Medical Changes Needed for Large-Scale Combat Operations

Observations from Mission Command Training Program Warfighter Exercises

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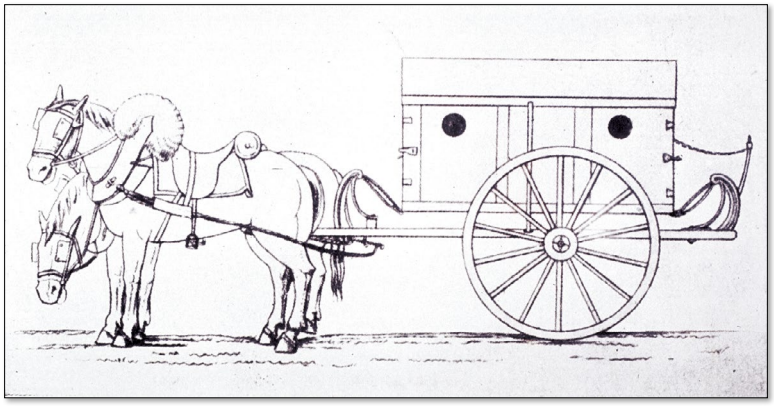
Successful treatment of combat casualties, for the most part, has become an expectation throughout the past eighteen years of combat operations. The U.S. military has the highest level of survival for preventable death in history, with a 92 percent survivability of battlefield injuries.[1] The lessons learned in the treatment of these casualties have not been lost; however, when looking through the lens of large-scale combat operations (LSCO), many of these underlying assumptions and expectations cannot be taken for granted by commanders, soldiers, and the American public.

Changes in the nature of warfare required Baron Dominique-Jean Larrey to revolutionize medical planning and operations under Napoléon Bonaparte.[2] Similarly, the transition to LSCO brings with it a multitude of challenges, not only for operational forces (e.g., fires integration, multi-domain threats, lack of air superiority) but also for all enabling functions including sustainment, protection, and intelligence. Medical considerations in LSCO have the same challenges. Reliance on past successes in wars in which we controlled the majority of operational variables does not guarantee success or readiness for the next war. A generation of officers and enlisted soldiers is unfamiliar with the medical actualities of prolonged, multi-corps fights against a peer or near-peer threat. Analysis and observations gained during Warfighter exercises (WFXs) identify areas in which the U.S. Army is not prepared for the medical realities of LSCO.



French surgeon Baron Dominique-Jean Larrey's *ambulance volante*, or flying ambulance, used to evacuate casualties from the battlefield during the Napoleonic wars. (Image courtesy of The National Library of Medicine)

The Mission Command Training Program (MCTP) trains and evaluates division and corps operations in a simulated operational environment to test mission command, staff synchronization, and staff integration (vertically and horizontally) through WFXs. The WFX program uses an intricate and robust system of computer programs and technicians to simulate (not replicate) combat situations to force commanders and staffs to maximize their processes and utilize subordinate units to achieve operational goals. In contrast to recent operations, in LSCO, brigades and divisions are no longer the pinnacle of operational forces; rather, they are tactical units used by the corps in a singular or multi-corps fight to defeat a peer or near-peer adversary. In contrast to the counterinsurgency paradigm of the past eighteen years where the focus was on small-unit engagements with an enemy of limited weaponry, peer/near-peer threats possess a scale and lethality not witnessed since World War II.

Within the MCTP construct, divisions and corps fight for eight days. Based on last year's five exercises, the average number of combat casualties (for a fighting force of approximately one hundred thousand) is consistently fifty thousand to fifty-five thousand: about thirty thousand to thirty-five thousand soldiers sustained wounds requiring evacuation out of theater, ten thousand to fifteen thousand were killed, and ten thousand to fifteen thousand were injured but able to return to duty. This is roughly the same number of casualties collectively incurred in Iraq and Afghanistan; however, the survivability percentage in Iraq and Afghanistan is significantly higher. Nevertheless, while injuries and death will occur in any war, it is the U.S. military's collective responsibility to minimize the number of deaths and combat injuries.

