INSTITUTE FOR DEFENSE ANALYSES

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Philip M. Lurie, Project Leader
Sarah K. Burns
John E. Whitley
James M. Bishop
Dylan J. Carrington-Fair

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INSTITUTE FOR DEFENSE ANALYSES
4850 Mark Center Drive
Alexandria, Virginia 22311-1882

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For More Information:
Philip M. Lurie, Project Leader
plurie@ida.org, (703) 575-4693

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

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Executive Summary

Background

Medical readiness (i.e., the readiness of the military medical force) has received a lot of attention recently from both the media and the Congress. Although long on the Congress's radar screen, concerns over the readiness of the military medical force have intensified since the publication of the final report of the Military Compensation and Retirement Modernization Commission (MCRMC) in January 2015. The most recent manifestation of those concerns is the National Defense Authorization Act for Fiscal Year (FY) 2017, which contains several provisions designed to enhance medical readiness.

Among other issues, the MCRMC report addressed the health and combat casualty care for those serving in an operational environment. Because the ability of the Military Health System (MHS) to provide operational healthcare is measured by the readiness of its medical personnel and related capabilities, the MCRMC report went on to recommend that the Congress and the Department of Defense (DoD) define and measure essential medical capabilities (EMCs) to promote and maintain critical capabilities within the military medical force. As part of a research effort for the MCRMC, the Institute for Defense Analyses (IDA) developed a preliminary list of EMCs based on an analysis of theater medical data from the DoD Trauma Registry from Iraq in 2007 (a year with high casualty counts and significant amounts of hospital data). That research also found that inpatient workload performed in theater bore little resemblance to that performed in garrison in terms of both nature and complexity. Whereas the in-theater workload distribution was composed largely of traumatic injuries, the in-garrison workload was largely related to pregnancy and childbirth. This comparison suggests that direct care inpatient platforms may not be providing the workload volume and diversity needed for military providers to maintain currency in wartime clinical skills.

In response to a Resource Management Decision (RMD) directing an assessment of the ability of military hospitals to support EMCs, the Director, Cost Assessment and Program Evaluation (CAPE) asked IDA to:

- Develop methods to evaluate direct care inpatient data to identify the extent to which MTF workload volume and diversity of care are sufficient to sustain clinical skills for surgically related in-theater procedures; and
- Identify and evaluate potential solutions to reduce or eliminate any identified gaps between the workload necessary to sustain wartime clinical skills and the actual current MTF workload.

Although the use of volume as a partial measure of currency is growing in civilian practice, it is not universally accepted, and volume standards have not been developed in the academic literature for the EMC procedures we identified in our previous work. Given the lack of any relevant volume standards in the private sector, we decided on an approach that uses the San Antonio Military Medical Center (SAMMC) as a benchmark for EMC volume. It is important to note that workload volume benchmarks derived from a reference MTF or any other facility cannot be interpreted as minimum volume standards. Rather, the benchmarks represent a workload goal that could be achieved by implementing policies and procedures to address any workload gaps, such as those we consider in this paper. Falling short of a benchmark does not imply that a provider is not ready to perform in an operational environment, but it seems logical that the more readiness-related workload a provider performs, the more operationally ready they will be.

Establishing Workload Benchmarks

EMC Benchmarks

SAMMC is DoD's only Level I trauma center, receiving about 40 percent of its EMC workload from civilian emergency cases. To receive Level I designation from a state Emergency Medical Services (EMS) department, a hospital must provide education and research services, be capable of providing total care for every aspect of the most severe trauma cases, meet a minimum annual volume requirement of severely injured patients, and be part of a regional trauma system. To bolster our confidence in using SAMMC as a basis for setting EMC workload volume benchmarks, we compared the volume for each EMC at SAMMC in FY 2015 with the corresponding median volume at civilian Level I and Level II trauma centers in the National Trauma Data Bank (NTDB), a standardized hospital trauma registry database maintained by the American College of Surgeons (ACS). The comparisons showed that SAMMC EMC workload met or exceeded the Level I trauma center NTDB median for 91 percent of EMCs and the Level II trauma center NTDB median for 96 percent of EMCs.

A major advantage to using SAMMC to establish inpatient workload benchmarks is that its hospital data are included in DoD's Standard Inpatient Data Records (SIDRs), which contain more detailed information than is typically available from civilian trauma registries, including the NTDB. In particular, the SIDR data contain information on providers, including individual identifiers, specialty/subspecialty, and which ones performed which procedures (up to four providers per procedure). This allowed us to determine surgical specialists and how many EMCs they performed. We then calculated the median number of EMCs for each surgical specialty/subspecialty to establish our benchmarks. By dividing the total actual EMC workload for each specialty by the SAMMC benchmark median for that specialty, we were able to compute the total number of

providers that the current level of EMC workload could support. Of the 650 surgical (plus anesthesiology) providers in the United States we were able to evaluate with our benchmarks, we estimate enough EMC workload currently exists to allow 92 of them, or about 14 percent, to be supported at the SAMMC EMC benchmark levels.

Major Trauma Benchmarks

Although EMCs are based on the procedures used to treat severe trauma cases DoD has actually encountered in theater and are ideally what DoD should want its clinicians to be performing in garrison, we also evaluated MTF workload against a more general standard, i.e., one that is related to trauma generally and not specific to what providers actually do in theater. To develop a general trauma procedures list, we used the ACS's criteria for designating a trauma center as Level I.

Analogous to the methodology we used to determine EMC workload benchmarks, we calculated the median number of major trauma procedures for each surgical specialty/ subspecialty and the total number of providers that the current level of major trauma workload could support. As expected, major trauma workload volume exceeds that for EMCs and the number of specialties involved in treating major trauma cases is greater than the number performing EMCs. Of the 843 surgical (plus anesthesiology) providers in the United States we were able to evaluate with these alternative benchmarks, we estimate enough major trauma workload currently exists to allow 238 of them, or about 28 percent, to be supported at the SAMMC major trauma benchmark levels. Although that is higher than the percentage of providers that can be supported by EMC workload (14 percent), it is low enough to call into question the MHS's ability to sustain the readiness-related skills of its military surgeons. In other words, both the EMC and major trauma workload gaps are substantial and need to be addressed.

Addressing Workload Gaps

The readiness-related workload shortage facing surgical specialists stems from the MHS's beneficiary population, which generates workload consisting largely of childbirth, pediatrics, and primary care in the Active Duty family member population and conditions associated with aging in the retiree population. To address the workload gaps currently experienced by critical wartime trauma-related surgical specialties, DoD must find ways to tap into a larger population of trauma patients, including civilians.

Civilian trauma centers are designated by the state in which they are located and participate in a regional trauma system. Trauma center designation is based largely on the resources available in a hospital (e.g., 24-hour coverage by certain surgical specialties, ability to perform certain procedures, and teaching and research resources) and patient volume. Obtaining designation requires a substantial commitment of resources (financial

and otherwise) by the hospital. Most states have a tiered designation system consisting of three levels (with Level I having the highest status), although a few states have up to five.

DoD has five trauma centers operating in the United States—one Level I, two Level IIs, and two Level IIIs. SAMMC is DoD's only Level I facility and currently the only facility that treats a significant number of civilian cases. If DoD works to increase its role in regional civilian trauma regulating systems, pursuing state designation and increasing access to civilian trauma patients will be essential.

While it is clear that Level I and Level II DoD trauma centers perform a much greater volume of EMC-based workload (or trauma workload in general) than other DoD facilities, determining which facilities have the potential to become trauma centers is more challenging. Whether or not any given DoD hospital has the potential to become a trauma center is based on several factors, including facility size, local demand for trauma care, and local supply of trauma care.

Based on an analysis of data from the American Trauma Society, we calculated the distribution of facility size (number of beds) for Level I and Level II facilities nationwide and found the minimum size for a DoD facility to potentially upgrade to a Level I or II trauma center to be 100 beds. Of the 40 current DoD hospitals in the United States, only 12 meet the minimum size criterion, as shown in the table below.

DoD Hospitals with 100 or More Beds, FY 2016

Rank	Name	Bed Count
1	San Antonio Military Medical Center (Level I)	425
2	Naval Medical Center San Diego	285
3	Naval Medical Center Portsmouth	274
4	Walter Reed National Military Medical Center (Level II)	247
5	Madigan Army Medical Center (Level II)	227
6	William Beaumont Army Medical Center (Level III)	209
7	Tripler Army Medical Center	194
8	Womack Army Medical Center	156
9	Naval Hospital Camp Lejeune	117
10	David Grant USAF Medical Center	116
11	Carl R. Darnall Army Medical Center (Level III)	109
12	Dwight D. Eisenhower Army Medical Center	107

Market Overviews

The main text of this paper provides an overview of the 12 markets identified in the table above, including a brief description of each facility's size, patient volume (including

civilian emergency cases), and the share of the workload that is considered trauma. The facility overviews are followed by a discussion of the surrounding market areas, including the demand for trauma care and the supply of civilian trauma centers.

Market Assessments

After reviewing the market conditions for the candidate facilities, we considered which option seems best suited to each: (1) stand-alone DoD trauma center investment or (2) joint military-civilian trauma center investment. For the first option, we consider SAMMC as a model of what a stand-alone DoD trauma center could look like. For the second option, no jointly operated military-civilian trauma centers currently exist. We therefore created case studies for what such an arrangement might look like. In markets where not enough workload exists to support a DoD trauma center and jointly run military-civilian trauma centers are not feasible, the MHS could expand the use of a currently existing third option, i.e., placing military providers in high-volume civilian trauma centers. We did not, however, address the feasibility of that option in those markets.

After assessing the feasibility of each option, we determined the most viable path and designation (Level I or II) we thought each facility should pursue to maximize its potential trauma workload. We sorted facilities into three tiers that indicate the strength of their candidacy for trauma investment. Tier I facilities are the facilities we believe are the strongest candidates to become stand-alone or joint military-civilian trauma centers and the facilities that could help fill gaps in the civilian trauma infrastructure. Those facilities might also serve well as pilots or test models on which additional trauma investments could be modeled. Tier II facilities are somewhat less strong candidates with fairly clear opportunities and partners. Tier III facilities could also be candidates for partnerships but they are generally smaller facilities in more crowded trauma markets with smaller populations, making it more difficult for them to attract additional civilian trauma cases.

Potential Effects of Workload Enhancement Measures

To better understand how creating stand-alone DoD trauma centers or joint military-civilian trauma centers would affect the workload gaps identified previously, we conducted two analytical excursions based on a range of assumptions about the number of trauma centers or joint military-civilian trauma centers DoD could form and the number of providers those arrangements could support. In the first excursion, we assumed that each partnership or stand-alone DoD facility would have enough trauma workload to support its providers at the same level that SAMMC currently achieves. We then computed the workload gap improvement across the MHS under several alternative scenarios.

Using the EMC benchmark, our estimates indicate that investing in the top candidate facilities so that they could support their providers at the same level as SAMMC would close the supported provider gap by 15 to 80 providers, depending on how many facilities

were upgraded. Similarly, using the major trauma benchmark, our estimates indicate that investing in the selected facilities so that they could support their providers at the same level at SAMMC would close the supported provider gap by 25 to 134 providers.

In the second excursion, we assumed that DoD chooses to invest in all 11 facilities, and the investments not only allow each facility to achieve support for their surgical specialists at the same rate as SAMMC, but they also allow the facilities to support additional providers. Surgical specialists from the remaining MTFs would be reallocated to the larger DoD trauma centers that now require more providers. Using the EMC benchmark, we estimated the supported provider gap would be reduced by 84 to 91 providers, depending on the percentage of additional providers each facility could support (5, 10, or 15 percent more). This improvement would increase the percentage of MHS providers supported by EMC workload from the current 14 percent to between 27 and 28 percent. Likewise, using the major trauma benchmark, we estimated the supported provider gap would be reduced by 139 to 149 providers and the percentage of supported providers would increase from the current 28 percent to between 45 and 46 percent.

Supplementary Actions

Although we did not perform a quantitative analysis, we examined two additional actions that could potentially be used to enhance the availability of operationally ready medical providers. These actions are not meant to be alternatives to the options discussed previously; rather, they could be used in conjunction with them. The first action we examined could be deemed a "surgical team" approach and would be modeled along the lines of the Sponsored Reserves concept currently in place in the United Kingdom (UK), although not used by the UK in a medical context. Sponsored Reserves is a category of reserve forces in the UK that allows for certain support or specialist tasks to be carried out by trained civilian professionals under contract with a participating employer.

The second option we examined is the National Language Service Corps (NLSC) model, which is more of an individual, rather than a team, approach. The NLSC consists of volunteers who offer their language skills to support federal agencies, particularly during surge conditions that occur during times of crisis or urgent national need. In the medical context, such a model could possibly be used to backfill DoD hospitals, allowing longer deployments of Active Duty and Reserve personnel.

Conclusions

The MHS currently lacks the case volume and mix required to sustain the skills of a subset of providers whose readiness is crucial to the combat casualty care mission. This subset of providers includes surgical specialists (e.g., trauma surgeons, general surgeons, orthopaedic surgeons, and vascular surgeons) and other providers of critical care such as the critical care nurses, operating room nurses, nurse anesthetists, and medics who work

together with the surgeons to save life and limb. Our research developed a methodology for quantifying the extent of the workload shortage facing surgical providers and found that the MHS's inpatient platforms can currently support only 14 percent of its surgical providers with EMC workload and 28 percent with major trauma workload.

