 from Iraq and Afghanistan

Sources: Armed Forces Health Surveillance Center, *Medical Surveillance Monthly Report*, February 2012 and June 2013.

Note: ICD-9-CM = International Classification of Diseases, Ninth Revision, Clinical Modification.

Battle-injury evacuations may be expressed not only as a percentage of all medical evacuations, but as a percentage of all WIA. For example, there were 31,503 WIA in OIF/OND through December 2011. The 8,944 battle-injured evacuations from OIF/OND represent 28.4 percent of the 31,503 total WIA.¹³ The other nearly three-quarters of WIA from OIF/OND were treated in theater and returned to duty without the need for medical evacuation. Similarly, there were 18,218 WIA in OEF through December 2012, so the 5,647 battle-injured evacuations represent 31.0 percent of all WIA from that conflict. For OEF, about two-thirds of WIA did not require medical evacuation. Figure 2 displays the medical and operational dispositions of the 5,647 evacuees.

¹³ Goldberg, "Casualty Rates of US Military Personnel." The percentage of medical evacuations among WIA during OIF has been remarkably constant; the cumulative percentage through January 2007 (just prior to the surge in Iraq) was 6,670/22,834 or 29.2 percent. See also Matthew S. Goldberg, "Death and Injury Rates of U.S. Military Personnel in Iraq," *Military Medicine* 175, No. 4 (April 2010): 222, https://www.ncbi.nlm.nih.gov/pubmed/20446496.



Sources: Armed Forces Health Surveillance Center, *Medical Surveillance Monthly Report*, June 2013; and Matthew S. Goldberg, "Taking Stock of Death and Injury Rates of U.S. Military Personnel during the Conflicts in Iraq and Afghanistan," presented at the MORS Symposium, Alexandria, VA, June 2014.



The two studies by the Armed Forces Health Surveillance Center classified DNBI cases into 18 illness or injury categories based on the ICD-9-CM diagnostic codes reported on records of medical encounters after evacuation. Battle injuries and eight categories of DNBI (in virtually the same rank order in both conflicts) accounted for about 90 percent of medical evacuations from both theaters (see Table 1). The largest single category of DNBI was musculoskeletal disorders, mostly of the back or knee. Non-battle injuries are mostly sprains and fractures of the extremities. The most frequent mental health disorders are adjustment reactions, mood disorders, anxiety disorders, and post-traumatic stress disorder (PTSD).

Signs, symptoms, or ill-defined conditions comprise a variety of codes for patients exhibiting abnormal symptoms absent or in advance of a specific disease diagnosis; one example would be elevated blood pressure without a diagnosis of hypertension.¹⁴ That category—along with disorders of the nervous, digestive, and circulatory systems— combine for 23.4 percent of the evacuations from Iraq and 22.0 percent of those from Afghanistan. Although those disorders suggest various physician specialties, a common link is that an internal medicine visit may have been adequate to determine the need for

¹⁴ More expansively, according to the Department of Veterans Affairs: "[This category] is not a diagnosis of an unknown syndrome or unusual illness ... This category includes more than 160 sub-categories and primarily consists of common symptoms and isolated laboratory abnormalities." See "Health Care Use by Gulf War & OEF/OIF/OND Veterans," U.S. Department of Veterans Affairs, www.publichealth.va.gov/epidemiology/reports/health-care-use-gulfwar-oefoifond/.

medical evacuation, or at least served as a gateway to a visit with a specialist who would make that determination.

C. Medical Evacuations of Female Military Personnel

Female Service members have had an increasing role in the US military over the past two decades. In 1993, they were given the opportunity to fly fighter jets and serve on combat ships at sea. The Direct Ground Combat Definition and Assignment Rule—which prohibited women from being assigned to units whose primary mission was to engage in direct ground combat—was rescinded in January 2013, when then-Secretary of Defense Leon Panetta directed that all military occupations be opened to qualified women by January 2016. His successor twice removed, former Secretary Ash Carter, endorsed and implemented that policy change as of January 1, 2016.¹⁵ However, because irregular warfare does not respect an established front line, female members who served in support roles before the policy change were still at considerable risk for combat injuries and death—for example, while riding in vehicles that struck improvised explosive devices.

Table 2 illustrates casualty statistics by gender. Female Service members contributed an estimated 9.4 percent of the troop-years in OEF through December 2012. Females comprised 2.1 percent of the Service members who were either KIA or DOW in that conflict, and 1.9 percent of those WIA (albeit measured for the entirety of OEF, through December 2014). In OIF/OND through December 2011, females comprised 2.5 percent of the KIA/DOW and 2.0 percent of the WIA.

¹⁵ Ash Carter, Secretary of Defense Speech: "Remarks on the Women-in-Service Review," December 3, 2015, U.S. Department of Defense, www.defense.gov/News/Speeches/Speech-View/Article/632495 /remarks-on-the-women-in-service-review/.

	Males			Females			
	Number	Percentage	Rate per 1,000	Number	Percentage	Rate per 1,000	
		Afghanis	stan (OEF)				
Troop-years in theater		90.6%			9.4%		
Killed in action/ Died of wounds	2,296	97.9%	4.3	50	2.1%	0.9	
Wounded in action	19,644	98.1%	36.7	383	1.9%	6.9	
Evacuated for battle injury	5,570	98.6%	10.0	77	1.4%	1.3	
		IRAQ (OIF/OND)				
Troop-years in theater		N/A			N/A		
Killed in action/ Died of wounds	4,373	97.5%	N/A	111	2.5%	N/A	
Wounded in action	31,503	98.0%	N/A	639	2.0%	N/A	
Evacuated for battle injury	8,764	98.0%	N/A	180	2.0%	N/A	

Table 2. Casualty Statistics for US Military Personnel, by Theater and Gender

Sources: Troop-years and evacuations from Armed Forces Health Surveillance Center, through December 2012 for OEF and through December 2011 for OIF/OND. Killed in action, died of wounds, and wounded in action from Defense Casualty Analysis System, through December 2014 for OEF and through December 2011 for OIF/OND.