Previous page: An Army Ranger combat medic conducts routine medical training during 2nd Battalion, 75th Ranger Regiment, task force training in August 2019. The Ranger O Low Titer (ROLO) Whole Blood Program protocol, designed to bring emergency blood transfusion from the hospital to the battlefield, is practiced multiple times a year with volunteers and medics to maintain a high level of medical proficiency. (Photo by Sgt. Jaerett Engeseth, U.S. Army)

Since combat operations must continue despite a large number of casualties, the United States must continue to provide personnel to fight the fight. All too often, the Army calculation of combat power is focused primarily on major end items like tanks, vehicles, artillery, and helicopters. Unfortunately, if there are a thousand tanks but only one hundred crews, there are effectively one hundred tanks and nine hundred road blocks. In order to maximize combat strength, the U.S. military must invest in the necessary medical infrastructure to care for the anticipated massive number of casualties (as well as in a robust personnel replacement system).

From the medical perspective, the primary focus of the Army Medical Department's (AMEDD) previous motto "to conserve fighting strength," has never been truer than now.[3] This kind of focus incorporates everything from preventive medicine and day-to-day readiness to treating infectious diseases and performing lifesaving damage-control surgery. Historically, the impacts of noncombat medical issues greatly outnumber combat injuries; in my personal experience of eleven deployments in multiple operational assignments, over 90 percent of medical duties were for noncombat-related issues. The significance of nonbattle injuries is vitally important and cannot be overlooked because it dramatically affects combat power. Force health protection must be emphasized in all environments.

Lessons learned from the MCTP WFXs will highlight the medical realities of LSCO and will identify areas that must be addressed in order to minimize deaths and maximize the fighting force (combat power).

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A Change in Thinking

As Gen. Mark Milley has repeatedly stated, the United States must be prepared for war on a large scale.[4] The operational realities, the stresses upon the medical system and sustainment units, and the psychological and emotional impact of significant casualties cannot be underestimated and must be prioritized.

A large-scale war will resemble World War II in scale but will involve modern lethality. A day of combat could potentially incur three thousand to four thousand casualties daily, and the U.S. military's medical system lacks the capacity (not the capability) to care for all of these casualties. Triage as we know it, namely that the most severely injured (who can survive) are treated first, will change. Not everyone who can survive will survive (there are not enough resources). Furthermore, the Golden Hour will become a goal, not an expectation. This is not a paradigm shift; instead, it would be a return to the patterns and expectations of World War II operations and Cold War planning, exacerbated by current technology and lethality. Lastly, although mass casualty situations will occur periodically across the battlefield, realistically, the entire operation will experience a continuous mass casualty environment.

The number of casualties will require massive investments into intratheater surgical and hospitalization capabilities. Furthermore, it will require a vast number of ground and air assets to medically evacuate the wounded to higher levels of care. As air superiority cannot be guaranteed, the threats to aviation assets could limit aerial medical evacuation (medevac), and thus, ground medevac will be the primary means of movement from point of injury to Role 2 treatment facilities (lab and holding capabilities, possibly surgical assets) and potentially to definitive Role 3 hospitals (full surgical services and ICU capability). However, tactical ground vehicles have limited litter transport capabilities. Therefore, when aligning the need for assets with the total number of casualties, the need vastly exceeds the medical system inventory in both direct patient care and in evacuation capacity. The resultant effect will dramatically increase died-of-wounds rates. Expedited transportation may be further limited by degraded road networks (due to enemy damage or threat), displaced civilians, and dense urban environments. Casualty evacuation by nonmedical platforms will be limited by an overall shortage of troop transport assets due to competing mission requirements.