While the workload gap appears large, there are means to address it. The primary avenue for closing the workload gap is to increase DoD's role in the civilian trauma system, thereby tapping into the trauma workload generated by a much larger patient base. We considered three strategies through which DoD could achieve that goal: (1) upgrading DoD medical centers to DoD trauma centers that treat civilian trauma cases, (2) forming joint military-civilian trauma centers, and (3) sending DoD providers to work in busy civilian trauma centers. Our analysis found that the optimal path for the MHS will probably be to employ a mix of those strategies and that a careful assessment of each market area is needed to determine the best market-specific approach.

Contents

1. Introduction

Medical readiness (i.e., the readiness of the military medical force) has received a lot of attention recently from both the media and the Congress. Although long on the Congress's radar screen, concerns over the readiness of the military medical force have intensified since the publication of the final report of the Military Compensation and Retirement Modernization Commission (MCRMC) in January 2015.[1] The most recent manifestation of those concerns is the National Defense Authorization Act (NDAA) for Fiscal Year (FY) 2017, which contains the following readiness-related provisions:

- Section 703 added high-level trauma capabilities to the requirements for a military hospital to qualify for designation as a medical center.
- Section 706 directs the Department of Defense (DoD) to "establish military-civilian integrated health delivery systems through partnerships with other health systems, including local or regional health systems in the private sector…to maintain services within military treatment facilities that are essential for the maintenance of operational medical force readiness skills of health care providers of the Department."
- Section 707 directs DoD to "establish a Joint Trauma System within the Defense Health Agency that promotes improved trauma care to members of the Armed Forces and other individuals who are eligible to be treated for trauma at a military medical treatment facility."
- Section 708 directs DoD to "establish a Joint Trauma Education and Training Directorate…to ensure that the traumatologists of the Armed Forces maintain readiness and are able to be rapidly deployed for future armed conflicts."

The MCRMC report addressed the issue of health benefits, including both the peacetime benefit and the health and combat casualty care for those serving in an operational environment. Because the ability of the Military Health System (MHS) to provide operational healthcare is measured by the readiness of its medical personnel and related capabilities, the MCRMC report went on to recommend that the Congress and DoD define and measure essential medical capabilities (EMCs) to promote and maintain critical capabilities within the military medical force.

[1] Military Compensation and Retirement Modernization Commission (MCRMC), *Report of the Military Compensation and Retirement Modernization Commission: Final Report*, January 29, 2015.

As part of a research effort for the MCRMC,[2] the Institute for Defense Analyses (IDA) developed a preliminary list of EMCs based on an analysis of theater medical data from the DoD Trauma Registry from Iraq in 2007 (a year with high casualty counts and significant amounts of hospital data), including diagnoses and procedures performed. Using data from the Theater Medical Data Store, the IDA effort also compared inpatient workload performed in theater (also from Iraq in 2007) with that performed in garrison in FY 2015 and found that the two bore little resemblance to one another. Whereas the in-theater workload distribution was composed largely of traumatic injuries, the in-garrison data were highly represented by diagnoses related to pregnancy and childbirth. Further, an analysis of mortality rates indicated that medical conditions encountered in theater are more severe than those confronted in the direct care system (an unsurprising but nevertheless important conclusion). These comparisons suggest that direct care inpatient platforms may not be providing the workload volume and diversity needed for military providers to maintain currency in wartime clinical skills.

Shortly after the release of the MCRMC's final report, the Assistant Secretary of Defense for Health Affairs (ASD(HA)) completed an assessment of Military Treatment Facility (MTF) workload issues in the *MHS Modernization Study*.[3] This study found insufficient workload in many MTFs to ensure economic viability of inpatient capacity. It did not address the readiness question—what workload is required to maintain readiness of the military medical force—but it is integrally related to the readiness challenge because insufficient workload for economic viability is correlated with insufficient workload for clinical currency maintenance.

Drawing on the analyses and recommendations from the above-cited studies, the Under Secretary of Defense for Personnel and Readiness and the Director, Cost Assessment and Program Evaluation (CAPE), in coordination with the Under Secretary of Defense for Acquisition, Technology and Logistics, Joint Staff, and Military Services, directed in an FY 2017–21 Resource Management Decision (RMD) to:

> assess the extent to which each inpatient platform provides the necessary workload volume and diversity of care to maintain Essential Medical Capabilities (EMCs), with a particular focus on how direct care workload sustains readiness required currency. The assessment will also describe supplementary actions the Services take to maintain staff currency, and present a business case analysis of changes that may increase medical readiness and quality of care (including increasing the use of local purchased care networks for non-readiness or currency-related workload).

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[2] See John E. Whitley et al., "Essential Medical Capabilities and Medical Readiness," IDA Paper NS P-5305 (Alexandria, VA: Institute for Defense Analyses, July 2016). http://www.dtic.mil/dtic/tr/fulltext/u2/1014147.pdf.

[3] Department of Defense, *Military Health System Modernization Study Team Report,* May 29, 2015.

The objective of this paper is to provide CAPE with analytic support in its RMD-directed assessment of the extent to which each inpatient platform provides the necessary workload volume and diversity of care to maintain readiness. More specifically, CAPE asked IDA to:

- Develop methods to evaluate direct care inpatient data to identify the extent to which MTF workload volume and diversity of care are sufficient to sustain clinical Knowledge, Skills, and Abilities (KSAs) for surgically related in-theater procedures; and
- Identify and evaluate potential solutions to reduce or eliminate any identified gaps between the workload necessary to sustain KSAs and the actual current MTF workload.

The KSA concept is used in Civil Service job descriptions to define the unique attributes required of a job applicant. The original impetus for their development was the RMD referenced on the previous page that directed the ASD(HA) to assess the ability of MTFs to support EMCs. Because there were no EMCs identified at the time the RMD was issued, the ASD(HA) focused on assessing individual readiness as a determinant of EMC support and chose the KSA framework for that purpose. The KSA domains are shown in Table 1.

Table 1. KSA Domains for Assessment

Wound & Amputation /Fx Mgt	Head and Spine Injury	Torso Trauma
Management of War Wounds	Cervical and TL Spine Injury	Pelvic Fracture Care
Compartment Syndrome and Fasciotomy	Concussion / mTBI Management	Blunt Abdominal Trauma
Amputation	Neurosurgical Management	Damage Control Surgery (ABD)
Burn Care	Cervical Spine Evaluation	Damage Control Surgery (Chest)
High Bilateral Amputations	Management of Severe Head Injury	Damage Control Surgery (Neck)
Additional Extremities		Thoracic Trauma
		Wartime Vascular Injury
Transfusion and Resuscitation	**Airway and Breathing**	**Critical Care/Prevention**
Frozen Blood	Trauma Airway Management	Hypothermia Prevention
Damage Control Resuscitation	Acute Respiratory Failure	Prevention of Venous Thromboembolism
Fresh Whole Blood	Trauma Anesthesia	Catastrophic Care
Inj Doc Resus Record	Inhalational Injury	Infection Control
REBOA for Hemorrhagic Shock		Management of Pain/Anxiety/Del
Emergency Thoracotomy		Critical Care additional
Military Other	**Universal Domains**	**Emergency War Surgery**
UXO Management	Systems Based Practice	EWS Amputation
TCCC/ Prehospital Care	Practice Based Learning and Improvement	EWS Hands and Foot
EPW & Detainee Care	Interpersonal and Communication Skills	EWS OBGYN Emergencies
Pediatric Trauma	Professionalism	EWS Extremity Fractures
Intratheater Transport		
Clinical Mgt of Mil Working Dogs		
Initial Care of occular/adnexal injuries		
Joint Trauma System		
Urologic Trauma		

Source: Defense Health Agency.

At the time of this writing, KSA development was still too preliminary to be of use in assessing workload gaps. We therefore use the EMCs we developed in IDA Paper NS P-5305 as the basis for our assessment, but use the KSA domains as a taxonomy for classifying EMCs. The mapping of EMCs into KSA domains is shown in Appendix A.

The remainder of this paper is organized as follows: Chapter 2 analyzes MTF inpatient workload volume and diversity and defines benchmarks against which to compare them. Chapter 3 provides an overview of civilian trauma systems and discusses three general strategies for increasing DoD's role in those systems to gain access to readiness-related case mix and volume. Chapter 4 discusses the principles that should guide each workload enhancement option as well as the benefits and challenges that accompany those options. Next, Chapter 5 provides overviews of the markets for trauma care around selected military hospitals, including the existing supply of civilian trauma centers and the demand for care in those markets with an eye toward exploring the possibility for military-civilian partnerships. Chapter 6 discusses how some of those partnerships might work and provides estimates of the degree to which the DoD workload gap could be ameliorated by such arrangements. Chapter 7 describes supplemental actions DoD could consider to enhance the readiness of the operational force. Finally, Chapter 8 summarizes our conclusions.

2. MTF Inpatient Workload Volume and Diversity

A. Computing MTF Workload per Provider

IDA Paper NS P-5305 produced a list of 93 EMCs based on an analysis of DoD Trauma Registry data. The EMCs constitute a list of major diagnostic and therapeutic International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) hospital procedure codes. In the United States, all inpatient professional services (i.e., the physician's cost of delivering care in a hospital setting) are billed using Current Procedural Terminology (CPT) codes, as those are what commercial and government insurers (Medicare and Medicaid) require for reimbursement. In theater, however, providers do not file claims with public or private insurers and, consequently, only hospital ICD-9-CM procedure codes are recorded. Because we were not aware of any generally reliable mapping of ICD-9-CM codes to CPT codes, we used the Standard Inpatient Data Records (SIDRs—direct care hospital data) from the MHS Data Repository (MDR) to calculate inpatient workload and volume by ICD-9-CM procedure code. We selected FY 2015 as the reporting year because the MHS started using the ICD-10-CM system in FY 2016, which would have created additional mapping issues.

The MDR SIDR data include each provider's National Provider Identifier (NPI) and Health Insurance Portability and Accountability Act (HIPAA) Provider Taxonomy Code, which indicates a provider's specialty. There are up to 20 procedures recorded on each SIDR record, with up to four provider NPIs recorded for each procedure. This allows us to compute the numbers and types of procedures performed for each provider/specialty. As called for in our tasking, we limited the HIPAA Provider Taxonomy Codes to only surgical specialties plus anesthesiology. Table 2 shows the surgical specialties we considered (not all are represented in the SIDR data).

Table 2. Surgical Provider Specialties

Provider Classification	Provider Specialty
Anesthesiology	Anesthesiology (no subspecialty)
Anesthesiology	Addiction Medicine
Anesthesiology	Critical Care
Anesthesiology	Hospice and Palliative Medicine
Anesthesiology	Pain Medicine
Anesthesiology	Pediatric Anesthesiology
Colon & Rectal Surgery	Colon and Rectal Surgery
Dentist	Oral and Maxillofacial Surgery
Neurological Surgery	Neurological Surgery
Obstetrics and Gynecology	Obstetrics and Gynecology (no subspecialty)
Obstetrics and Gynecology	Bariatric Medicine
Obstetrics and Gynecology	Critical Care Medicine
Obstetrics and Gynecology	Female Pelvic Medicine and Reconstructive Surgery
Obstetrics and Gynecology	Gynecologic Oncology
Obstetrics and Gynecology	Gynecology
Obstetrics and Gynecology	Hospice and Palliative Medicine
Obstetrics and Gynecology	Maternal and Fetal Medicine
Obstetrics and Gynecology	Obstetrics
Obstetrics and Gynecology	Reproductive Endocrinology
Ophthalmology	Ophthalmology
Oral & Maxillofacial Surgery	Oral and Maxillofacial Surgery
Orthopaedic Surgery	Orthopaedic Surgery (no subspecialty)
Orthopaedic Surgery	Adult Reconstructive Orthopaedic Surgery
Orthopaedic Surgery	Foot and Ankle Surgery
Orthopaedic Surgery	Hand Surgery
Orthopaedic Surgery	Orthopaedic Surgery of the Spine
Orthopaedic Surgery	Orthopaedic Trauma
Orthopaedic Surgery	Pediatric Orthopaedic Surgery
Orthopaedic Surgery	Sports Medicine
Otolaryngology	Otolaryngology (no subspecialty)
Otolaryngology	Facial Plastic Surgery
Otolaryngology	Otolaryngic Allergy
Otolaryngology	Otology and Neurotology
Otolaryngology	Pediatric Otolaryngology
Otolaryngology	Plastic Surgery within the Head and Neck
Otolaryngology	Sleep Medicine
Plastic Surgery	Plastic Surgery (no subspecialty)
Plastic Surgery	Plastic Surgery within the Head and Neck

Provider Classification	Provider Specialty
Plastic Surgery	Surgery of the Hand
General Surgery	General Surgery (no subspecialty)
General Surgery	Hospice and Palliative Medicine
General Surgery	Pediatric Surgery
General Surgery	Plastic and Reconstructive Surgery
General Surgery	Surgery of the Hand
General Surgery	Surgical Critical Care
General Surgery	Surgical Oncology
General Surgery	Trauma Surgery
General Surgery	Vascular Surgery
Thoracic Surgery	Thoracic Surgery
Transplant Surgery	Transplant Surgery
Urology	Urology (no subspecialty)
Urology	Female Pelvic Medicine and Reconstructive Surgery
Urology	Pediatric Urology

Further limiting the data to include only Active Duty, Guard, or Reserve clinicians at the 40 domestic DoD hospitals, we arrived at our final provider workload dataset.

B. The Literature on Volume Standards for Clinical Proficiency

In the civilian healthcare sector, basic clinical "competency" is typically measured by appropriate licensure or board certification. The higher level of "proficiency" denotes increased clinical skills and knowledge by adding a dimension of experience. In turn, "currency" is defined as being up to date, i.e., being clinically proficient and ready to immediately deliver care at a particular level of skill. Procedure volume is one useful measure of this level of skill and directly translates to how readiness is measured in many communities across DoD. Quality outcomes are, of course, a more direct measure of results than volume, but studies have shown that when providers perform a higher volume of selected procedures, outcomes tend to be of higher quality.[4] Furthermore, if a provider does not consistently achieve quality outcomes, he or she is not likely to be allowed to continue treating patients without remedial training or may even be terminated. There is therefore a bidirectional relationship between volume and outcomes.