Female Service members were less likely to be evacuated from Afghanistan if wounded: they made up 1.9 percent of the wounded, but only 1.4 percent of those evacuated for battle injuries. Because males had both a higher WIA rate than females and a higher evacuation rate among the wounded, their rate of evacuation for battle injury (the composite of those two factors) was much higher than that of females: 10.0 versus 1.3 per 1,000 deployed troop-years.

Dye et al. (2016) reported on combat injuries among female Service members during OIF and OEF.¹⁶ They found 433 such injuries in OIF between January 2003 and December 2011, and 411 such injuries in OEF between 2007 (month unspecified, presumably January) and May 2014.¹⁷ They used the Injury Severity Score (ISS) to classify the severity

¹⁶ Judy L. Dye et al., "Characterization and Comparison of Combat-Related Injuries in Women During OIF and OEF," *Military Medicine* 181, No. 1 (January Supplement 2016): 92–8, doi: 10.7205/MILMED-D-15-00237.

¹⁷ With reference to Iraq, Dye et al. were apparently referring to both OIF and OND. The latter operation replaced the former and ran from September 1, 2010 through December 15, 2011. Over the identical time period for OIF/OND, we show 639 (rather than 433) female WIAs in Table 2, a figure compiled from DoD's Defense Casualty Analysis System (DCAS). Regarding OEF, Dye et al. report 411 female WIAs for the sub-period 2007 through May 2014. We show a smaller total, 383 female WIAs, for the

of those injuries.¹⁸ They tabulated 23 serious injuries (ISS between 9 and 15) and seven severe injuries (ISS \geq 16) in Iraq; they found 39 serious injuries and 13 severe injuries in Afghanistan. They conducted a one-year follow-up of the 82 female Service members who suffered injuries with ISS \geq 9. Some 78, or 95 percent, required acute care hospitalization; the median number of inpatient days during the follow-up was 19 and the mean was 32. Among the same group, 35 of the 82 (43 percent) were admitted at least once to the intensive care unit (ICU); the median number of ICU days was 2 (reported only to the nearest whole number) and the mean was 5.

The medical needs of deployed female Service members are different from those of their male counterparts, at least as indicated by the conditions of sufficient severity to warrant medical evacuation from the wartime theater. Some of those gender differences are displayed in Table 3, which is reproduced from the Armed Forces Health Surveillance Center's tabulations for OEF through December 2012 (including a few more categories than were shown in Table 1 above). For example, females were evacuated at a rate of 6.1 per 1,000 troop-years for musculoskeletal injuries (the second-highest category for both genders combined, after battle injuries), but that rate only slightly exceeds the rate of 5.5 per 1,000 for males. Figure 3 highlights the diagnostic categories for which females have either much larger or much smaller incidence rates than males, as indicated by both a large absolute difference (the baseline being 0.0) (column 3) and a large relative difference (the baseline being 1.0) (column 4). (The available tabulations for OIF/OND do not contain sufficient detail to perform a similar analysis.)

entire conflict from October 2001 through December 2014. Although the base numbers of WIA in their study do not match official DoD tallies, their analysis of severity is still informative.

 ¹⁸ W. S. Copes et al., "The Injury Severity Score Revisited," *Journal of Trauma and Acute Care Surgery* 28, No. 1 (January 1998): 69–77. http://journals.lww.com/jtrauma/Citation/1988/01000 /The_Injury_Severity_Score_Revisited_.10.aspx.

		Rate per 1,00	0 Troop-Years	
Diagnostic Category (ICD-9-CM)	Males	Females	Female - male	Female / male
Battle injuries	10.0	1.3	-8.7	0.13
Musculoskeletal system	5.5	6.1	0.6	1.10
Non-battle injuries and poisonings	5.7	4.1	-1.6	0.73
Mental health disorders	4.3	7.6	3.3	1.76
Signs, symptoms, or ill-defined conditions	3.3	7.0	3.7	2.11
Digestive system	1.8	2.0	0.2	1.14
Nervous system	1.7	2.5	0.8	1.46
Genitourinary system (except breast disorders)	1.4	3.9	2.5	2.73
Circulatory system	1.2	1.0	-0.2	0.85
Respiratory system	0.5	0.8	0.3	1.49
Neoplasms	0.4	1.5	1.1	3.43
Skin and subcutaneous tissue	0.5	0.7	0.2	1.43
Infectious and parasitic diseases	0.4	0.6	0.2	1.59
Endocrine, nutrition, and immunity	0.3	0.9	0.6	2.92
Breast disorders	0.1	2.7	2.6	27.74

Table 3. Gender Differences in Medical Evacuation Rates from Afghanistan

Source: Armed Forces Health Surveillance Center, for the time period October 2001 through December 2012.



Source: Armed Forces Health Surveillance Center, for the time period October 2001 through December 2012.

Figure 3. Rates of Medical Evacuation from OEF by Gender and Selected Diagnoses

Although males, too, develop breast disorders, the evacuation rate is more than 27 times as high for females. One of the detailed codes in this category is primarily a concern for females: code 611.72, "lump or mass in breast." Female Service members with that diagnosis would be evacuated to Germany or the United States for further diagnosis and treatment options that are not available in theater.

The rate of 1.8 per 1,000 females for pregnancy and childbirth is consistent with 103 evacuations from Afghanistan between October 2001 and December 2012. Not reflected in Figure 3, there were 268 evacuations of females from Iraq for the same reasons between January 2003 and December 2011.