Corps, division, and brigade medical staffs conduct operational planning and synchronization 8 February 2020 in the I Corps surgeon's planning area during Warfighter Exercise 20-3 at Joint Base Lewis-McChord, Washington. (Photo courtesy of James Garner, Mission Command Training Program)

To mitigate these challenges, medics, nurses, and providers at all levels must be trained and prepared for prolonged casualty care to maximize the survivability rates of wounded soldiers. The importance of Tactical Combat Casualty Care and lifesaving medical skills by all members of the military cannot be overstated.[5] Individuals and leaders at all levels must prioritize medical skills training (combat lifesaver) and medical specialist training in order to preserve life and combat power. As demonstrated in Operations Iraqi Freedom and Enduring Freedom, when soldiers reach surgical treatment promptly, the AMEDD has the medical skills and capabilities to provide greater than a 90 percent survivability rate. However, AMEDD's current structure and staffing lacks sufficient capacity for far-forward extended casualty care to meet these medical demands. The resultant effect will be a lower survivability rate and the inability to sustain the impressive gains and successes in tactical medical care witnessed over the past two decades. Lack of medical access and bed availability is even further compounded when considering the significant burden of noncombat casualty care demands from those with infectious diseases or other conditions requiring observation and hospitalization.

Assessing the medical realities of LSCO requires a significant shift in expectations from the counterinsurgency environment. As mentioned previously, no longer can surgical treatment within the Golden Hour be an expectation. Not only will air medevac be tactically unavailable at point of injury or from Role 1 (unit aid stations), but the assets necessary to move thousands of casualties to surgical facilities also do not exist. And even if the transportation assets were available, inadequate numbers of surgeons and operating tables translate to insufficient supply to meet the demand. Lastly, and potentially the most challenging change in expectations, relates to triage of casualties. The standard principles of triage may need to be reversed in order to maximize combat power. Instead of prioritizing casualties based on severity of injuries,

An aerial view of the 10th Field Hospital, 627th Hospital Center, and augmentation detachments setup for a field training exercise at Fort Carson, Colorado, in September 2017. (Photo courtesy of the U.S. Army)

determination of who gets treated first may be based on a utilitarian principle to maximize the number of service members who can remain in the fight (e.g., treating three to four individuals who can return to fighting versus one critically wounded individual who requires vast quantities of medical resources). Moreover, all of these considerations and challenges are magnified when in a chemical, biological, radiological, or nuclear environment. All leaders, not just medical leaders, must wrestle with this reality and the resultant difficult decisions that must be made.

Direct and Indirect Effects on Combat Operations

The United States has one mission in war: to win! The majority of the focus in war planning and execution lies in maximizing lethality with weapon systems, employing the most successful tactics, and utilizing adjunct systems (such as intelligence, surveillance, and reconnaissance; engineer support; and nonlethal assets). However, as proven throughout U.S. military operations, combat support planning and sustainment operations are critical for combat success. In the same manner that the sustainment community quickly resupplies units with ammunition, fuel, and repair parts, the human dimension must have similar attention during LSCO.

As previously mentioned, the tens of thousands of casualties encountered in LSCO will have direct effects on combat power and combat operations. The movement of casualties will also require dedicated and continued coordination to clear the battlefield and medical facilities to ensure capacity for the next day's wounded. Prioritization of medical supplies on constrained

movement assets will need synchronization at the highest levels (as medical logistics is dependent on sustainment brigades and combat support supply battalions to distribute Class VIII medical supplies). Medical supplies will compete for limited transportation assets and will diminish the throughput of Class III (petroleum, oil, and lubricants), Class V (ammunition), and Class VII (major end items) to forward-deployed units.

The same level of attention and synchronization is required in retrograde operations to incorporate movement of casualties to the rear. The current medical evacuation system does not possess the robustness needed for massive medevac. Dedicated ground and air medevac will properly move critical patients needing ongoing en route medical care. However, moving the remaining patients will necessitate use of nonmedical assets to include ground logistical vehicles and contracted support by bus and rail.