Although the concept of minimum volume standards for assessing provider currency is growing in civilian healthcare practice, it has proven to be a controversial topic among

[4] See, for example, Rick L. Lau et al., "The role of surgeon volume on patient outcome in total knee arthroplasty: a systematic review of the literature," *BMC Musculoskeletal Disorders* 13:250 (December 14, 2012), doi: 10.1186/1471-2474-13-250.

clinicians. However, it has recently been gaining grudging acceptance even within the clinical community. A recent article in *The New England Journal of Medicine*[5] describes a campaign by leaders of three large hospital systems to prevent certain surgical procedures from being performed by surgeons who perform relatively few of them. The campaign, called "Take the Volume Pledge," proposed both hospital and surgeon volume standards for 10 surgical procedures, including gastrointestinal, cardiovascular, and joint-replacement surgeries. And, as reported in *U.S. News & World Report*,[6] the American College of Surgeons (ACS) has independently been considering whether to recommend linking minimum-volume standards to surgeons' hospital privileges.

The concept of volume as a partial measure of currency has been used in the area of credentialing and privileging as well. For example, the Credentialing Resource Center website contains sample competency standards for a variety of practice areas and procedures. These white papers[7] include the positions of various specialty boards, such as the Accreditation Council for Graduate Medical Education (ACGME), on standards for credentialing graduates of residency programs seeking initial hospital privileges, including minimum procedure volumes. However, the procedures are generally not specific enough to be of use in our current research. For example, the Clinical Privilege White Paper for Vascular Surgery states the ACGME position on credentialing of vascular surgeons completing a five-year residency: "residents should perform a minimum of 500 operations, to include 250 major vascular reconstructive procedures that reflect an adequate representation of current trends, as well as a breadth and balance of experience in the surgical care of vascular diseases." Nowhere does the paper go on to define what constitutes a "major vascular reconstructive procedure." That is left for individual hospitals to decide.

In a supporting research report for the MCRMC,[8] the Center for Naval Analyses (CNA) cited data from studies showing that a higher volume of surgeries correlates with a lower number of surgical complications and higher quality outcomes for patients. In particular, they cited minimum annual volumes for a limited set of surgical procedures for a hospital to qualify for special recognition by some medical insurance programs, such as Aetna's Institutes of Quality and Institutes of Excellence and Blue Cross/Blue Shield's

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5 David R. Urbach, "Pledging to Eliminate Low-Volume Surgery," *The New England Journal of Medicine* 373, No. 15 (October 2015): 1388–1390. doi: 10.1056/NEJMp1508472.

6 Steve Sternberg, "Surgeons Push Back Against Minimum Volume Standards," *U.S. News & World Report*, June 23, 2015, http://health.usnews.com/health-news/hospital-of-tomorrow/articles/2015/06/23/surgeons-push-back-against-minimum-volume-standards.

7 The Credentialing Resource Center, http://www.credentialingresourcecenter.com. The white papers, published by HCPro, are available by subscription only.

8 Holly Brevig et al., "The Quality-Volume Relationship: Comparing Civilian and MHS Practice" (Alexandria, VA: CNA Corporation, January 2015). https://www.cna.org/CNA_files/PDF/DIM-2014-U-009221-Final.pdf.

Blue Distinction Centers. Additionally, the report published data from the Leapfrog Group, a non-profit organization that compiles and publishes safety ratings based on data provided by hospitals that volunteer to participate in its program. Participating hospitals are rated on patient outcomes, on their use of appropriate safety processes, and on meeting minimum annual volumes for select procedures. For some procedures, there are minimum volume standards for individual providers (of particular relevance to this paper) in addition to facility standards. However, most of the procedures, although complicated, can probably not be classified as "readiness-related" (e.g., bariatric surgery, coronary artery bypass graft, and knee and hip replacements). Furthermore, none of the procedures intersects our list of EMCs.

C. Other Potential Sources of Volume Standards

The academic literature establishes the use of volume as a measure of proficiency, but does not provide standards for the procedures of interest in this paper. We therefore had to consider other sources of potential standards. The American College of Surgeons (ACS) maintains the National Trauma Data Bank (NTDB),[9] which collects and standardizes data from the trauma registries of participating hospitals throughout the United States. We ordered data from the NTDB National Sample Program (NSP), a nationally representative sample of 100 Level I and Level II trauma centers (see Section 3.A.1 for definitions of the trauma center designations). At the time of this research, the most current year of data available was 2013. Although the NTDB contains detailed hospital records, including information on multiple diagnoses and procedures, there is no information whatsoever on the providers performing the procedures. In particular, we cannot determine provider counts or specialties.

Another approach we considered was to evaluate the standards civilian hospitals use to renew provider privileges for each surgical specialty. We contacted several large Level I trauma centers to ask for the factors they consider when privileging providers. There is also a wealth of information available online[10] but, as expected, there is a great deal of variation across hospitals. We obtained sample privileging forms for many civilian hospitals, but most offer only general guidelines for renewing privileges (for example, "a minimum of 100 core cases required during the past 2 years"). Core cases would include something like "trauma, including multisystem trauma" but not define what constitutes a trauma case. These hospitals often use privileging panels to evaluate applicants to determine procedures for which privileges will be granted. In interviews with these

9 "National Trauma Data Bank," American College of Surgeons, https://www.facs.org/quality%20programs/trauma/ntdb.

10 See, for example, "Medical Staff: Credentialing and Privileging," Stanford Health Care, https://stanfordhealthcare.org/health-care-professionals/medical-staff/credentialing-and-privileging/shc-privileging-references.html.

facilities, it was stated that most applicants are experienced, high-volume surgeons and the focus of those panels is more about identifying areas of risk where privileges to practice independently may not be immediately granted. We were not able to determine specific procedure codes and standards that we could match against the SIDR data from the information provided by these hospitals.

We also had conversations with the ACS, the Trauma Center Association of America (TCAA—an advocacy group for trauma centers), the Greeley Company (a health services consulting company, specializing in credentialing and privileging), the National Association Medical Staff Services (a professional organization for medical and credentialing services staff), and authors of books on privileging. The responses from each were similar: that every hospital is different and that privileging panels weigh a number of factors in addition to volume when granting privileges, including direct observation of a provider's decision making abilities, case logs, patient outcomes, continuing medical education, etc. Although volume is considered, trauma surgery does not yet have widely accepted volume standards similar to those emerging in civilian healthcare in non-traumatic surgical areas.

D. Using DoD Experience as a Benchmark

1. Determining a Reference MTF

Given the lack of any relevant volume standards in the private sector, we decided on an approach that uses the San Antonio Military Medical Center (SAMMC) as a benchmark for EMC volume per provider. It is important to note that workload volume benchmarks derived from a reference MTF or any other facility cannot be interpreted as minimum volume standards, i.e., they do not necessarily equate to reliable workload targets for proficiency. Rather, the benchmarks represent a workload goal that could be achieved by implementing policies and procedures to address any workload gaps, such as those we consider in subsequent chapters of this paper. Falling short of a benchmark does not imply that a provider is not ready to perform in an operational environment, but it seems logical that the more readiness-related workload a provider performs, the more operationally ready they will be.

A recent study of orthopaedic trauma cases at SAMMC[11] demonstrated the importance of supplementing the highly variable and declining number of military trauma cases with a local civilian trauma mission to maintain provider currency. SAMMC is DoD's only Level I trauma center, receiving about 40 percent of its EMC workload from civilian emergency cases. To receive Level I designation from a state Emergency Medical

[11] Haydn Roberts et al., "Being Prepared for the Next Conflict: A Case Analysis of a Military Level I Trauma Center," *Military Medicine* 182, No. 5 (May 2017): e1681–e1687, doi: 10.7205/MILMED-D-16-00168.

Services (EMS) department, a hospital must provide education and research services, be capable of providing total care for every aspect of the most severe trauma cases, meet a minimum annual volume requirement of severely injured patients, and be part of a regional trauma system. Based on the American Trauma Society's Trauma Information Exchange Program (TIEP) database, there were 216 state-designated Level I trauma centers and 306 Level II trauma centers in the United States at the end of 2015. According to the SAMMC website,[12] the hospital has 425 beds, placing it at the 26th percentile among nationwide Level I trauma centers and at the 73rd percentile among Level II trauma centers.

A possible concern about using SAMMC as a reference MTF is that military hospitals in general are less efficient than their civilian counterparts;[13] therefore, setting benchmarks using SAMMC data may be "setting the bar too low." However, as SAMMC does meet the rigorous requirements for Level I designation, the efficiency concern may be inconsequential, especially as trauma cases are treated immediately upon arrival to the emergency department (i.e., they are not subject to scheduling inefficiencies).

To further bolster our confidence in using SAMMC as a basis for setting EMC workload volume benchmarks, we compared the volume for each EMC at each DoD hospital in FY 2015 with the corresponding median volume at civilian Level I and II trauma centers in the NTDB NSP dataset. As no publicly available civilian hospital workload data exist at the provider level (as far as we have been able to determine), we had no choice but to make the comparisons at the facility level. We counted the number of EMCs for which each DoD hospital's volume was greater than or equal to the civilian hospital median, excluding those civilian hospitals that had zero volume. The results are shown in Table 3, where the comparisons are made for a total of 96 EMCs.[14]

Table 3. Comparison of EMC Workload by MTF with NTDB Medians

Facility Name	Designation Level	Level I Count	Level II Count	Level I Percent	Level II Percent
San Antonio MMC-Ft. Sam Houston	I	87	92	90.6%	95.8%
Walter Reed NMMC	II	45	59	46.9%	61.5%
Madigan AMC-Ft. Lewis	II	38	54	39.6%	56.3%
NMC San Diego	–	34	50	35.4%	52.1%
Tripler AMC-Ft. Shafter	–	32	47	33.3%	49.0%
NMC Portsmouth	–	32	44	33.3%	45.8%

[12] Brooke Army Medical Center, https://www.bamc.amedd.army.mil/bamc-facts.asp.

[13] See, for example, Philip M. Lurie, "Comparing the Costs of Military Treatment Facilities with Private Sector Care," IDA Paper NS P-5262 (Alexandria, VA: Institute for Defense Analyses, February 2016). https://www.ida.org/idamedia/Corporate/Files/Publications/IDA_Documents/CARD/2017/P-5309.ashx.

[14] IDA Paper NS P-5305 determined 93 EMCs based on trauma data in Iraq in 2007. Since that time, a few of the ICD-9-CM codes have been replaced with more than one code, resulting in 96 EMCs.

Facility Name	Designation Level	Level I Count	Level II Count	Level I Percent	Level II Percent
William Beaumont AMC-Ft. Bliss	III	23	34	24.0%	35.4%
Eisenhower AMC-Ft. Gordon	–	23	30	24.0%	31.3%
Womack AMC-Ft. Bragg	–	22	30	22.9%	31.3%
81st Med Grp-Keesler	–	18	24	18.8%	25.0%
60th Med Grp-Travis	–	17	30	17.7%	31.3%
88th Med Grp-Wright-Patterson	–	13	20	13.5%	20.8%
96th Med Grp-Eglin	–	10	20	10.4%	20.8%
Martin ACH-Ft. Benning	–	10	13	10.4%	13.5%
Evans ACH-Ft. Carson	–	9	18	9.4%	18.8%
Darnall AMC-Ft. Hood	III	8	18	8.3%	18.8%
Ft. Belvoir Community Hospital	–	8	16	8.3%	16.7%
99th Med Grp-O'Callaghan Hospital	–	7	19	7.3%	19.8%
633rd Med Grp Langley-Eustis	–	7	13	7.3%	13.5%
NH Camp Lejeune	–	6	17	6.3%	17.7%
Blanchfield ACH-Ft. Campbell	–	6	12	6.3%	12.5%
NH Camp Pendleton	–	6	12	6.3%	12.5%
673rd Med Grp-Elmendorf	–	6	12	6.3%	12.5%
NH Jacksonville	–	4	10	4.2%	10.4%
NH Bremerton	–	4	7	4.2%	7.3%
Bassett ACH-Ft. Wainwright	–	4	4	4.2%	4.2%
L. Wood ACH-Ft. Leonard Wood	–	3	6	3.1%	6.3%
Keller ACH-West Point	–	3	4	3.1%	4.2%
Irwin ACH-Ft. Riley	–	2	6	2.1%	6.3%
NH Pensacola	–	2	4	2.1%	4.2%
NH Beaufort	–	2	4	2.1%	4.2%
Winn ACH-Ft. Stewart	–	1	4	1.0%	4.2%
Moncrief ACH-Ft. Jackson	–	1	4	1.0%	4.2%
Bayne-Jones ACH-Ft. Polk	–	1	3	1.0%	3.1%
Ireland ACH-Ft. Knox	–	1	3	1.0%	3.1%
Weed ACH-Ft. Irwin	–	1	3	1.0%	3.1%
NH Twentynine Palms	–	1	2	1.0%	2.1%
NH Oak Harbor	–	1	2	1.0%	2.1%
Reynolds ACH-Ft. Sill	–	1	2	1.0%	2.1%
366th Med Grp-Mountain Home	–	1	2	1.0%	2.1%

ACH = Army Community Hospital
AMC = Army Medical Center
MMC = Military Medical Center
NH = Naval Hospital
NMC = Naval Medical Center
NMMC = National Military Medical Center

The "Level I Count" in Table 3 refers to the number of EMCs for which the MTF volume equals or exceeds the NTDB median for Level I trauma centers. The "Level II Count" is the corresponding number for Level II trauma centers. The last two columns represent the percentage equal to or exceeding the NTDB median, and is merely the count divided by 96 (the number of EMCs). As Table 3 shows, SAMMC performs well in terms of EMC workload volume, whether compared against civilian Level I or II hospitals. It far exceeds the performance of any other MTF, including both DoD Level II trauma centers (Walter Reed and Madigan).