Three of the high-incidence codes in Afghanistan for genitourinary disorders apply exclusively to females. Male Service members did not have those three particular codes, but did have a total evacuation rate for genitourinary disorders of 1.4 per 1,000 troop-years. Females, at 3.9 evacuations per 1,000, had 2.7 times the incidence in that overall category.

Conversely, female Service members show significantly lower evacuation rates than males in several other categories such as non-battle injuries and poisonings, and diagnoses involving the circulatory system.

D. Most-Common DNBI Conditions Treated in Iraq and Afghanistan

The two respective surges occurred in Iraq during 2007 and in Afghanistan during 2010. Whitley et al. (2016) tabulated the most-common inpatient and outpatient diagnosis groups for care administered in-theater during those periods.¹⁹ That research was not restricted to patients who were medically evacuated; therefore, its coverage of DNBI incidents is much broader than the evacuation statistics reported above, albeit for just those two years. Even the less-severe cases that did not result in evacuation still required significant medical activity in theater, because of both the volume of DNBI cases and their complexity, often entailing inpatient procedures.

Although the focus of Whitley et al. (2016) was on the treatment of battle injuries, it also provided counts of DNBI diagnoses, ordered by the total occurrences of both battle injuries and DNBI. In this paper, we reorder the diagnoses by the volume of DNBI, but we also carry along the information on the number of battle injuries in the high-DNBI categories.

The top 10 diagnostic groups accounted for 73 percent of all inpatient diagnoses of DNBI in Iraq in 2007 (see Figure 4). Eight of the top 10 diagnoses cluster into these three larger categories:

- Internal medicine: nonspecific chest pain, abdominal pain, appendicitis (34 percent).
- Non-combat wounds: skin infections; open wounds of extremities; open wounds of head, neck, and trunk (16 percent).
- Non-combat injuries: other injuries, fracture of lower limb (12 percent).

Although many of the same types of injuries and body systems are involved in both battle and non-battle injuries, the nature and severity of those injuries differ, particularly at the extremes of the severity scale. DoD defines a major amputation as the loss of limb at or proximal to (at or nearer to the central portion of the body than) the wrist or ankle joint. During the period from the beginning of the two conflicts through March 2011, some 1,186 Service members (809 in Iraq and 377 in Afghanistan) from all four branches of service

¹⁹ Whitley, "Essential Medical Capabilities and Medical Readiness." There are thousands of ICD-9-CM diagnosis codes in the Theater Medical Data Store (TMDS), but that research grouped them into clinically similar categories using the Clinical Classifications Software (CCS) tool. The tool was developed by the Agency for Healthcare Research and Quality (AHRQ) and is available at www.hcup-us.ahrq.gov/toolssoftware/ccs/ccs.jsp#download.

suffered major amputations in Iraq and Afghanistan.²⁰ In OIF/OND during that period, 770 major amputations of a hostile nature and 39 (4.8 percent of the total) of a non-hostile nature occurred. During OEF, 353 major amputations of a hostile nature and 24 (6.4 percent of the total) of a non-hostile nature occurred. Non-hostile injuries from falls, for example, might result in fractured limbs but would not typically lead to amputation. However— although further detail on the particular cases is not available—some of the non-hostile amputations certainly rivaled their hostile-injury counterparts: two Marines each lost two major limbs in OIF, as did two soldiers in OIF and two soldiers in OEF. All of these amputations are presumably captured in the diagnostic groups for "other injuries and conditions due to external causes" and "open wounds of the extremities" in Figure 4 (with the blue bars indicating the preponderance of battle injuries in those categories).



Source: Whitley, "Essential Medical Capabilities and Medical Readiness."

Figure 4. Top 10 Inpatient Diagnosis Groups in Iraq (2007)

²⁰ Source of data was U.S. Army, Office of the Surgeon General; as reported in Goldberg, "Casualty Rates of US Military Personnel," 16.

The top 10 diagnostic groups accounted for 67 percent of all inpatient diagnoses of DNBI in Afghanistan in 2010 (see Figure 5). Here, all of the top 10 diagnoses cluster into the three larger categories identified above, with a few additional to those categories:

- Internal medicine: nonspecific chest pain, abdominal pain, appendicitis, epilepsy/convulsions (35 percent).²¹
- Non-combat wounds: skin infections; open wounds of extremities; open wounds of head, neck, and trunk; burns (18 percent).

• Non-combat injuries: other injuries, fracture of lower limb (12 percent).

Source: Whitley, "Essential Medical Capabilities and Medical Readiness."

Figure 5. Top 10 Inpatient Diagnosis Groups in Afghanistan (2010)

The top 10 diagnostic groups accounted for 70 percent of all outpatient diagnoses of DNBI in Iraq in 2007 (see Figure 6). Nine of the top 10 diagnoses cluster into these three

²¹ Some medical evidence links seizures to high altitude. See, for example, Edward H. Maa, "How Do You Approach Seizures in the High Altitude Traveler?" *High Altitude Medicine & Biology* 12, No. 1 (Spring 2011): 13–9, doi: 10.1089/ham.2010.1071.

larger categories, which are not the same as the ones identified above for inpatient diagnoses:

- Non-surgical orthopedics/rheumatology: rehabilitation care, back problems, sprains and strains, non-traumatic joint disorders, connective tissue disease (37 percent).
- Internal medicine: medical examination/evaluation, upper respiratory infections, immunizations and infectious disease (20 percent).

• Mental health: administrative/social (8 percent).²²

Source: Whitley, "Essential Medical Capabilities and Medical Readiness."

Figure 6. Top 10 Outpatient Diagnosis Groups in Iraq (2007)

²² Administrative/social diagnoses are assigned when a Service member receives counseling for any of a wide range of issues, including family and household problems, alcohol or drug abuse, or HIV. Appendix A enumerates the complete list of such diagnoses.