Army Role 3 Capacity, Support, Structure, and Utilization

The Army has two deployable hospital models: the combat support hospital (CSH) and the hospital center, which has two subordinate field hospitals. The transformation from the CSH to the hospital center is currently ongoing and should be complete within the next two to three years. Both hospitals provide Role 3 care; the hospital center uses a modular construct to provide greater flexibility to meet varying mission demands. In terms of total beds, there is little difference as the CSH has a total of 248 beds and the hospital center (with both field hospitals) has a total of 240 beds.

For medical planning, the basis of allocation (the determination of hospitals needed for an expected number of casualties) for a hospital is 3.78/1,000 conventional hospital patients per day in the corps.[6] Depending on the responsiveness of casualty movement, in a war with three thousand combat casualties requiring hospitalization a day, the total bill is around ten fully functional CSHs or hospital centers. In fiscal year 2019, the total Army inventory is twenty-eight CSHs (ten active, eighteen reserve), or twelve hospital centers (six active component/six reserve component) and nineteen field hospitals (seven active/twelve reserve).[7] Thus, a one-corps fight will require half of all available hospitals, and a multicorps war will require most of the entire inventory, leaving little to none in reserve or for other missions worldwide.

To further complicate the situation, CSHs and hospital centers are not fully equipped. Full sets of equipment and perishable medical supplies are stored in national warehouses. Unfortunately, current inventory of equipment, supplies, and personnel limit the ability to quickly resource mobilization. Thus, the number of hospitals that could be deployed tomorrow is dramatically fewer than what is needed on the battlefield. Conversion of CSHs to hospital centers has been delayed due to problems with equipment issuance. Furthermore, in contrast to many of the U.S. wars, there may not be multiple months available to mobilize and activate the industrial base in a LSCO situation to fully stock hospitals and medical units.

Another significantly compounding factor is the lack of adequate medical staffing. The AMEDD relies heavily on military reserve medical professionals to staff units, particularly for very highly trained, low-density positions like surgeons, anesthesiologists, and emergency medicine physicians. Based on historical combat experience, 70 percent of combat injuries require surgical intervention due to the mechanism of injury.[8] The current manning of board-certified orthopedic and general surgeons (active and reserve) is around 30 percent.[9] Thus, there are insufficient numbers of providers to staff the operating tables required to support LSCO and still provide casualty follow-up care at military bases in the United States, garrison care (preventive and treatment), graduate medical education (training and development of the next generation of providers), and contingency support throughout the rest of the combatant commands.

An added medical capability to bring surgery forward on the battlefield and increase the capacity of operating rooms is the forward surgical resuscitative team (FRST). In the past two decades, these teams have performed magnificently and saved countless lives as shown by the historic survival rates on the battlefield. But in LSCO, with a lack of air superiority, difficult resupply, and fluid front lines, forward surgical teams may have limited functionality (perhaps outside of the special operations environment). Having forward surgical capability gives confidence to commanders and soldiers, but what true value does it hold when there are three thousand to four thousand casualties a day, 70 percent of which are surgical, and an FRST that has only two operating tables? Prioritizing evacuation and consolidation of surgical

assets at higher levels of care may be more important than putting these limited assets forward.

On average, the WFX allocates four CSHs and ten FRSTs within the medical brigade to directly support the tactical corps. The total personnel bill is forty-six general surgeons, twenty-eight orthopedic surgeons, and twenty-eight emergency medicine physicians. In aggregate, this number makes up a significant portion of the AMEDD inventory; it is equivalent to the staffing of a large metropolitan trauma system. Conflict with a peer or near-peer enemy will eventually require more hospitals than what we've allocated in the WFXs, and the United States simply does not have the inventory. Senior military leaders and politicians need to be prepared for probable need of a medical draft when LSCO occurs.