2. Computing EMC Summary Statistics

To calculate EMC benchmarks, we first matched each SAMMC provider's NPI in the SIDR data against the corresponding NPI in the Defense Medical Human Resource System – Internet database, which contains the provider's specialty (HIPAA Taxonomy Code). All non-student providers were included in the calculations, including civilians. We then limited the providers to those with one of the surgical specialties given in Table 2 (page 6), and the procedure codes to the list of EMCs. Next, we aggregated the SIDR data by provider NPI, provider specialty, and ICD-9-CM procedure code and counted the number of times a procedure from the EMC list was performed (i.e., treating the EMCs as a group, much like a core procedures list, rather than as individual procedures). This approach assumes that each provider is performing the EMCs that relate to his or her specialty. Although providers may sometimes be called upon to cross specialty lines in theater, that is a less frequent occurrence in garrison.

Before calculating the EMC summary statistics, we addressed two issues that could possibly bias the statistics downward. First, not all providers are stationed at an MTF for an entire year. About one third of all providers either transferred in or transferred out of an MTF sometime during the year, meaning that we did not observe a full year of workload for them. To adjust for varying provider availability, we first annualized each provider's workload by dividing the procedure counts by the fraction of the year the provider was available (referred to as a full-time equivalent, or FTE) and then weighted the annualized workload by the FTE value (this is equivalent to weighting by the inverse of the variance of the annualized workload estimate). Second, the data include providers who do not routinely treat trauma cases. They may be focused more on non-trauma-related procedures such as knee and hip replacements and only occasionally called upon to treat a trauma case. To overcome this potential bias, we calculated the percentage of each provider's total

inpatient workload that was related to trauma using the NTDB's definition of a trauma case:[15]

- All patients with an ICD-9-CM discharge diagnosis code between 800.00 and 959.9, excluding codes
  - 905–909 (late effects of injury)
  - 910–924 (blisters, contusions, abrasions, and insect bites)
  - 930–939 (foreign bodies)
  - AND who were admitted, died, or transferred in or out of the reporting hospital.

We applied the above criteria to the diagnosis codes in the SIDR data to calculate each provider's trauma workload percentage and then established several trauma workload percentage thresholds (in 10-percent increments), each representing a lower bound on the percentage of a provider's total inpatient workload that is related to trauma. We then computed EMC summary statistics for the subgroups of providers that met successively higher thresholds. For example, we computed EMC summary statistics for the subsets of providers within each specialty whose trauma workload percentage was at least 0 percent (i.e., all providers), 10 percent, 20 percent, etc. For each specialty, we settled on the highest practical threshold that balanced the generally higher workload volume at each threshold against the dwindling number of providers as the thresholds increased. The thresholds differed from specialty to specialty because of the uneven mix of injury types presented in trauma cases.

Table 4 shows SAMMC EMC workload summary statistics by provider specialty at the highest practical trauma workload thresholds. Although we display summary statistics for all provider specialties having performed at least one EMC, we have grayed out those with only one provider (except for Orthopaedic Trauma because of its particular relevance to this analysis), very little EMC workload, or a low provider trauma workload threshold, because they may not produce reliable benchmarks.

[15] American College of Surgeons, "ACS NTDB National Trauma Data Standard: Data Dictionary, 2015 Admissions," March 2015, https://www.facs.org/~/media/files/quality%20programs/trauma/ntdb/ntds/data%20dictionaries/ntds%20data%20dictionary%202015.ashx.

Table 4. SAMMC EMC Workload Summary Statistics by Provider Specialty

Provider Specialty	Provider Subspecialty	Median	75th Percentile	Maximum	Provider Count	Trauma Threshold
Anesthesiology	Anesthesiology	110	112	112	3	70%
Anesthesiology	Critical Care Medicine	16	28	28	2	20%
Anesthesiology	Pain Medicine	3	3	3	1	20%
Anesthesiology	Pediatric Anesthesiology	24	24	24	1	10%
Dentist	Oral and Maxillofacial Surgery	1	3	3	3	30%
Neurological Surgery	Neurological Surgery	28	51	51	4	20%
OB/GYN	Obstetrics & Gynecology	3	15	18	8	0%
OB/GYN	Gynecology	1	2	2	3	0%
OB/GYN	Obstetrics	2	2	2	1	0%
OB/GYN	Reproductive Endocrinology	1	1	1	1	0%
Ophthalmology	Ophthalmology	1	2	3	5	50%
Orthopaedic Surgery	Orthopaedic Surgery	67	100	103	4	70%
Orthopaedic Surgery	Hand Surgery	10	17	17	2	70%
Orthopaedic Surgery	Foot & Ankle Orthopaedics	12	12	12	1	90%
Orthopaedic Surgery	Orthopaedic Trauma	36	36	36	1	60%
Orthopaedic Surgery	Pediatric Orthopaedic Surgery	16	16	16	1	20%
Otolaryngology	Otolaryngology	3	7	7	3	20%
Otolaryngology	Facial Plastic Surgery	5	5	5	1	0%
Otolaryngology	Otology & Neurotology	3	5	5	2	0%
Plastic Surgery	Plastic Surgery	3	5	5	2	0%
General Surgery	General Surgery	104	131	131	7	80%
General Surgery	Pediatric Surgery	21	21	21	1	0%
General Surgery	Surgical Critical Care	58	80	80	3	80%
General Surgery	Surgical Oncology	17	17	17	1	0%
General Surgery	Trauma Surgery	67	67	112	4	60%
General Surgery	Vascular Surgery	12	12	12	1	0%
Urology	Urology	3	4	5	12	0%
Urology	Pediatric Urology	1	1	1	1	0%

The provider specialties for which we were able to find suitable workload benchmarks are anesthesiology, general surgery, neurological surgery, and orthopaedic surgery. For all providers with those specialties (and, in some cases, subspecialties), we computed the EMC workload gap as the sum of the actual EMC workload per provider minus the SAMMC benchmark median from Table 4 (the third column in the table). By dividing the total actual EMC workload for each specialty by the SAMMC benchmark median for that specialty, we were also able to compute the total number of providers that the current level of EMC workload could support. Both the workload gap and supported provider calculations are based on all military providers within a given specialty, not just those who saw a significant percentage of trauma cases. The results are shown in Table 5.

Table 5. MHS-Wide EMC Workload Gaps (Dispositions) by Provider Specialty

Provider Specialty	Provider Subspecialty	Workload Gap	Avg. Gap per FTE Provider	Provider FTEs	Supported Providers
Anesthesiology	Anesthesiology	-13,372	-127.7	104.8	6.4
Anesthesiology	Critical Care Medicine	-82	-11.4	7.2	3.9
Neurological Surgery	Neurological Surgery	-539	-15.9	30.2	14.8
Orthopaedic Surgery	Orthopaedic Surgery	-13,352	-58.8	192.7	26.2
Orthopaedic Surgery	Hand Surgery	-112	-6.2	14.2	6.8
Orthopaedic Surgery	Orthopaedic Trauma	-72	-18.0	3.1	2.0
General Surgery	General Surgery	-33,788	-96.5	278.9	24.0
General Surgery	Surgical Critical Care	-596	-42.6	11.7	3.6
General Surgery	Trauma Surgery	-201	-28.7	6.7	4.0
Total	**Total**	**-62,114**	**-95.6**	**649.5**	**91.7**

Note: Data from domestic DoD hospitals only.

Of the 650 surgical (plus anesthesiology) providers with specialties listed in Table 5, we estimate there is currently enough EMC workload to support 92 of them, or about 14 percent. To put that percentage in perspective, there is currently enough EMC workload at SAMMC to support 40 percent of its surgical providers.[16]

3. Relaxing the EMC Workload Requirement

Although EMCs are based on the procedures used to treat severe trauma cases DoD has actually encountered in theater and are ideally what DoD should want its clinicians to be performing in garrison, we also evaluated MTF workload against a more general standard, i.e., one that is related to trauma generally and not specific to what providers actually do in theater. To develop a general trauma procedures list, we used the ACS's criteria for designating a trauma center as Level I. Specifically, to receive Level I designation, a hospital must admit at least 1,200 trauma patients yearly or have 240 admissions with an Injury Severity Score (ISS)[17] of greater than 15.[18] Although there are

[16] There is unlikely to be enough EMC workload to support 100 percent of a hospital's providers, even at Level I trauma centers, as provider staffing requirements are based at least in part on the demand for all types of care, not just trauma cases.

[17] The ISS is an anatomical injury scoring system for measuring trauma severity that has been in use for over 40 years. Scores range from 1 (minor injury) to 75 (unsurvivable). Scores over 15 are considered to be major trauma.

[18] Michael F. Rotondo, Chris Cribari, and R. Stephen Smith, eds., *Resources for Optimal Care of the Injured Patient 2014* (Chicago: American College of Surgeons, 2014).

now multiple alternatives to the ISS for measuring trauma severity, we prefer to use the ISS because we want to use the ACS definition of major trauma rather than having to define our own.

A drawback to relying on the ISS is that the direct care hospital data do not record that measure, or any other trauma severity measure for that matter (trauma severity measures are typically found in trauma registries, not in hospital data containing mostly non-trauma cases). However, methods exist to convert ICD-9-CM diagnosis codes to ISS scores. Though not as accurate as direct calculation of an ISS from anatomical injury scores, the methods have been found to produce good approximations.[19] In particular, we used a program called ICDPIC (ICD Programs for Injury Categorization) on SAMMC trauma cases to make the conversion.[20] Once we estimated an ISS for each trauma case (using the same NTDB definition of a trauma case as used in Section 2.D.2), we limited the cases to those with an ISS greater than 15. We then identified the major diagnostic and therapeutic procedures[21] that were used to treat those cases. Of the 222 major trauma procedures, 72 (of 96) were also EMCs. The list of major trauma procedures is provided in Appendix A.

Analogous to the EMC statistics in Table 4, Table 6 shows major trauma (ISS > 15) workload summary statistics by provider specialty at the highest practical trauma workload thresholds. As with EMCs, we have grayed out rows with only one provider, very little major trauma workload, or a low provider trauma workload threshold, because they may not produce reliable benchmarks. As expected, major trauma workload volume exceeds that for EMCs and the number of specialties involved in treating major trauma cases is greater than the number performing EMCs.

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[19] See, for example, Ross J. Fleischman et al., "Validating the Use of ICD-9 Code Mapping to Generate Injury Severity Scores," *Journal of Trauma Nursing* 24, No. 1 (January/February 2017): 4–14, 10.1097/JTN.0000000000000255.

[20] ICDPIC software is available as a Stata script and can be downloaded for free. "ICDPIC: Stata module to provide methods for translating International Classification of Diseases (Ninth Revision) diagnosis codes into standard injury categories and/or scores," IDEAS, https://ideas.repec.org/c/boc/bocode/s457028.html.

[21] The Agency for Healthcare Research and Quality website, https://www.hcup-us.ahrq.gov/toolssoftware/procedure/procedure.jsp, has a downloadable file that classifies all ICD-9-CM procedure codes into one of four categories: minor diagnostic, minor therapeutic, major diagnostic, and major therapeutic.

Table 6. SAMMC Major Trauma Workload Summary Statistics by Provider Specialty

Provider Specialty	Provider Subspecialty	Median	75th Percentile	Maximum	Provider Count	Trauma Threshold
Anesthesiology	Anesthesiology	149	159	159	3	70%
Anesthesiology	Critical Care Medicine	35	65	65	2	20%
Anesthesiology	Pain Medicine	9	9	9	1	20%
Anesthesiology	Pediatric Anesthesiology	53	53	53	1	10%
Dentist	Oral and Maxillofacial Surgery	14	15	20	6	30%
Neurological Surgery	Neurological Surgery	174	178	178	4	20%
OB/GYN	Obstetrics and Gynecology	4	11	41	14	0%
OB/GYN	Gynecology	3	7	11	3	0%
OB/GYN	Maternal and Fetal Medicine	2	2	2	2	0%
OB/GYN	Obstetrics	6	6	6	1	0%
OB/GYN	Reproductive Endocrinology	7	7	7	1	0%
Ophthalmology	Ophthalmology	1	5	15	4	70%
Orthopaedic Surgery	Orthopaedic Surgery	97	139	141	4	70%
Orthopaedic Surgery	Hand Surgery	18	29	29	2	70%
Orthopaedic Surgery	Foot and Ankle Orthopaedics	12	12	12	1	90%
Orthopaedic Surgery	Orthopaedic Trauma	70	70	70	1	60%
Orthopaedic Surgery	Pediatric Orthopaedic Surgery	47	47	47	1	20%
Otolaryngology	Otolaryngology	11	23	23	3	20%
Otolaryngology	Facial Plastic Surgery	35	35	35	1	30%
Otolaryngology	Otology and Neurotology	4	7	7	2	0%
Plastic Surgery	Plastic Surgery	4	5	5	2	0%
General Surgery	General Surgery	134	172	178	7	80%
General Surgery	Pediatric Surgery	36	36	36	1	0%
General Surgery	Surgical Critical Care	70	104	104	3	80%
General Surgery	Surgical Oncology	35	35	35	1	0%
General Surgery	Trauma Surgery	89	89	155	4	60%
General Surgery	Vascular Surgery	83	83	83	1	0%
Thoracic Surgery	Thoracic Surgery	1	1	1	1	0%
Urology	Urology	12	19	23	12	0%
Urology	Pediatric Urology	2	2	2	1	0%

For each of the specialties (and, in some cases, subspecialties) above, we computed the major trauma workload gap as the sum of the actual major trauma workload per provider minus the SAMMC benchmark median from Table 6 (the third column in the table). By dividing the total actual major trauma workload for each specialty by the SAMMC benchmark median for that specialty, we were also able to compute the total number of providers that the current level of major trauma workload could support. Both the workload gap and supported provider calculations are based on all military providers

within a given specialty, not just those who saw a significant percentage of trauma cases. The results are shown in Table 7.