The top 10 diagnostic groups accounted for 66 percent of all outpatient diagnoses of DNBI in Afghanistan in 2010 (see Source: Whitley, "Essential Medical Capabilities and Medical Readiness."

Figure 7). Here, seven of the top 10 diagnoses cluster into the three larger categories identified above:

- Non-surgical orthopedics/rheumatology: back problems, sprains and strains, non-traumatic joint disorders, connective tissue disease (28 percent).
- Internal medicine: medical examination/evaluation, upper respiratory infections (16 percent).

• Mental health: administrative/social (7 percent).

Source: Whitley, "Essential Medical Capabilities and Medical Readiness."

Figure 7. Top 10 Outpatient Diagnosis Groups in Afghanistan (2010)

3. Medical Specialties Required to Provide Population Health of Deployed Forces

In the June 2016 issue of *Journal of the American Academy of Orthopaedic Surgeons*, researchers reported that 80.5 percent of military aeromedical evacuations from theater between October 2001 and December 2012 were for DNBI, compared to 19.5 percent for those wounded in action, making a strong case for ensuring adequate staffing levels of certain non-combat medical specialties to maintain the population health of deployed forces.²³ We propose further research on three non-combat medical specialty areas: women's health, mental health, and non-combat orthopedics. We distinguish combat orthopedics (for example, treating a femur that was fractured in an explosion or as a result of a gunshot wound) from non-combat orthopedics (for example, a sprained ankle or a sore back); the latter are less likely to require immediate surgical solutions. For each specialty area, we are interested in the role it plays in the maintenance of population health and whether the current provision of that type of care is adequate.

A. Women's Health

The argument for sending obstetricians to the wartime theater used to be framed in terms of whether, by dint of having performed Cesarean deliveries, obstetricians were qualified to perform surgical repair of gunshot, blast, and other types of kinetic injuries. Perhaps the argument should be framed, instead, in terms of sending sufficient numbers of obstetricians and gynecologists to treat the particular health needs of as many as 20,000 deployed female Service members;²⁴ those needs were highlighted in Figure 3.

²³ P. J. Belmont, B. D. Owens, and A. J. Schoenfeld, "Musculoskeletal Injuries in Iraq and Afghanistan: Epidemiology and Outcomes Following a Decade of War," *Journal of the American Academy of Orthopaedic Surgeons* 24, No. 6 (June 2016): 341–8, doi: 10.5435/JAAOS-D-15-00123. Data displayed in Table 1 (page 7) are consistent with this article, showing evacuation percentages due to WIA of 17.7 percent in OIF/OND and 23.8 percent in OEF.

²⁴ In Table 2, we reported an estimate that 9.4 percent of cumulative troop-years in OEF were provided by females. That estimate is based on Armed Forces Health Surveillance Center, "Medical Evacuations from Afghanistan during Operation Enduring Freedom, Active and Reserve Components, U.S. Armed Forces, 7 October 2001–31 December 2012." With troop levels in Afghanistan peaking at about 110,000 during early calendar year 2011, the female count may have reached 10,000. Using data from DMDC's Contingency Tracking System, we have independently estimated that during calendar year 2010, a larger total of 14,500 female Service members were deployed to Afghanistan proper, plus the staging areas in Kyrgyzstan and Qatar. Similarly, during calendar year 2007 (the surge in Iraq), a total of 19,500 females were deployed to Iraq or Kuwait.

A 2006 *Military Medicine* article reported the results of a survey on women's healthcare given to female soldiers stationed in camps with Echelon I or II facilities (currently referred to as Role I or II facilities) during OIF.²⁵ The survey questions covered the quality of predeployment screening, availability of contraception, accessibility of gynecologic care, and field hygiene counseling. The researchers found that gynecologic screening, contraceptive options, and cycle control counseling prior to deployment were not adequately provided, and that specialty gynecologic care and medications for cycle control were not readily accessible to all female soldiers during deployments. This suggests that the staffing of women's health providers was not adequate both prior to and during deployment.

Our preliminary review of the literature suggests several questions regarding the deployment of women's health providers (e.g., obstetricians and gynecologists):

- How many were deployed? Were they enough? Are there enough providers in the total inventory to sustain the required number of deployers?
- How well do obstetricians function as combat/trauma surgeons?

We attempt to address the first question by looking at personnel data from DMDC. Figure 8 presents snapshots of deployment counts for women's health providers (from the medical and nursing corps) in two different years. We focus on deployments in 2007 and 2010 because those were the years of peak activity ("surges") in Iraq and Afghanistan, respectively. The main takeaway from this chart is the surprisingly low number of deployed providers compared to the vast numbers of deployed personnel in those years—not quite five annual-equivalent women's health providers were deployed in 2007 to Iraq and only one was deployed in 2010 to Afghanistan. Those deployed providers represented less than 1 percent of the inventory in the Active and Reserve Component forces (see Figure 9).

²⁵ Brook Allen Thomson and Peter Edward Nielsen, "Women's Health Care in Operation Iraqi Freedom: A Survey of Camps with Echelon I or II Facilities," *Military Medicine* 171, No. 3 (March 2006): 216–9, doi: 10.7205/MILMED.171.3.216.

Figure 8. Deployment Counts of Women's Health Providers to Iraq and Afghanistan

Figure 9. Deployment Rates of Women's Health Providers to Iraq and Afghanistan

Regarding the last of the bulleted questions, in Whitley et al. (2014), Navy and Marine Corps representatives indicated during interviews that a field hospital with a requirement for 10 general surgeons could be staffed by substituting obstetricians for two of the general surgeons.²⁶ However, in the narrower situation of a forward-deployed surgical team with a requirement for two surgeons, the same representatives indicated that substitution of an obstetrician for one of the surgeons would not be satisfactory.