The final area for consideration and discussion involves whether CSHs and field hospitals are the proper models for a LSCO. Designed in the era of Iraq and Afghanistan, hospital centers and field hospitals prioritized modularity, flexibility, and enhanced capabilities that may not be as critical in LSCO. Having modularity or a computed topography scanner (which was added in the new design) is nice for some environments, but to maximize readiness for LSCO, constrained resources (people, equipment, and money) need to be allocated to produce the greatest possible throughput. The U.S. military needs to prioritize funding to provide the greatest number of operating room beds and hospital beds to minimize deaths. In LSCO, the number of casualties would be overwhelming, and in its current state, the U.S. Transportation Command would be unable to evacuate everyone expeditiously. Thus, bolstering the capacity and capability of the hospitals should be prioritized.

Additionally, CSHs and field hospitals are considered mobile. But when they take over thirty C-17s or one hundred assorted trucks, how mobile are they?[10] Commanders must understand and anticipate the herculean efforts required to move a hospital and consider the needed space (over fifteen acres) and the daily consumables required to operate one, much less ten, CSHs or hospital centers. Commanders must thoroughly weigh the decision of when and where to establish a hospital, and consider the time and resources required to transfer or discharge all the patients, tear down, pack, move, and then reestablish the hospital in a new location.

Changes in Training

One area requiring change is the way in which the U.S. military integrates medical planning and operations into WFXs and other training exercises. At MCTP, medical brigades have recently been added in a limited role as response cells. This allows commanders and staffs the opportunity to exercise mission command through their subordinate combat support hospitals, hospital centers, and multifunctional medical battalions. As a functional brigade, medical brigades are assigned to either a tactical corps or the medical command (deployment support).[11] An added benefit of inclusion in WFXs is the ability for medical brigade commanders and staffs to work directly with their corps' higher headquarters counterparts during the exercise in order to fully integrate and coordinate operational and sustainment planning. Too often, medical exercises occur separately from an operational unit's training exercises, which deprives both elements the ability to train, synchronize, and improve. Future iterations should include medical brigades as training audiences or enhanced response cells in order to fully simulate all ten medical functions for which they are responsible.[12] Once fully enmeshed as training audiences, an option would be simultaneous medical-unit command-post exercises (CSHs or hospital centers) during the WFX to further expand the medical realism and train all units collectively. This option also provides sustainment units (expeditionary sustainment commands and sustainment brigades) with the opportunity to coordinate and plan support for deployed medical units and medical logistic requirements. For example, a typical CSH requires massive amounts of life support that must be provided by other entities (see table on page 43 for a summary of space and daily sustainment requirements).[13] The integration of medical considerations in the exercise through operationally experienced and focused medical officers allows this discussion to be integral to the scenario design and WFX.

The final expansion of medical integration would add the medical high command role. Similar to the function of an expeditionary sustainment command, the Army Medical Command (Deployment Support) units provide the medical high command for medical brigades and a theater-enabling command for the Army. Furthermore, the medical command has the critical role of coordinating with Air Force theater hospitals, Navy hospitals and hospital ships, and host-nation medical assets (if authorized) for care and medical regulation (movement of

Table. Hospital Center Requirements

Hospital center sections	Diesel (gallons/day)	Gas (gallons/day)	Power (kilowatts/day)	Water (gallons/day)	Operational space (acres)	Housing (acres)	Commercial trucks (assisted)	Rail (flatcar)	Air (C-17)
Headquarters and headquarters detachment, hospital center, 27 personnel	10	0	118	Surgical 625 Patient care 4,135 Universal unit level 3,889 Laundry 3,836 Showers 2,633	1.12	0.35	4	2	2
Hospital augmentation detachment, 24-bed surgical, 66 personnel	360	97	380		1.09	0.2	13	6	6
Hospital augmentation detachment, 32-bed medical, 45 personnel	240	75	263		0.23	0.2	12	6	6
Medical augmentation detachment, 60-bed intermediate care ward, 33 personnel	120	55	89		0.32	0.14	5	3	3
Medical augmentation detachment, 60-bed intermediate care ward, 33 personnel	120	55	89		0.32	0.14	5	3	3
Field hospital, 166 personnel	1,006	176	755		6.78	0.39	37	15	13
Field hospital, 166 personnel	1,006	176	755		6.78	0.39	37	15	13
Total 536 personnel	2,862	635	2,450	15,117	16.64	1.81	113	50	46