Table 7. MHS-Wide Major Trauma Workload Gaps (Dispositions) by Provider Specialty

Provider Specialty	Provider Subspecialty	Workload Gap	Avg. Gap per FTE Provider	Provider FTEs	Supported Providers
Anesthesiology	Anesthesiology	-17,423	-136.1	104.8	11.1
Anesthesiology	Critical Care Medicine	-158	-17.6	7.2	4.5
Dentist	Oral and Maxillofacial Surgery	-486	-7.6	48.2	29.3
Neurological Surgery	Neurological Surgery	-2,955	-86.9	30.2	17.0
Ophthalmology	Ophthalmology	-13	-0.2	50.3	43.0
Orthopaedic Surgery	Orthopaedic Surgery	-17,484	-77.0	192.7	46.8
Orthopaedic Surgery	Hand Surgery	-205	-11.4	14.2	6.6
Orthopaedic Surgery	Orthopaedic Trauma	-138	-34.5	3.1	2.0
Orthopaedic Surgery	Pediatric Orthopaedic Surgery	-163	-27.2	5.5	2.5
Otolaryngology	Otolaryngology	-866	-8.0	87.2	28.6
Otolaryngology	Facial Plastic Surgery	-103	-25.8	2.8	1.0
General Surgery	General Surgery	-42,043	-120.1	278.9	36.7
General Surgery	Surgical Critical Care	-657	-47.0	11.7	4.6
General Surgery	Trauma Surgery	-236	-33.7	6.7	4.3
Total	**Total**	**-82,930**	**-80.6**	**843.3**	**238.0**

Note: Data from domestic DoD hospitals only

Of the 843 surgical (plus anesthesiology) providers with specialties listed in Table 7, we estimate enough major trauma workload currently exists to support 238 of them, or about 28 percent. By comparison, enough major trauma workload currently exists at SAMMC to support 73 percent of its surgical providers.[22]

Although the percentage of providers that can be supported by major trauma workload (28 percent) is higher than that of providers that can be supported by EMC workload (14 percent), it is low enough to call into question the MHS's ability to sustain the readiness-related skills of its military surgeons. In other words, the EMC and major trauma workload gaps are substantial and need to be addressed. In the chapters that follow, we will discuss options for addressing the gaps, including the potential advantages and disadvantages of each, as well as the possible barriers to their implementation.

[22] There is unlikely to be enough major trauma workload to support 100 percent of a hospital's providers, even at Level I trauma centers, as provider staffing requirements are based at least in part on the demand for all types of care, not just trauma cases.

3. Addressing Workload Gaps

The analyses of the previous chapter suggest that the direct care system, in its current state, may not provide the full range of case mix and volume required to sustain the readiness of the medical force. The analysis focused on surgical specialists (plus anesthesiology), often associated with trauma and combat casualty care. However, it should be noted that the workload shortage facing these providers also has an impact on the teams they work with (such as critical care nurses, operating room nurses, nurse anesthetists, and medics).[23] Most other deployed functions associated with outpatient care, such as providing primary care to the force in the field, have ample workload for the sustainment of readiness skills and were therefore not considered in this analysis.

The readiness-related workload shortage facing surgical specialists stems from the MHS's beneficiary population, which generates workload consisting largely of childbirth, pediatrics, and primary care in the Active Duty family member population, and conditions associated with aging in the retiree population. To address the workload gaps currently experienced by critical wartime trauma-related surgical specialties, DoD must find ways to tap into a larger population of trauma patients, including civilians. This chapter begins with a broad overview of civilian trauma systems followed by an outline of three general strategies that could be pursued to increase DoD's access to civilian trauma workload. Understanding civilian trauma systems is key to learning how DoD can increase its role in those systems and the existing opportunities and constraints.

A. Overview of Civilian Trauma Systems

This section provides a brief overview of what it means to be a trauma center participating in a regional trauma system. This includes a discussion of the requirements for different levels of trauma center designation and touches briefly on how trauma regulating systems work.

1. Trauma Center Designation

Trauma center designation is based largely on the resources available in a hospital (e.g., 24-hour coverage by certain surgical specialties, ability to perform certain procedures, and teaching and research resources) and patient volume. Designation is a process developed and controlled at the state or local level. There is also a trauma center

[23] Quantifying the workload gaps for support staff is not possible, as only clinician workload is recorded in the SIDR data.

verification evaluation process run by the ACS at the national level. However, ACS verification does not designate trauma centers—it only indicates the presence of the resources needed for optimal care of trauma patients at various levels. In order to gain designation, a facility must apply to the state, ACS, or both. The process requires rigorous documentation and a substantial commitment of resources (financial and otherwise).

In both the state and ACS verification processes, hospitals are classified as trauma centers of a certain level. The ACS trauma verification levels are I, II, and III, while some states also designate lower level trauma centers (IV and V). While one state's designation criteria may vary slightly from another's or the ACS verification criteria, the Level I, II, and III classifications are very similar and can be generalized as follows:

- **Level I.** This is the highest trauma center designation. Level I trauma centers are capable of providing total care for every aspect of the most severe trauma cases. Level I status requires 24-hour in-house coverage by general surgeons and anesthesiologists, and prompt availability of care in specialties such as orthopaedic surgery, neurosurgery, cardiac surgery, thoracic surgery, vascular surgery, hand surgery, microvascular surgery, plastic surgery, obstetric and gynecologic surgery, ophthalmology, oral and maxillofacial surgery (OMFS), otolaryngology, and urology. Specialists in emergency medicine, radiology, internal medicine, pediatrics, and critical care are also required. There is also a minimum annual volume requirement of severely injured patients (1,200 trauma patients per year or 240 admissions with an ISS greater than 15). Lastly, Level I facilities must play an active leadership role in the trauma system in areas including but not limited to injury prevention, education, and research.[24]
- **Level II.** A Level II facility should be able to initiate definitive care for all patients, but may have to refer patients to Level I centers for certain tertiary care needs such as cardiac surgery, hemodialysis, and microvascular surgery. Level II status requires 24-hour immediate coverage by general surgeons, as well as coverage by the specialties of orthopaedic surgery, neurosurgery, anesthesiology, emergency medicine, radiology, and critical care. Leadership and educational responsibilities are also imposed on Level II facilities, but to a lesser degree than Level I facilities. While the ACS does not impose volume requirements on Level II facilities, some states, such as Maryland, do.
- **Level III.** These facilities must be able to demonstrate an ability to provide prompt assessment, resuscitation, intensive care, and stabilization of severely injured patients. Like Level II facilities, they may have to transfer patients to

[24] Based on "Trauma Center Levels Explained," American Trauma Society, http://www.amtrauma.org/?page=traumalevels; and Rotondo, Cribari, and Smith, *Resources for Optimal Care of the Injured Patient 2014*.

higher-level facilities for tertiary care needs. They should have 24-hour immediate coverage by emergency medicine physicians and the prompt availability of general surgeons and anesthesiologists but are not required to have certain specialists (e.g., neurosurgeons, radiologists) available at all times. Volume requirements are generally not imposed, and leadership and educational responsibilities are less than at higher-designated facilities.

DoD has five trauma centers operating in the United States—one Level I, two Level IIs, and two Level IIIs. SAMMC is DoD's only Level I facility and currently the only facility that treats a significant number of civilian cases. Table 8 lists the DoD trauma centers by their level and location. The source of the trauma status is also indicated (state designation versus ACS verification).

Table 8. DoD Trauma Centers and Designations

Facility Name	City/State	Level	State Designation	ACS Verification
San Antonio MMC	San Antonio, TX	I	Yes	Yes
Walter Reed NMMC	Bethesda, MD	II	No	Yes
Madigan AMC	Tacoma, WA	II	Yes	Yes
William Beaumont AMC	El Paso, TX	III	Yes	Yes
Carl Darnall AMC	Fort Hood, TX	III	Yes	Yes

AMC=Army Medical Center, MMC=Military Medical Center, NMMC=National Military Medical Center.

If DoD works to increase its role in regional civilian trauma regulating systems, pursuing state designation and increasing access to civilian trauma patients will be essential. The following briefly describes how state trauma regulating systems work.

2. Trauma Systems

In the United States, authority and oversight for trauma system development is largely controlled by the states. States enact statutes and regulations controlling trauma centers (including the designation process) and trauma center participation. It should be noted that each state's trauma system is unique and has been developed to meet local needs based on the region's population, economic circumstances, and geographic characteristics.[25] A range of federal stakeholders also engages in civilian care, although no single federal entity

[25] The National Academies of Sciences, Engineering, and Medicine (NAS), *A National Trauma Care System: Integrating Military and Civilian Trauma Systems to Achieve Zero Preventable Deaths after Injury*, eds. Donald Berwick, Autumn Downey, and Elizabeth Cornett (Washington, DC: National Academies Press, 2016), doi: 10.17226/23511.

is accountable for trauma capabilities and coordination across state boundaries.[26] Our analysis will therefore be focused on state and local trauma systems.

Many states have adopted a Regional Advisory Council (RAC) model, in which states are divided into smaller regions with separate administrative bodies that oversee the development of the region's trauma infrastructure and regulating system. RACs are typically tasked with developing and maintaining a regional emergency medical service trauma system plan, usually done by a multidisciplinary group of stakeholders that includes trauma surgeons, emergency physicians, nurses, trauma program managers, prehospital personnel, rehabilitators, hospital administrators, and prevention experts, among others. RACs typically have a designated lead trauma facility (the highest level trauma center in the area) that takes responsibility for trauma system plans. Figure 1 illustrates the RAC model using the state of North Carolina as an example.

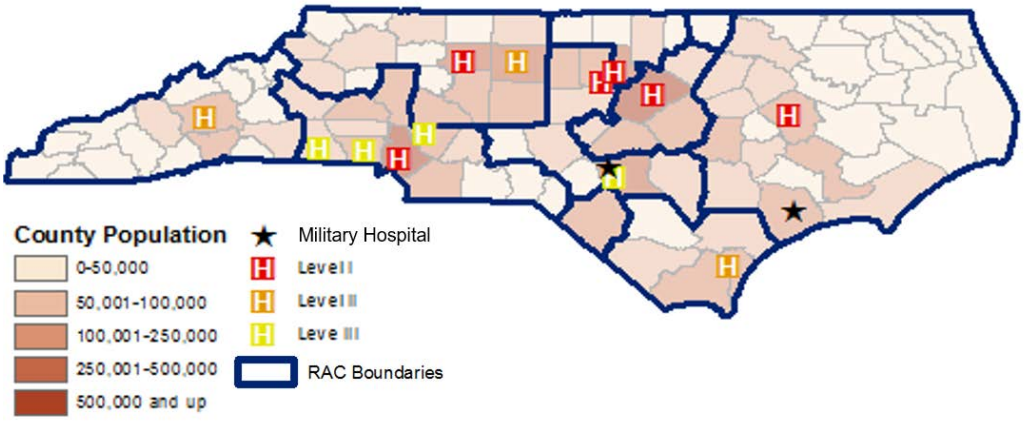

Figure 1. North Carolina Trauma Regulating System

The figure shows all trauma centers participating in the state's trauma regulating system as well as RAC boundaries, which are drawn based on county boundaries. More populous areas, indicated by darker shading, have more trauma centers and smaller geographic RACs, while rural areas tend to have larger RACs with fewer facilities. It should be noted that RAC boundaries are generally formed based on common referral patterns. They are not strict boundaries dictating that a trauma patient must receive all their care within a RAC. Patients may be transferred out of their trauma RAC or even out of the state when it is optimal for their care.

Having discussed the process of trauma center designation and trauma systems, we now turn to establishing a set of criteria that can be used to assess whether a given DoD

[26] Ibid. Federal stakeholders include the Department of Health and Human Services (HHS), the Department of Transportation (DOT), the National Highway and Traffic Safety Administration (NHTSA), the Department of Homeland Security (DHS), and the Department of Veterans Affairs (VA).

facility is a candidate for having its trauma capabilities upgraded and its role in the civilian trauma system expanded. The same criteria can be used to determine the feasibility of creating a joint civilian-military trauma center.

B. DoD's Current Role in the Civilian Trauma System

DoD already has some role in the civilian trauma system. As previously discussed, SAMMC is a Level I state-designated trauma center that treats many civilian trauma cases each year. Several other state-designated trauma centers also exist, but they treat very few civilian cases. Here we focus on the other option through which DoD currently participates in the civilian trauma system—the placing of DoD providers in civilian facilities.

Placing military providers in civilian facilities for the purpose of skill maintenance is not a new concept. Today, there exist many examples of arrangements under which military providers rotate through civilian trauma centers either on short temporary duty (TDY) training assignments, or, in some instances, longer permanent change of station (PCS) assignments. The shorter training rotations are more common—we refer to these as "just-in-time" arrangements, as military personnel or units often rotate through them to prepare them for a coming deployment. The longer assignments are of two main varieties. The first is a teaching assignment (i.e., the military personnel who deploy to the just-in-time training program sites to conduct the training). These individuals typically become fully integrated into the civilian hospital and treat patients when they are not busy running training events. The second type occurs when military personnel, often a specific unit, are embedded or stationed to a civilian hospital where they work as full-fledged staff members. We refer to these situations as "full-time practice" arrangements. In addition, many civilian hospitals take part in longer-term education/training programs for military medical personnel (e.g., residency programs). The following sub-sections describe several of these arrangements in further detail. It should be noted that the selected examples are only a subset of those in existence.