Army doctrine also addresses the substitution issue. The Army allows an obstetrician/ gynecologist or urologist (either of whom has completed a surgical oncology fellowship) to substitute for one of three general surgeons in that service's forward medical support teams.²⁷

²⁶ Whitley, "Medical Total Force Management," 13.

Army Regulation 601-142, "Army Medical Department Professional Filler System," October 22, 2015, http://www.apd.army.mil/epubs/DR_pubs/DR_a/pdf/web/r601_142.pdf.

B. Mental Health

It is recognized by many that mental health is "an important component in maintaining the operability of military units."²⁸ The first military mental health providers (MMHPs) were civilians during the First World War, and they focused on addressing "the mental health care needs of both military personnel and their families with the goal of keeping the active duty personnel healthy to fulfill their assigned duties."²⁹ During OIF and OEF, MMHPs—consisting of psychiatrists, psychologists, and social workers assigned to provide mental health services for military personnel—continued to address the mental healthcare needs of military personnel under the doctrine of "forward psychiatry." This doctrine relies on four principles: proximity (interventions are provided in close proximity to battle), immediacy (interventions are provided as soon as possible after developing a combat stress reaction), expectancy (an expectation of recovery and return to duty after brief treatment versus evacuation), and simplicity (interventions are kept simple and clear); these principles are also known by the acronym of "PIES."

For the US military and most of the world's modern militaries, the doctrine of "forward psychiatry" is an essential part of military mental healthcare because of its supposed efficacy as a treatment for both combat and operational stress disorders, and a preventive measure for long-term psychiatric disorders such as PTSD. Consequently, this has led to the deployment of increasing numbers of MMHPs in combat zones. However, combat stress is not the only clinical problem that the MMHPs have to contend with. An account by two Army clinical psychologists deployed to Iraq describes a wide variety of clinical problems that they encountered including "combat trauma and PTSD, marriage and family issues, anger management, personality disorders, tic disorders, eating disorders, psychotic disorders, neuropsychological disorders and response to sexual assault."³⁰ There is also a growing body of research focused on the mental health needs of the medical providers themselves. This all suggests the critical need for adequate provision of mental healthcare.

Figure 10 also comes from our preliminary analysis of DMDC personnel data. Like Figure 8, which depicted the deployment of women's health providers, the main takeaway from Figure 10 is the surprisingly low number of deployed providers compared to the vast numbers of deployed personnel in those years—only 120 annual-equivalent mental health

²⁸ M. McCauley, H. Liebling-Kalifani, and J. Hacker Hughes, "Military Mental Health Professionals on Operational Deployment: an Exploratory Study," *Community Mental Health Journal* 48 (2012): 238– 48, doi: 10.1007/s10597-011-9407-8.

²⁹ Phil E. Miller and Bud Warner, "Postdeployment Experiences of Military Mental Health Providers," *Military Medicine* 178, No. 12 (December 2013): 1316–21, doi: 10.7205/MILMED-D-13-00023.

³⁰ B. A. Moore, and G. M. Reger, "Clinician to Frontline Soldier: a Look at the Roles and Challenges of Army Clinical Psychologists in Iraq," *Journal of Clinical Psychology* 62, No. 3 (March 2006): 397, doi: 10.1002/jclp.20218.

providers (including both enlisted and officer personnel) were deployed in 2007 to Iraq and only 45 were deployed in 2010 to Afghanistan. Those totals represented between about 1 percent and 4 percent of the Active inventory of mental health providers (see Figure 11), and between 1 percent and 5 percent of the Reserve inventory (although in terms of annual equivalents, the apparently higher 5 percent represents only 0.8 mental-health nurse practitioners out of the Reserve Component inventory of 16).

Figure 10. Deployment Counts of Mental Health Providers to Iraq and Afghanistan

Figure 11. Deployment Rates of Mental Health Providers to Iraq and Afghanistan

The literature also suggests that in the early years of the OIF and OEF campaigns, inadequate numbers of MMHPs were working both in the rear and on the front lines. A military mental health task force in 2007 reported that the personnel shortage was putting stress on the non-deployed MMHPs and causing high attrition rates.³¹ Dr. Layton McCurdy, a psychiatrist who served on the task force, said, "The psychiatrists are working with more people than they have time to work with."³² The topic of adequate MMHP staffing levels came to a head during a tragic incident at Ft. Hood in November 2009, when an Army psychiatrist, Maj. Nidal Hasan, committed one of the worst mass shootings ever on a military base in the United States.³³ That event brought the acute shortage of MMHPs to the forefront. A media article from that timeframe reported that the Army had only 408

³¹ Department of Defense Task Force on Mental Health, *An Achievable Vision: Report of the Department of Defense Task Force on Mental Health* (Falls Church, VA: Defense Health Board, June 2007), http://intransition.dcoe.mil/files/MHTFReportFinal.pdf.

³² Kimberly Hefling, "Shortage of Military Therapists Creates Strain," Salon, November 8 2009, http://www.salon.com/2009/11/08/us_fort_hood_stressed_out_psychiatrists/.