(Table from *Army Health System Doctrine Smart Book*, 3 February 2020)

patients throughout the area of operation). Only the U.S. Army has a designated higher-level mission command to provide command and control for theater medical operations and to conduct joint medical coordination. Currently, there are three medical command units in the Army (one active duty unit and two reserve units). As the higher medical command, those units will own the majority of the medical regulation and movement coordination. Given the enormous numbers of casualties, integration in planning and training is essential since that has not been stressed at this level for decades. Furthermore, holistic medical integration provides the theater commander with accurate medical updates and potential impacts on operations. Medical command incorporation in the exercise provides greater robustness to the overall exercise and fulfills the missing higher medical command function for the medical brigades. Finally, involvement in the exercise can help shape and refine Army and joint doctrine to clearly articulate these units' roles and authorities in joint medical planning and operations.

Intertheater Management and Movement

As in World War II, many casualties will remain in theater to recuperate and rejoin their units. Units at large may cycle to the rear to refit, retrain, and return to the

U.S. Air Force Expeditionary Aeromedical Evacuation Squadron members monitor patients 25 February 2007 during a C-17 aeromedical evacuation mission from Balad Air Base, Iraq, to Ramstein Air Base, Germany. (Photo by Master Sgt. Scott Reed, U.S. Air Force)

front lines. Extensive medical networks will need to exist to care for and feed those recovering.

Moreover, many patients will need to leave the-ater, but the military lacks the ability to manage and transport the large number of casualties anticipated in LSCO. Currently, two airframes in the inventory conduct intertheater aerial medevac, C-17s and C-130s. Although both platforms provide needed capabilities, the thousands of litter patients that must be rapidly evacuated from theater means there will be a capacity shortfall. One potential joint material solution is to resurrect the concept of dedicated medevac aircraft with the capacity to hold a much greater number of casualties. Just as with the now retired Nightingale C-9, a modification of civilian aircraft designed to hold a large number of casualties and to provide critical capabilities is possible. With new designs (such as the Airbus 380), a double-deck aircraft can be configured with critical care capabilities above and minimal care below. When returning to theater, these aircraft can be utilized to transport Class VIII medical resupply and decrease the burden on other airframes. The military does not need this capability daily, so utilization of a system like the Civil Response Air Fleet could be the ideal model. Additionally, Navy hospital ships could be configured to transport greater numbers of casualties from the theater back to the United States. Many casualties may recover and recuperate in theater (much like World War II); however, those unable to return to the fight could take a longer transport home via the hospital ships. This is not solely a material gap; the U.S. military must also have the trained critical care teams to treat the wounded while in transit.

Lastly, where do recovering casualties go when they get home? Military treatment facilities and Veterans Affairs hospitals do not have the capacity to house a large number of casualties. In order to correct this problem, there must be a nationwide effort to coordinate efforts

through the U.S. Department of Health and Human Services and the National Disaster Medical System.

Conclusion

Awareness of and attention to medical considerations related to LSCO is critical. By utilizing and applying observations from the WFX, the U.S. military can simulate the challenges that commanders, operational headquarters, and sustainment and medical units could face in LSCO. MCTP's units use complex algorithms to drive the exercise; even if the accuracy is not perfect, the conclusions drawn from the system data are accurate enough to recognize that the United States is not fully prepared for this number of casualties. The military, and society at large, must acknowledge there are constrained resources, and it must manage expectations on survivability. Depending on the combat environment and threat (such as the use of chemical, biological, or nuclear weapons), all of these sobering challenges could be significantly worse. The U.S. military has a professional and personal responsibility to think hard now to be able to make hard choices later. The focus must be on medical capacity, not only on capabilities, and there must be a joint solution. Just as Maj. Jonathan Letterman's changes to the medical department saved countless lives during the bloodiest day of combat in the Nation's history at Antietam, the remainder of the Civil War, and all subsequent wars, we owe it to all service people, their families, and America to evaluate and make changes now.[14] ■

Notes

1. David Vergun, "Survival Rates Improving for Soldiers Wounded in Combat, Says Army Surgeon General," Army.mil, 24 August 2016, accessed 10 February 2020, https://www.army.mil/article/173808/survival_rates_improving_for_soldiers_wounded_in_combat_says_army_surgeon_general.