1. Just-in-Time Arrangements

Each Service currently operates some form of just-in-time training for their medical personnel out of high-volume civilian trauma centers. The Air Force currently operates three trauma training sites, while the Army and Navy each have one site. Each site offers two-to-three-week courses for trainees rotating through on TDY assignments (often pre-deployment). Several military personnel are also deployed to each site on two- or three-year PCS orders to serve as teaching staff. These individuals become fully credentialed members of the civilian hospital's staff and work in the trauma centers when they are not training. The following describes the each Service's trauma training program.

a. The Air Force Centers for the Sustainment of Trauma and Readiness Skills (C-STARS)

The Air Force currently runs three trauma training sites out of civilian trauma centers through its Centers for the Sustainment of Trauma and Readiness Skills (C-STARS) program. Each program is integrated with a large university academic partner (The University of Maryland, the University of Cincinnati, and the University of St. Louis) and has a specific focus. C-STARS Baltimore, located at the R. Adams Cowley Shock Trauma Center, conducts training for Air Force medical personnel emphasizing pre-hospital and field hospital care. C-STARS Cincinnati, located at the University of Cincinnati Medical Center, focuses on pre-deployment readiness training for critical care air transport teams (CCATTs). C-STARS St. Louis operates out of Saint Louis University School of Medicine (SSM) Health Saint Louis University Hospital and provides training primarily for Air National Guard and Air Force Reserve medical personnel. At each C-STARS site, a number of Air Force personnel are stationed full time to form a training cadre. The size and composition of the stationed cadres vary by location but they are generally less than 20 personnel and include some combination of surgeons (general, trauma, and orthopaedic), anesthesiologists and certified registered nurse anesthetists, critical care nurses, respiratory therapists, and medical technicians. Members of the training cadre are privileged to treat patients in the civilian hospital when they are not running training events. Trainees who come for two-to-three-week courses spend their time in classrooms sessions, small group trainings, simulations, and cadaver laboratories, and typically conclude with a few days of supervised hands-on patient care.

b. The Army Trauma Training Center (ATTC)

Since 2002, the Army has run a trauma training program out of the Ryder Trauma Center located in Miami's Jackson Memorial Hospital. The Army sends approximately 10 forward surgical teams (FSTs) through the program each year. These teams are a mix of 20 highly trained medical personnel. They are composed of 10 officers (including three general surgeons and one orthopaedic surgeon; two certified registered nurse anesthetists (CRNAs); one operating room nurse, one emergency room nurse, and one intensive care nurse; and an executive/operations officer) and 10 enlisted personnel (a mix of enlisted operating room technicians, licensed practical nurses, and combat medics).[27] The training runs two weeks and is separated into three phases: a classroom and simulation phase (five days), a clinical rotation phase in which members of the FST rotate through the trauma resuscitation unit and operating room and the trauma intensive care unit managing patients under the supervision of faculty, and a capstone exercise in which the trainees take control

[27] Linda A. Valdiri, Virginia E. Andrews-Arce, and Jason M. Seery, "Training forward surgical teams for deployment: the US Army Trauma Training Center," *Critical Care Nurse* 35, No. 2 (2015): e11–e17, doi: 10.4037/ccn2015752.

of the trauma resuscitation unit and operating room for 48 hours with oversight from the hospital staff. The instructors are 10 full-time Active Duty Army personnel whose composition mirrors the FST.

c. The Navy Trauma Training Center (NTTC)

The Navy also began its Navy Trauma Training Center (NTTC) program in 2002. It is located at the Los Angeles County Medical Center and designed particularly for the Navy's forward resuscitating surgical suites (FRSS).[28] These teams are composed of approximately eight to ten individuals (two surgeons, one critical care nurse, one anesthesiologist, and four to six corpsmen). Fleet surgical teams and the Navy personnel who support US Marines on board ships also pass through the training. The course lasts 21 days and includes formal lectures, case discussions, simulator training, time in fresh tissue dissection labs, and clinical shift rotations.[29] Approximately 28–30 individuals pass through the training each month.

2. Full-Time Arrangements

Military providers may also be stationed at civilian facilities on a more permanent basis (rather than on a TDY assignment). For example, the Air Force Special Operations Surgical Team-Special Operations Critical Care Evacuation Team (SOST-SOCCET) is currently stationed at the University of Alabama at Birmingham's (UAB) Level I trauma center, where they work as full-fledged staff members. The team consists of trauma and orthopaedic surgeons, emergency physicians, a nurse anesthetist, a surgical scrub tech, a critical-care nurse, and a respiratory tech. They work together performing surgery in the trauma center and intensive care units. The SOST-SOCCET team has been based out of UAB since 2010, with one classified deployment in 2011.[30]

C. Options for Increasing DoD's Role in the Civilian Trauma System

1. General Strategies

At the highest level, improving DoD's access to trauma patients could be achieved by either bringing civilian trauma patients into military hospitals (the SAMMC model) or sending military providers into civilian trauma centers (like the programs discussed in the

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[28] Chad M. Thorson et al., "Military trauma training at civilian centers: a decade of advancements." *Journal of Trauma and Acute Care Surgery* 73, No. 6, Supp. 5 (December 2012): S483–9. doi: 10.1097/TA.0b013e31827546fb.

[29] "Navy Trauma Training Center (NTTC)," NMOTC – Pensacola, http://www.med.navy.mil/sites/nmotc/nemti/nttc/Pages/default.aspx.

[30] Bob Shepard, "Air Force special ops medical team calls UAB home," UAB News, November 2, 2011, http://www.uab.edu/news/latest/item/1794-air-force-special-ops-medical-team-calls-uab-home.

previous section). Below we outline three general strategies that could be pursued to achieve these ends:

- **Upgrade some DoD hospitals to trauma centers.** In some market areas, DoD could upgrade military medical centers and hospitals into state-designated trauma centers. Trauma center designation would allow those facilities to expand their patient base to include civilian trauma cases. In accordance with section 703 of the FY 2017 NDAA, those facilities should be Level I or Level II trauma centers. This option is best suited for the largest DoD hospitals, operating in markets that are not already saturated with civilian trauma services. Those facilities must work within the existing civilian regional trauma system and be seen as improving that existing system.[31]
- **Form Joint Military-Civilian trauma centers.** In many markets, a stand-alone DoD trauma center may not make sense due to low trauma case volumes or the presence of a robust civilian trauma capability. In such areas, it may be possible to form mutually beneficial military-civilian partnerships that combine DoD and civilian resources to improve the overall trauma system for the local area where DoD already has a base and military hospital. These jointly administered trauma centers could be located at the civilian partner's facility, the military hospital, or be spread across both the military and civilian facilities, depending on market circumstances.
- **Place military providers in civilian trauma centers.** In markets where there is not enough workload to support a DoD trauma center and jointly run military-civilian trauma centers are not feasible, military providers could be placed in high-volume civilian trauma centers. Civilian centers selected for these arrangements may be in the military installation's market area or in markets further away that offer strong opportunities for trauma-related workload (especially those involving penetrating trauma, e.g., in high-crime areas).[32]

The first and third options outlined above are already recognized concepts in military medicine. DoD currently operates several trauma centers, although only one (SAMMC) treats a significant number of civilian trauma cases. Similarly, small-scale implementations of military providers practicing in civilian trauma centers can be found throughout the

[31] John B. Holcomb, "Training for Optimal Combat Casualty Care: Combining the Strengths of the Military and Civilian Systems," unpublished, undated.

[32] For this option, we focus on how Active Component personnel could be placed in civilian trauma centers. An alternative option would be to alter the Active/Reserve Component mix to utilize more Reserve and National Guard providers whose civilian employment entails working in high-volume trauma centers.

MHS (although most of those are short-term training arrangements and the discussion in this report is on permanent stationing at civilian centers).

The second option, forming joint military-civilian trauma centers, constitutes a middle ground between the two and could represent a valuable opportunity to increase medical readiness and help improve the local trauma system. This approach is consistent with section 706 of the NDAA, which called for the "establishment of high performance military-civilian integrated health delivery systems." It would also constitute a step in the direction of creating one National Trauma Care System, as called for by the National Academies of Sciences, Engineering, and Medicine (NAS) in their recent report on integrating the military and civilian trauma systems.[33] That study presented a vision for one united national trauma care system with the objective of achieving "zero preventable deaths from injury" for both our uniformed Service members and civilian population. While the options examined here fall short of full integration, they could serve as a stepping stone in that direction.

It is likely that the optimal MHS strategy for ensuring readiness would employ a mixture of the three approaches and that the approach selected for a given market will depend on that market's existing DoD and civilian infrastructure, as well as the case mix and volume present in the area. Given the market-based nature of the problem, a market-based analysis is required to identify which MTFs are best suited to each of the three options.

2. Criteria for Selecting the Best Trauma Workload Enhancement Options for each MTF Market

While it is clear that Level I and Level II trauma centers perform a much greater volume of EMC-based workload (or trauma workload in general), determining which DoD facilities have the potential to become trauma centers is more challenging. Whether or not any given DoD hospital has the potential to become a trauma center is based on several factors. These include:

- Facility size and volume (smaller facilities would require a much larger investment by DoD to become trauma centers),
- Local demand for trauma care (a large enough population to keep the trauma center busy), and
- Local supply of trauma care (number of civilian trauma centers already serving the area).

These criteria, which are developed below, can be used to identify which MTFs are potential candidates to be upgraded into stand-alone DoD trauma centers and which are

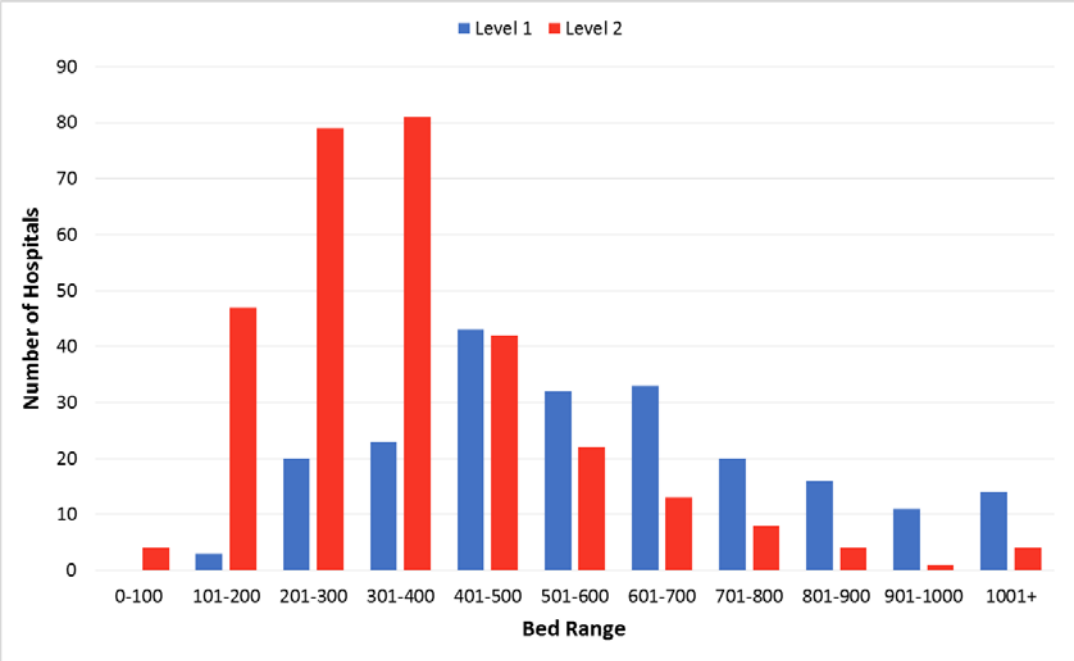
[33] NAS, *A National Trauma Care System*.

potential candidates to become joint military-civilian trauma centers. MTFs that do not meet the criteria described below are all considered candidates for the third option—placing their military providers in civilian trauma centers.

a. Facility Size and Volume

We use facility size as the first filter to help identify the best set of DoD hospitals that could have their trauma capacity expanded. As previously discussed, trauma centers are required to have many surgical specialties available around the clock. This becomes more feasible as the size of the hospital increases. That fact is apparent in civilian trauma centers that are generally located in large hospitals.

Figure 2 shows the distribution of the number of beds (a common proxy for hospital size) at Level I and Level II facilities.[34] No Level I facilities and only four Level II facilities (less than 2 percent) have fewer than 100 beds. The median Level I facility has 540 beds while the median Level II has 325. Level III facilities, not shown, have a median bed count of 233 beds.



Source: American Trauma Society TIEP database.

Figure 2. Number of Beds at Level I and Level II Trauma Centers

[34] There is no standardized way of counting hospital beds. The bed count could be a simple enumeration of the total number of physical beds in a hospital at a given point in time. Some hospitals might include spaces with capacity for beds while others might count only beds they consider to be funded or fully staffed. The bed counts cited in this paper represent whatever the hospitals chose to report and may not be consistently measured.

Given the above, we focus our analysis on DoD hospitals with at least 100 beds. Applying this first filter leaves us with 12 facilities. These facilities are listed in Table 9 with their bed counts (in descending order) and average daily patient load (ADPL). The ADPL is simply the total number of bed-days in a year divided by 365 (or 366 for a leap year).