³³ Benedict Carey, Damien Cave, and Lizette Alvarez, "Painful Stories Take a Toll on Military Therapists," *The New York Times*, November 7. 2009, http://www.nytimes.com/2009/11/08/us /08stress.html?mcubz=0.

psychiatrists (including military, civilian, and contractors) serving about 553,000 Active Duty troops deployed around the world and that 200 such specialists were serving more than 130,000 troops in Iraq.³⁴ Other articles hinted at the spread of forward-deployed MMHPs:

2005: Dr. Peter Linnerooth, a former Army psychologist who treated soldiers in Germany and Iraq and at Fort Hood, said that in Schweinfurt, Germany, he was the sole psychologist for a community of 10,000 people in 2005.³⁵

2011: "I had to take time out from being a psychologist to have 'me time' and relax," said Dr. Mayfield, who was the forward operating base psychologist for about a thousand troops.³⁶

2012: Data used for this study were collected by 19 U.S. Navy mental health providers (9 psychiatrists and 10 psychologists) serving with the 1st Marine Expeditionary Force in the combat theater primarily in and around the Al Anbar province of Iraq. These providers served a population of approximately 30,000 military personnel—primarily Marines, but also personnel from other service branches.³⁷

Since 2007, the military has actively worked to increase the number of MMHPs. A 2015 Government Accountability Office (GAO) study reported that DoD increased the number of MMHPs by about one-third, from 4,608 providers in fiscal year (FY) 2009 to 6,186 providers in FY 2013, with the increase mostly in social workers and psychologists.³⁸ Separately, the military has conducted annual field surveys of the mental health of deployed personnel via Army Mental Health Advisory Team (MHAT) and Joint MHAT (JMHAT) studies. One part of the survey focuses on the factors (i.e., stigma and barriers) that affect military personnel's decisions to receive mental health services. We are interested particularly in the barriers and the 2013 MHAT survey reports that "the percent of Soldiers endorsing the items 'mental health services aren't available' and 'it is too

³⁴ Ibid. Data from DMDC's Contingency Tracking System indicate that the total number of Active and Reserve personnel deployed to locations outside of the United States may have been only around 400,000, but according to the cited article, that number of personnel were still served by only 408 deployed psychiatrists.

³⁵ Ibid.

³⁶ Robyn Mincher, "Psychology Course Prepares Military Providers for Deployment Concerns," Defense Centers of Excellence for Psychological Health and Traumatic Brain Injury, June 21, 2011.

³⁷ Kimberly J. Schmitz et al., "Psychiatric Diagnoses and Treatment of U.S. Military Personnel While Deployed to Iraq," *Military Medicine* 177, No. 4 (April 2012): 380–9. doi: 10.7205/MILMED-D-11-00294.

³⁸ Government Accountability Office (GAO), "DEFENSE HEALTH CARE: Additional Information Needed about Mental Health Provider Staffing Needs," GAO-15-184 (Washington, DC: GAO, January 30, 2015), https://www.gao.gov/assets/670/668208.pdf.

difficult to get to the location where the mental health specialist is' have both dropped significantly since MHAT 6 and reflect the changes in behavioral health staffing since 2009" (see Table 4).³⁹

Not Screen Positive for Any Mental Health Problems								
				Percent	Agree	or Stron	gly Agre	е
	MH	AT 6	J-MH	AT 7	J-MH	AT 8	MH/	AT 9 2013
		Do Not		Do Not	ULI	Do Not		Do Not
Factors that affect your decision to receive mental health services	Screen Positive							
Mental health services aren't available.	<u>35.1%</u>	15.1%	<u>27.1%</u>	10.9%	14.6%	5.3%	11.7%	4.2%
I don't know where to get help.	20.2%	6.5%	15.7%	4.9%	22.6%	7.4%	20.1%	6.5%
It is difficult to get an appointment.	31.1%	12.0%	26.3%	9.8%	28.2%	10.6%	26.2%	9.8%
There would be difficulty getting time off work for treatment.	50.2%	20.7%	45.0%	17.5%	47.7%	19.1%	45.6%	17.8%
It's too difficult to get to the location where the mental health specialist is.	<u>41.5%</u>	18.8%	31.0%	12.8%	27.3%	11.0%	26.9%	10.8%
My leaders discourage the use of mental health services.	20.8%	6.6%	16.1%	4.9%	16.2%	4.9%	15.6%	4.7%

Table 4. Barriers to Mental Health Services for E1-E4 Soldiers Deployed to Afghanistan Theater for 7 months in 2013

Table 7.4b: Sample-Adjusted Barriers Percents for E1-E4 Soldiers in Theater 7 Months who Screen Positive and Who Do Not Screen Positive for Any Mental Health Problems

Source: Reproduced from Mental Health Advisory Team 9 (MHAT 9), Operation Enduring Freedom (OEF) 2013, Afghanistan, Table 7.4b.

DoD created the Psychological Health Risk-Adjusted Model for Staffing (PHRAMS) in 2007 to evaluate current and future mental health provider staffing needs, but the 2015 GAO report found that the Services had not been using it as the main tool for determining their staffing needs; instead, the Services have relied on their own service-specific methods.⁴⁰ The Services argued that PHRAMS did not account for factors that are crucial to assess mental health provider staffing needs, such as mental health providers needed for deployments. For example, Navy officials reported that they supplemented PHRAMS estimates with additional information because PHRAMS did not include estimates of mental health provider staffing needs on Navy vessels and for deployed Marine Corps units. They used traditional methods—such as on-site industrial engineering reviews and industry standards—to calculate these operational requirements for Navy mental health providers.

³⁹ Office of the Command Surgeon, U.S. Forces Afghanistan and Office of the Surgeon General, United States Army Medical Command, *Mental Health Advisory Team 9 (MHAT 9), Operation Enduring Freedom (OEF) 2013, Afghanistan*, October 10, 2013. Reprint available at https://books.google.com /books/about/Report_of_the_Mental_Health_Advisory_Tea.html?id=xqtWngEACAAJ.

⁴⁰ GAO, "DEFENSE HEALTH CARE: Additional Information Needed about Mental Health Provider Staffing Needs."