2. Britannica.com, s.v. "Dominique-Jean, Baron Larrey," accessed 10 February 2020, https://www.britannica.com/biography/Dominique-Jean-Baron-Larrey#accordion-article-history.

3. "The 'New' Army Medical Department (AMEDD) Regimental Insignia," U.S. Army Medical Department, last modified 2 February 2015, accessed 10 February 2020, https://ameddregiment.amedd.army.mil/heraldic/distinct.html. "To Conserve Fighting Strength" was the Medical Corps motto from 1986 to 2014.

4. Sydney J. Freedberg Jr., "Let Leaders Off the Electronic Leash: CSA Milley," Breaking Defense, 5 May 2017, accessed 10 February 2020, https://breakingdefense.com/2017/05/let-leaders-off-the-electronic-leash-csa-milley/; C. Todd Lopez, "Future Warfare Requires 'Disciplined Disobedience,' Army Chief Says," Army.mil, 5 May 2017, accessed 10 February 2020, https://www.army.mil/article/187293/future_warfare_requires_disciplined_disobedience_army_chief_says; David Barno and Nora Bensahel, "Three Things the Army Chief of Staff Wants You to Know," War on the Rocks, 23 May 2017, accessed 10 February 2020, https://warontherocks.com/2017/05/three-things-the-army-chief-of-staff-wants-you-to-know/.

5. "Tactical Combat Casualty Care," NAEMT [National Association of Emergency Medical Technicians], accessed 10 February 2020, https://www.naemt.org/education/naemt-tccc.

6. *Army Health System Doctrine Smart Book* (Washington, DC: U.S. Government Publishing Office [GPO], 15 April 2019), 69, accessed 10 February 2020, https://medicalservicecorps.amedd.army.mil/leader_dev/Army_Health_System_Doctrine_Smart_Book_15April2019.pdf.

7. U.S. Army Directorate of Force Management, Force Management System Website, accessed 10 February 2020, https://fmsweb.fms.army.mil/unprotected/splash/.

8. Frank A. Reister, "Battle Casualties and Medical Statistics: U.S. Army Experience in the Korea War," chap. 3 in *Battle Casualties and Medical Statistics* (Washington, DC: Office of Medical History, U.S. Army Medical Department, 2009), accessed 10 February 2020, https://history.amedd.army.mil/booksdocs/korea/reister/ch3.html; Russ A. Kotwal et al., "A Review of Casualties Transported to Role 2 Medical Treatment Facilities in Afghanistan," *Military Medicine* 183, no. S1 (March 2018): 134–45.

9. Personal interviews with FORSCOM Surgeon's office 4 February 2019 and email communications and U.S. Army Consultants to the Surgeon General for General Surgery and Orthopedic Surgery, 7 November 2019.

10. *Army Health System Doctrine Smart Book*, 82.

11. Field Manual (FM) 4-0, *Sustainment Operations* (Washington, DC: U.S. GPO, July 2019), 2-54. "Functional brigades or groups provide a single function or capability."

12. The ten medical functions are listed in FM 4-02, *Army Health System* (Washington, DC: U.S. Government Printing Office, August 2013), 1-10.

13. *Army Health System Doctrine Smart Book*, 82.

14. "Jonathan Letterman," American Battlefield Trust, accessed 11 February 2020, https://www.battlefields.org/learn/biographies/jonathan-letterman.