Table 9. DoD Hospitals with 100 or More Beds, FY 2016

Rank	Name	Bed Count	ADPL
1	San Antonio MMC (LI)	425	254
2	NMC San Diego	285	162
3	NMC Portsmouth	274	148
4	Walter Reed NMMC (LII)	247	168
5	Madigan AMC (LII)	227	130
6	William Beaumont AMC (LIII)	209	71
7	Tripler AMC	194	134
8	Womack AMC	156	79
9	NH Camp Lejeune	117	47
10	David Grant USAF Medical Center	116	63
11	Carl R. Darnall AMC (LIII)	109	62
12	Dwight D. Eisenhower AMC	107	63

Source: AHA 9/19/2016 and information obtained directly from the facilities.

Of the 12 facilities shown above, five are already DoD trauma centers (although only one is a Level I center). For the remaining non-Level I facilities, we will explore whether additional investments would allow the facility to begin playing a more significant role in its local civilian trauma system. This might entail becoming a state-designated trauma center or, in some instances, increasing a state trauma designation level (e.g., upgrading a Level III center to a Level II). It could also entail becoming a trauma center in partnership with a civilian facility.

b. Demand for Trauma Care

In addition to infrastructure and personnel, trauma centers require a steady stream of trauma cases. Case volume is necessary to sustain both the clinical currency of the trauma providers and the financial viability of the center. For those reasons, Level I centers face volume requirements for ACS verification. As noted in Chapter 2, the current Level I standard is a minimum of 1,200 trauma cases or 240 severe trauma cases (ISS > 15) annually. Given the importance of volume, this must be the top consideration for any analyses pertaining to the feasibility of introducing a DoD trauma center (or upgrading one's designation level).

To assess demand for trauma in each market area, we consider the RAC's total population and the number of injuries in the area that result in hospitalization or fatalities. Data on injuries are presented for several categories, including firearm, knife/pierce, burns, motor vehicle traffic (MVT), and other.[35] It should be noted that the injuries included in the database do not all constitute trauma, but are severe enough to require hospitalization (or cause fatalities) and thus represent a good proxy for trauma volume. For each injury category, we present data on volume, rate of occurrence (cases per 100,000 residents), and share of total injuries (e.g., firearm injuries account for 5.8 percent of total injuries in Norfolk, Virginia but only 1.7 percent in El Paso, Texas). Those measures serve as proxies for the overall volume and mix of trauma cases available in a market area and will help us to identify markets with a higher (or lower) than average demand for trauma care (overall and by type), including certain types of care that are of particular relevance to DoD.

While working in any busy trauma environment is generally preferable to non-trauma environments, trauma environments with a higher rate of "penetrating" trauma as opposed to "blunt" or non-penetrating trauma are preferable for training purposes, as they provide a closer approximation to battlefield injuries. Penetrating trauma occurs when an object pierces the skin and enters the body, resulting in an open wound (e.g., gunshot or stabbing wound). Blunt trauma, on the other hand, refers to physical trauma to a body part through impact (e.g., automobile accident or physical attack). This type of trauma is far more common in the civilian trauma system. To assess the rate of penetrating trauma in an area, we examine the rate of injuries from firearm and knife/pierce injuries relative to other injury types to determine if a market has a higher than average rate of penetrating trauma.[36]

c. Supply of Trauma Care

Knowing the trauma volume that exists in a market is not sufficient information on its own for making determinations on whether a DoD facility may become a trauma center. Equally important is an understanding of the market area's current supply of trauma care. While experts agree some areas (especially rural areas) are underserved in terms of trauma services, many others could suffer with the introduction of a new trauma facility. When too many trauma centers exist in one market, they compete for cases and specialists, which can ultimately lower the quality of care while raising costs. While there is no clear standard for how many trauma centers should be operating in a given area, the ACS generally

[35] The injury data are derived from ICD-9 external-cause-of-injury codes (E-codes) and collected from various state EMS organizations. Some data were publicly available on websites while other data required a formal data request submission. More details are provide in table notes.

[36] Firearm and knife/pierce injuries will not capture all penetrating trauma injuries, but they provide a strong proxy. Penetrating trauma injuries may also be present in the MVT or "other" injury categories, but cannot be distinguished from the more commonly occurring blunt trauma-type injuries.

recommends up to two high-level (Level I or II) centers for every 1,000,000 residents.[37] This can vary in areas with very high trauma rates (which may require more trauma centers) or in rural areas where one trauma center may serve a very large geographic area. Another consideration is the size of the population that must travel long distances to reach a trauma center. For instance, the term "golden hour" is often used in trauma parlance to mean the first hour after injury, when reaching definitive care as quickly as possible will increase a critically injured patient's chance of survival.[38] More recently the term "platinum 10 minutes" has also emerged and refers to the notion that no critically injured patient should receive more than 10 minutes of on-scene stabilization by the pre-hospital team prior to transport to a definitive care center, again indicating the importance of reaching definitive care as soon as possible.[39]

In Chapter 6 (Section 6.C), we provide an analysis of the 12 DoD facilities identified and listed in Table 9 (page 31). For each DoD facility considered, we document all civilian facilities providing trauma care in the area and, when possible, data on the volume of trauma cases they see. We then use the ACS population guideline to test whether the demand for trauma is consistent with the current supply of trauma care or if additional trauma capability could enter the market. In areas without a high-level trauma center, we document the travel time to reach the nearest one.

In addition to examining each market's data, we also conducted phone interviews (and, in some cases, site visits) with state EMS directors, regional trauma coordinators, civilian trauma centers, representatives from the TCAA, the ACS, and leadership teams from several military hospitals. The discussions with subject matter experts were crucial for informing our understanding and analysis of local trauma systems.

Before providing these market overviews, we first discuss the principles, benefits, and challenges associated with each option.

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[37] Ellen J. MacKenzie et al., "National Inventory of Hospital Trauma Centers," *Journal of the American Medical Association* 289, No. 12 (2003): 1515–22, doi: 10.1001/jama.289.12.1515; Phil Galewitz, "Critics say too many trauma facilities can hurt care," *USA Today*, September 26, 2012, https://www.boundtreeuniversity.com/Trauma/news/1348711-Critics-say-too-many-trauma-facilities-can-hurt-care; and Phil Galewitz, "Trauma centers springing up as profits rise," *USA Today*, September 24, 2012, https://www.usatoday.com/story/money/business/2012/09/25/trauma-centers-profits-rise/1591209/.

[38] The term "golden hour" is widely attributed to R. Adams Cowley, the founder of the Baltimore Shock Trauma Institute.

[39] Chris Nickson, "Trauma Mortality and the Golden Hour," Life in the Fastlane, http://lifeinthefastlane.com/ccc/trauma-mortality-and-the-golden-hour/.

4. Principles, Benefits, and Challenges of Each Workload Enhancement Option

Chapter 3 introduced three options for increasing DoD's role in civilian trauma systems: (1) stand-alone DoD trauma centers, (2) joint military-civilian trauma centers, and (3) placing military personnel in civilian trauma centers. We then provided a brief overview of civilian trauma centers and systems and identified three criteria for assessing which MTFs were best suited for trauma center investment: (1) facility size, (2) market trauma demand, and (3) market trauma supply. Using the facility size criterion, we identified 12 MTFs that were strong potential candidates for trauma capability investment, either as stand-alone or joint military-civilian trauma centers (Option 1 or 2). The remaining MTFs are potential candidates for Option 3. Option 3 is similar to Option 2 in that it entails partnerships with civilian trauma centers, but on a smaller scale.

There are three general principles that should guide each arrangement. These include:

- Improve the access of military providers to civilian trauma patients;
- Expand and strengthen the local civilian trauma system; and
- Build a lasting relationship between the military and private sectors, i.e., arrangements should be designed to last through military and civilian leadership changes as well as the stresses brought on by deployments.

This chapter focuses on the principles, benefits, and challenges associated with each option.

A. Stand-Alone DoD Trauma Centers

1. Principles

- **Improve the access of military providers to civilian trauma patients.** DoD should consider upgrading trauma centers only in markets where there is a clear capability to expand the facility's civilian trauma caseload. This should be determined by analyzing the surrounding civilian population, data on the area's current trauma workload, and most importantly, the supply of trauma care already available in the area. The candidate facilities must work closely with the local civilian trauma centers and state EMS directors to determine how much civilian workload could potentially be regulated to the DoD facility.

- **Expand and strengthen the local civilian trauma system**. DoD should only invest in DoD trauma centers in markets where doing so will improve the overall trauma system by helping to improve trauma access. They should not invest in facilities located in crowded markets where they will have to compete with neighboring civilian facilities for volume.
- **Build a lasting relationship between the military and private sectors**. When DoD chooses to invest in a DoD trauma center and expands its role in the local trauma regulating system, it must commit to providing some given level of trauma care at all times. If the level needs to be lower when large deployment needs arise, detailed plans on alternative patient regulation should be worked out in advance with the local trauma system stakeholders. Plans to return the facility to its peacetime capability once deployment needs end should also exist.

2. Benefits

Some nations, such as the United Kingdom and Canada, have chosen to completely embed their military medical force in civilian institutions rather than operate military hospitals. While DoD could feasibly place all of their providers in busy Level I and II trauma centers, many would argue that large stand-alone DoD trauma centers may provide important strategic benefits. We outline several of these benefits below.

- **Deployment Speed and Flexibility.** DoD facilities may be better able to respond to an immediate deployment need than civilian-run facilities. By focusing on the military mission, these facilities can have surgical teams who have been working together in a trauma environment ready to deploy on very short notice. Civilian facilities more focused on their everyday trauma care mission may require more notice before DoD can begin pulling their staff. Managing deployment risk will be a crucial aspect of military/civilian partnerships.
- **Research and Training.** DoD trauma centers can serve as centers of excellence for research in important military medical fields such as optimal trauma care in theater and other conditions of specific interest to the military (e.g., traumatic brain injury, post-traumatic stress disorder and other behavioral health issues, chemical, biological, radiological and nuclear defense, prosthetics, and other cutting-edge rehabilitation technologies for those injured on the battlefield). Simulation labs can also be used to help train for injuries that we might expect to see in future wars such as an air/sea battle with a near-peer adversary. Injuries of this nature will likely not exist in even the busiest Level I trauma facilities, which means the military must find other means of training for these events. Today, many of the larger DoD medical centers have special research and

training centers. These will be discussed in more detail in the market overviews in Chapter 5.

- **Military Culture.** One potential concern with arrangements in which DoD personnel are stationed in civilian settings is the absence of a military culture. At least one Service has expressed a potential concern that such arrangements may reduce the medical personnel's connection to the military.[40] Some evidence has suggested that Air Force physicians that do their residencies in civilian hospitals may be less likely to stay in the military.[41] Maintaining large DoD trauma centers will ensure military personnel will have the opportunity to spend time fully immersed in a military setting.

While DoD trauma centers offer many benefits, they are only possible in a handful of markets. In some markets where DoD has fairly robust medical capabilities (large facilities staffed with multiple surgical specialists), gaining Level I or II status may not be feasible (or beneficial) due to low trauma volume or the presence of a robust competing civilian infrastructure. We now turn to the challenges associated with such stand-alone DoD trauma centers.

3. Challenges

There are multiple challenges associated with increasing an MTF's civilian trauma workload or forming trauma partnerships with civilian facilities. We discuss some of the most salient below.

- **Patient Regulation.** As previously discussed, trauma authority rests with the state and is often delegated to different stakeholders using an RAC system. One of the first challenges DoD must overcome is convincing the local trauma system to regulate more civilian trauma cases to their facilities. Seeking ACS trauma verification—and more importantly, state trauma designation—is a key first step. In addition, DoD trauma centers will have to become more engaged with the local trauma system including lead trauma facilities, EMS organizations, and other stakeholders in the local trauma system.
- **Billing.** Providing trauma care can be very expensive—especially for patients that are uninsured. In addition, many DoD facilities may lack the ability (infrastructure or authority) to bill civilian patients for the care they provide.

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[40] John C. Graser, Daniel Blum, and Kevin Brancato, *The Economics of Air Force Medical Service Readiness* (Santa Monica, CA: The RAND Corporation, 2010), http://www.rand.org/content/dam/rand/pubs/technical_reports/2010/RAND_TR859.pdf.

[41] Edward G. Keating et al., *Air Force Physician and Dentist Multiyear Special Pay: Current Status and Potential Reforms*, MG-866-AF (Arlington, VA: RAND Project Air Force, 2009), https://www.rand.org/pubs/monographs/MG866.html.

When only a small number of civilian trauma patients are treated each year, DoD may be willing to absorb the costs associated with providing this care because of the readiness value it provides. However, if its civilian trauma workload is to expand, DoD will need a greater ability to bill civilian insurance for services provided. There are also issues specific to the billing of Medicare and Medicaid beneficiaries. Specifically, Section 1814 (c) of the Social Security Act (P.L. 74-271) bars government agencies from billing patients insured through Medicare or Medicaid. Arrangements may have to be put in place to allow the military to be compensated for the care provided to these populations.

- **Deployment Risk.** If a DoD hospital becomes an important participant in its local civilian trauma system, it must have arrangements in place to mitigate disruption to the trauma system when wars break out and deployment needs arise. The need for a rotational base at home means some DoD providers will always be working in MTFs, but the number of personnel and capabilities at certain facilities can decrease as the demand for medical personnel in theater increases. Carefully designed deployment arrangements should be created between DoD and its civilian trauma partners that outline how many providers DoD can deploy (and on what timeline) and the minimum capability level that must always be available at the DoD trauma center. If patient regulation will change, these plans should be designed in advance as well.
- **Security.** Hospitals located on military installations can present security issues when we consider opening them up to civilian populations (i.e., trauma patients and their visitors). At SAMMC, the hospital is separated from the main installation and has its own security fence, police force, and gated entrance. The entrance is conveniently located right off Interstate I-35. All visitors over the age of 18 must present a valid photo ID to get through the gates and then pass through a visitor building where they receive a visitor pass. DoD facilities wishing to admit a higher volume of patients will likely need to consider altering their current security arrangements.