C. Non-Combat Orthopedics

In the June 2016 issue of *Journal of the American Academy of Orthopaedic Surgeons*, researchers reported their findings on the nature and frequency of musculoskeletal injuries (e.g., traumatic amputations and injuries to the spine) during the OIF and OEF campaigns. With regard to combat musculoskeletal injuries, they proposed that the unconventional nature of fighting that characterized these campaigns—the enemy's reliance on explosive devices and indirect ambush attacks (i.e., "irregular warfare")—resulted in a higher percentage of musculoskeletal injuries among all combat injuries as compared to the injury distributions from earlier conflicts. For example, 73 percent of all combat musculoskeletal injuries in this period were caused by explosive devices.⁴¹

With regard to non-combat musculoskeletal injuries, the researchers studied a US Army brigade combat team and found that the soldiers were three times more likely to suffer those types of injuries than combat injuries. They suggest various factors for this finding: "consistent exposure to tactical weapons and vehicles and hazardous geographic topography"; the predomination of sharp exposed surfaces; the patrolling of rough, uneven terrain; and mountainous settings, which may result in increased incidence of falls. We add to this list by suggesting as a factor the interaction between the age of Reserve and National Guard personnel and the carrying of heavy equipment load (e.g., a rifleman in Afghanistan averaged a 63-pound load). Common non-combat musculoskeletal injuries include anterior cruciate ligament (ACL) injuries of the knee and shoulder dislocations; Belmont and his colleagues found that the rate at which those injuries occurred among military Service members was nearly five times more than the rate among the civilian population.⁴²

The researchers argue that the large volume of musculoskeletal DNBI has highlighted the importance of providing orthopedic care in theater to minimize the loss of troops to their units. This raises the questions of how many providers were deployed to theater and whether that number was enough. Figure 12 is from our preliminary analysis of DMDC personnel data. Like the earlier charts in this chapter, the main takeaway from this chart is the surprisingly low number of deployed providers compared to the vast numbers of deployed personnel in those years—only 59 annual-equivalent orthopedics care providers were deployed in 2007 to Iraq and only five were deployed in 2010 to Afghanistan. The providers include enlisted as well as officer personnel, such as Army military occupational specialty (MOS) 68F for physical therapy specialists and MOS 68L for occupational therapy specialists. Those totals represented no more than 4 percent of the inventory levels in the orthopedic specialties (see Figure 13).

⁴¹ Belmont, Owens, and Schoenfeld, "Musculoskeletal Injuries in Iraq and Afghanistan."

⁴² Ibid.

Figure 12. Deployment Counts of Orthopedic Providers to Iraq and Afghanistan

A promising alternative to increasing the provision of care in theater is telemedicine. The Army established the Telemedicine Orthopaedic Consultation Program in July 2007 to connect medical personnel in theater to subspecialty-trained orthopedic surgeon consultants in the United States. A group of Army doctors performed an evaluation of the program, reviewing 208 consults initiated from July 2007 through April 2009. They found that surgical intervention or medical evacuation was recommended in only 25 percent and 16 percent of the consultations, respectively. Prior to this program, almost all military personnel requiring orthopedic consultations were evacuated from theater.⁴³ A similar study reported that at least 26 medical evacuations were averted and estimated \$1.7 million in savings by avoiding unnecessary medical evacuation.⁴⁴

⁴³ E. Blank et al., "Early Analysis of the United States Army's Telemedicine Orthopaedic Consultation Program," *Journal of Surgical Orthopaedic Advances* 20, No. 1 (Spring 2011): 50–5. https://www.ncbi.nlm.nih.gov/pubmed/21477534.

 ⁴⁴ B. R. Waterman et al., "Enhanced Casualty Care from a Global Military Orthopaedic Teleconsultation Program," *Injury* 45, No. 11 (November 2014): 1736–40. doi: 10.1016/j.injury.2014.03.012.

4. The Need for Additional Research

Additional research is called for to develop the requirement for a deployed medical force that can ensure the health of a deployed military population as large as 100,000 or even 200,000 individuals. The stages of that research would be to:

- Tabulate, in greater detail than was done here, the diagnoses of DNBI during the recent conflicts in Iraq and Afghanistan and the severity distributions of those diagnoses;
- Match up the DNBI incidents to the numbers and types of military medical providers who treated them;
- Estimate the number of ill or injured Service members treated, on average, by each deployed medical provider, and the population served ("panel size") for each such provider;
- Determine whether the numbers treated or the panel size exceed medical practice norms and, if so, how many additional medical providers might have been deployed; and finally,
- Estimate the fraction of the inventory of medical providers (counting both the Active and Reserve Components) that would have to be deployed in order to meet medical practice norms.

In light of the findings of the current document, special attention needs to be devoted to three clinical areas for which the numbers of medical providers deployed to Iraq and Afghanistan may not have been adequate: women's health, mental health, and non-combat orthopedics. Although this research does not directly address the biomechanical issues involved with heavy packs of equipment and body armor, it begins to spotlight some of the medical burden that may be at least partially attributable to the weight that soldiers have been carrying on their bodies.

Another important question is the effect of DNBI on the readiness of deployed units. When military personnel are absent from their units because of disease or injury—and especially if those absences are lengthened because adequate medical care in not available in theater—the personnel readiness levels of their units are degraded. An area for potential study is how large those degradations have been, and to what degree they might have been mitigated if additional medical providers were available in the combat theater. Some of the issues identified in this document call for possible improvements in either pre-deployment medicine or in-theater preventive care. Those efforts might reduce the frequency or severity of DNBI incidents that currently result not only in reduced readiness, but also in considerable medical activity within the theater (often entailing inpatient procedures).

An important final question is whether the demands for population health are subsumed by the medical personnel that provide combat casualty care, or whether instead those demands are largely additive.

Appendix A. Administrative/Social Diagnosis Code

In the ICD-9-CM classification scheme, the V-codes indicate "supplementary classification of factors influencing health status and contact with health services." This appendix enumerates the set of V-codes that comprise the category "administrative/social."

V-Code	Description	Other Notes
V200	Encounter for health supervision and care of foundling	
V201	Encounter for health supervision and care of other healthy infant and child	
V202	Encounter for routine child health examination without abnormal findings	
V600	Homelessness	
V601	Inadequate housing	
V602	Extreme poverty	
V603	Problems related to living alone	
V604	Need for assistance at home and no other household member able to render care	
V605	Holiday relief care	
V606	Problems related to living in residential institution	
V608		No current equivalent; historical information: Other specified housing or economic circumstances
V609	Problem related to housing and economic circumstances, unspecified	
V610		No current equivalent; historical information: Family disruption
V611		No current equivalent; historical information: Other family circumstances
V6110	Other specified counseling	Historical information: Counseling for marital and partner problems, unspecified
V6111	Encounter for mental health services for victim	

V-Code	Description	Other Notes
V6112	Encounter for mental health services for perpetrator of spousal or partner abuse	
V6120	Other specified counseling	
V6121	Encounter for mental health services for victim of parental child abuse	
V6122	Encounter for mental health services for perpetrator of parental child abuse	
V6129	Parental overprotection; Other specified problems related to upbringing	
V613	Other stressful life events affecting family and household	
V6141	Alcoholism and drug addiction in family	
V6149	Dependent relative needing care at home	
V616	Problems related to unwanted pregnancy	
V617	Problems related to unwanted pregnancy	
V618	Sibling rivalry, Other specified problems related to primary support group	
V619	Problem related to primary support group, unspecified	
V620	Unemployment, unspecified	
V621	Unspecified problems related to employment	
V622		No current equivalent; historical information: Other psychosocial circumstances
V623	Problems related to education and literacy, unspecified	
V624	Acculturation difficulty	Historical information: Social maladjustment
V625	Problems related to other legal circumstances	
V626	Procedure and treatment not carried out because of patient's decision for reasons of belief and group pressure	
V6281	Other specified problems related to psychosocial circumstances	Historical information: Interpersonal problems, not elsewhere classified
V6282	Disappearance and death of family member	
V6283	Encounter for mental health services for perpetrator of non-parental child abuse, Encounter for mental health services for perpetrator of other abuse	
V6289	Other specified problems related to psychosocial circumstances	Historical information: Other psychological or physical stress, not elsewhere classified

V-Code	Description	Other Notes
V629	Problem related to unspecified psychosocial circumstances	
V630	Unavailability and inaccessibility of health-care facilities	Historical information: Residence remote from hospital or other health care facility
V631	Medical services not available in home	
V632	Person awaiting admission to adequate facility elsewhere	
V638	Unavailability and inaccessibility of other helping agencies, Other problems related to medical facilities and other health care	
V639	Unavailability and inaccessibility of health-care facilities	
V650	Healthy person accompanying sick person, Other boarder to healthcare facility	
V651		No current equivalent; Historical information: Person consulting on behalf of another person
V6511	Expectant parent(s) pre-birth pediatrician visit	
V6519	Person encountering health services to consult on behalf of another person	
V652	Malingerer [conscious simulation]	Historical information: Person feigning illness
V653	Dietary counseling and surveillance	
V654		Historical information: Other counseling not elsewhere classified
V6540	Counseling, unspecified	Historical information: Counseling NOS
V6541	Other specified counseling	Historical information: Exercise counseling
V6542	Alcohol abuse counseling and surveillance of alcoholic	
V6543	Other specified counseling	Historical information: Counseling on injury prevention
V6544	Human immunodeficiency virus [HIV] counseling	
V6545	Other specified counseling	Historical information: Counseling on other sexually transmitted diseases
V6549	Other specified counseling	Historical information: Other specified counseling

V-Code	Description	Other Notes
V655	Person with feared health complaint in whom no diagnosis is made	
V658	Persons encountering health services in other specified circumstances	
V659	Counseling, unspecified	Historical information: Unspecified reason for consultation
V680		No current equivalent; Historical information: Issue of medical certificates
V681	Encounter for issue of repeat prescription	
V682	Encounter for examination and observation for other specified reasons	
V6881	Encounter for examination and observation for unspecified reason	
V6889	Encounter for other administrative examinations	
V689	Encounter for administrative examinations, unspecified	

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Abbreviations

AC	Active Component
ACL	Anterior Cruciate Ligament
AHRQ	Agency for Healthcare Research and Quality
CCS	Clinical Classifications Software
DCAS	Defense Casualty Analysis System
DMDC	Defense Manpower Data Center
DNBI	Disease and Non-Battle Injury
DoD	Department of Defense
DOW	Died of Wounds
FTE	Full-Time Equivalent
FY	Fiscal Year
GAO	Government Accountability Office
HIV	Human Immunodeficiency Virus
ICD-9-CM	International Classification of Diseases, Ninth Revision, Clinical Modification
ICU	Intensive Care Unit
IDA	Institute for Defense Analyses
ISS	Injury Severity Score
JMHAT	Joint Mental Health Advisory Team
KIA	Killed in Action
LRMC	Landstuhl Regional Medical Center
MHAT	Army Mental Health Advisory Team
MMHP	Military Mental Health Provider
MOS	Military Occupational Specialty
OEF	Operation Enduring Freedom
OIF	Operation Iraqi Freedom
OND	Operation New Dawn
PHRAMS	Psychological Health Risk-Adjusted Model for Staffing
PIES	Proximity, Immediacy, Expectancy, and Simplicity
PTSD	Post-Traumatic Stress Disorder
RC	Reserve Component

TMDS	Theater Medical Data Store
US	United States
WIA	Wounded in Action

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