B. Military-Civilian Trauma Centers

1. Principles

- **Improve the access of military providers to civilian trauma patients.** DoD should create joint military-civilian partnerships in markets where doing so will guarantee access to a high volume of civilian trauma cases. Selecting partners who are willing to take entire teams of military providers rather than only certain specialists would be more desirable. Partners that offer opportunities to combine graduate medical education (GME) programs are also desirable. Busy

lower-level trauma centers and hospitals that have shortages in certain types of medical personnel (i.e., orthopaedic surgeons, vascular surgeons, etc.) and capabilities (but with ambitions to grow their trauma capabilities) can make ideal partners. Large academic medical centers (Level I trauma centers) are also good partners but there may be more competition with residents for trauma workload at such locations. Discussions with potential partner facilities can be used to analyze how much trauma workload military providers will be able to access.

- **Expand and strengthen the local civilian trauma system.** The military should select partner civilian facilities who can use the infusion of military personnel and resources to raise their capability level and better serve their local market. Well-resourced trauma centers with many residents and fellows competing for trauma workload may find military partnership less beneficial and be less capable of providing the desired case volume.
- **Build a lasting relationship between the military and private sectors.** Local partnerships often come and go as leadership changes and priorities shift. Military-civilian trauma partnerships should be built to sustain such changes. Similarly, there must be plans in place to ensure deployments will not damage the partnerships and that they can return to normal once deployment needs subside.

2. Benefits

Three separate parties can benefit from well-designed military/civilian trauma programs. These include the military, their civilian partners, and the local patient population (both civilian and military beneficiaries), who will experience improved access to trauma care. Below we outline the benefits to each group:

- **Benefits to the Military:**
  - **Clinical skill maintenance.** The primary benefit of military/civilian partnerships from the military's perspective would be the improved access to trauma workload. Through partnerships, military providers could access some share of the local civilian trauma caseload that they would otherwise not have access to if they remained in the MTF treating only military beneficiaries.
  - **Access to case mix in markets with robust civilian infrastructure.** Forming partnerships could also help prevent the military from finding themselves in direct competition with local civilian hospitals for trauma workload. If the military tries to expand its role in the local trauma system without forming partnerships, it may meet resistance. While civilian

facilities may sometimes get overwhelmed and like to have the military hospitals as a backup, they likely will want to keep the majority of cases in their own facilities to ensure they meet volume requirements and have enough cases for training residents. By offering to partner with these facilities as opposed to competing with them, mutually beneficial arrangements could be reached that would still improve the military's access to trauma cases.

  - **Lower costs.** In addition, partnerships offer DoD the ability to become major participants in trauma systems at much lower cost. DoD could become a partner or co-lead in a facility without having to bear all of the infrastructure and personnel costs. DoD could participate in surgical and trauma GME programs and other activities without having to bear the cost of a full program, and maintain programs in specialties without a readiness requirement.

- **Benefits to Civilian Partners:**
  - **Financial.** A primary benefit to civilian partner facilities would be financial. Military personnel could be provided to civilian partners for free or at reduced labor rates to offset deployment risk. The infusion of military personnel would allow the civilian partner facility to treat a higher volume of trauma patients and perhaps to retain trauma patients with more severe injuries than was possible prior to the partnership. By treating more patients, the hospital would earn more revenue. These types of arrangements would be of particular value in rural communities where hospitals have trouble attracting enough surgical specialists, and communities where providing trauma care is costly due to a high share of uninsured patients. Costs for new equipment or infrastructure could also be shared with the military, increasing the joint facilities' capabilities beyond what would have been possible in the absence of a partnership.
  - **Staffing key specialist vacancies.** In some markets, civilian trauma centers have trouble attracting and retaining certain high-end specialists (e.g., neurosurgeons, oral and maxillofacial surgeons, and cardiothoracic surgeons). Having military partners with access to such specialists could be very beneficial.

- **Benefit to Local Trauma Patients:**
  - **Improved access to care.** Evidence suggests that serving traumatic injury depends on reaching the appropriate level of care as soon as possible.[42] Despite this fact, there remains a significant variation in access to trauma care across the country. For instance, studies have shown over 30 percent of Americans do not live within one hour of a Level I trauma center. These disparities are particularly sharp across the urban/rural divide. Many military bases are located in rural areas. These facilities may be able to access more trauma workload while improving the overall civilian trauma system by receiving civilian trauma patients or sending military providers to local civilian hospitals to augment their trauma capability. A higher local trauma capability would mean fewer trauma patients would have to be transferred long distances.
- **Additional Shared Benefits:**
  - **Sharing of knowledge.** Military providers experience some of the most extreme and austere trauma environments on earth. Surgeons returning from the battlefield bring home the lessons they have learned and advances in military medicine.[43] These advances can be better disseminated when military and civilian providers work side by side. Similarly, military providers can learn about the most recent advances and best practices in civilian trauma care.
  - **Recruitment/retention.** When the workload in DoD inpatient platforms does not provide enough volume and complexity to maintain the competency and professional progression required in certain surgical specialties, it becomes challenging to recruit and retain these specialists. Potential or current medical personnel may value the opportunity to work in civilian settings with civilian partners during their military service.[44] This may be especially true if military personnel believe experience in the

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[42] NAS, *A National Trauma Care System*; and A. Brent Eastman, Ellen J. MacKenzie, and Avery B. Nathens, "Sustaining a coordinated, regional approach to trauma and emergency care is critical to patient health care needs," *Health Affairs* 32, No. 12 (December 2013): 2091–8, doi: 10.1377/hlthaff.2013.0716.

[43] NAS, *A National Trauma Care System*.

[44] Christine Eibner, *Maintaining Military Medical Skills During Peacetime: Outlining and Assessing a New Approach* (Santa Monica, CA: The RAND Corporation, 2008), http://www.rand.org/content/dam/rand/pubs/monographs/2007/RAND_MG638.pdf; and Graser, Blum, and Brancato, *The Economics of Air Force Medical Service Readiness*.

civilian sector could improve their ability to transition into civilian employment after leaving the military.

- **Access to state and local funding.** Civilian hospitals may be entitled to local tax dollars and state funds to help fund their trauma programs—especially if they provide a disproportionate amount of care to the uninsured. Currently military hospitals are not eligible for federal funds for trauma, due to their federal status. In addition, federal legislation has been introduced to offer funding for civilian trauma centers who will participate in civilian/military partnerships[45] for the care provided to these populations.

3. Challenges

- **Reimbursement and Billing.** When DoD providers work in joint military-civilian facilities treating civilian patients, the question of reimbursement arises. First, will these military providers be fully paid for by DoD or should the civilian facility reimburse DoD for some of the services provided by military personnel (for which the civilian facility presumably billed the civilian patient's insurance)? Evidence collected from interviews suggests that civilian facilities would generally be willing to partially reimburse the military for personnel costs. However, most indicated they would require a discount to compensate for employment risk and other concerns.[46] Second, there are specific issues relating to patients covered by public insurance (i.e., Medicare/Medicaid) who make up an important share of trauma centers' patient population. Section 1814(c) of the Social Security Act (P.L. 74-271) bars government agencies from billing patients insured through Medicare or Medicaid. Civilian facilities tend to interpret this statute as restricting their ability to bill Medicare or Medicaid patients when the attending physician is a DoD staff member. The handling of this issue is usually addressed in Memoranda of Understanding (MOUs) with partner facilities.

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[45] Representatives Michael C. Burgess, M.D. (R-TX), Gene Green (D-TX), Richard Hudson (R-NC) and Kathy Castor (D-FL) reintroduced the MISSION Zero Act (H.R. 880), to assist DoD in assigning trauma surgeons to civilian trauma centers. See "Burgess Reintroduces Bill to Improve Trauma Care Through Military-Civilian Partnership," Trauma Center Association of America, accessible at http://www.traumacenters.org/news/330309/-Burgess-Reintroduces-Bill-to-Improve-Trauma-Care-Through-Military-Civilian-Partnership.htm for more information.

[46] See Eibner, *Maintaining Military Medical Skills During Peacetime*, for a summary of interviews with civilian institutions on the feasibility of employing DoD personnel. In addition, interviews conducted by the IDA team also generally found civilian facilities were willing to partially reimburse the military for personnel.

- **Licensing.** In the United States, medical licenses are usually granted by individual states. Each time a provider moves to a new state, they must obtain a license to practice there. The licensure process typically takes between 3 and 12 months and can cost over $1,000 dollars.[47] The time and monetary costs are due to the required extensive background checks and verification of education, training, and work history. Military physicians, who move frequently, are able to avoid this requirement because physicians practicing in federal facilities (including military hospitals, Department of Veterans Affairs (VA) facilities, federal prisons, and Indian Health Service facilities) are only required to hold a valid state license—from any state, not necessarily the one in which they are currently practicing. If military providers were to be deployed to civilian hospitals, several options exist by which the licensing issue could be addressed. First, federal law says that physician training is exempt from state licensure requirements. While this state licensure exemption for military providers exists, hospitals may still wish to have the military personnel licensed in state.[48] If this training exemption cannot apply to the personnel stationed at a civilian facility on a longer-term basis, several other options include:
  - **Have the providers obtain the required state license.** This option imposes a time and monetary cost, but may be appropriate for longer-term assignments. Currently, the Navy personnel stationed at Los Angeles County Medical Center (i.e., the training staff, not the trainees) must obtain a California license in order to treat patients. The Services could consider extending the PCS cycle for military providers deployed at civilian facilities to help offset that burden.
  - **Rely on professional license and practice reciprocity.** State legislation can be passed that provides professional license and practice reciprocity to military healthcare providers formally assigned to civilian hospitals. This type of arrangement is used to cover the training cadre deployed to the SSM Health Saint Louis University Hospital C-STARS site.
  - **Use Training Affiliation Agreements (TAAs) or Memoranda of Understanding/Memoranda of Agreement (MOUs/MOAs).** These have been used in the past to allow military providers to practice in civilian hospitals as trainees or embedded staff.

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47 Brittany La Couture, "The Traveling Doctor: Medical Licensure Across State Lines," American Action Forum, June 10, 2015, https://www.americanactionforum.org/insight/the-traveling-doctor-medical-licensure-across-state-lines/.

48 Training exemption is in accordance with 10 USC 1094 (d), as amended by Public Law 105-85, § 737.

- **Request a congressional waiver.** The Congress could attempt to extend the state licensing exemption that currently applies to physicians practicing in federal facilities to cover military physicians treating patients in civilian facilities. This approach, however, may be unlikely to succeed given that previous attempts to establish national medical licensing requirements have been deemed unconstitutional.[49]
- **Focus on partnerships with other federal facilities.** Military providers could be placed in other federal facilities where the state licensure requirement is waived. VA hospitals would be the most likely candidate among the different types of federal facilities, although federal prisons and Indian hospitals could also be considered. The main determinant of the benefit of such arrangements would be the caseload available at each location. While VA hospitals would not offer the trauma workload available at civilian trauma centers, they may offer a larger surgical workload with more complex procedures than the workload being performed in MTFs. Partnering with other federal facilities could perhaps serve as an intermediate step along the way to building stronger civilian/military partnerships.

- **Credentialing/Privileging.** Similar to licensing, each facility has a set of criteria that govern requirements for physicians to become privileged to treat patients in their facility. DoD providers will either have to meet each facility's standards or be covered through a TAA or MOU/MOA-type arrangement.
- **Malpractice.** In the civilian sector, the responsibility for obtaining liability coverage rests with the individual provider or the facility in which they practice. Military physicians, on the other hand, receive their coverage from the federal government. Specifically, the Federal Tort Claims Act (FTCA) makes the United States liable for "injuries caused by the negligent or wrongful act or omission of any federal employee acting within the scope of his employment, in accordance with the law of the state where the act or omission occurred."[50]

  To date, the decision as to whether this provision would provide adequate malpractice insurance to military providers practicing in civilian facilities has been made on a case-by-case basis. The Eibner study previously referenced

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49 Eibner, *Maintaining Military Medical Skills During Peacetime*.

50 Congressional Research Service, *CRS Report for Congress: Federal Tort Claims Act*, CRS Report 95-717 (Washington, DC: Congressional Research Service, updated January 2010), https://www.everycrsreport.com/files/20100129_95-717_a8875221186ef2e0d96c1f4eb175e17faeb09b09.pdf . One major exception to the FTCA is the Feres doctrine, which prohibits suit by military personnel for injuries sustained while on active duty.

reported that one of the two trauma centers they interviewed on this matter accepted the federal tort protection as sufficient malpractice coverage for DoD physicians working in their facilities, while the second did not. The second facility believed it could be exposed to liability under the "borrowed-servant doctrine" and thus required DoD to purchase additional insurance through the affiliated university's malpractice insurance policy. For permanent trauma staff, this cost was approximately $90,000 per physician per year.[51]

- **Personnel matters.** Potential civilian partners have raised questions about their ability to manage the military providers placed in their facilities. Common questions related to their ability to discipline or terminate military providers whose performance was deemed to be inadequate, as well as their ability to reallocate military providers to various locations if needed. There were also questions regarding legal issues such as worker's compensation or sexual harassment. These issues would also be relevant for joint military-civilian trauma centers. Additional personnel matters might arise if certain specialties in the civilian partner facility are unionized.
- **Deployment risk.** DoD personnel will form a crucial part of the trauma team in joint military-civilian trauma centers and will contribute to the facility's ability to handle a higher volume and perhaps a higher acuity level of trauma patients. However, due to the potential for rapid deployments of military trauma teams, careful plans must be worked out between the military, their civilian partner facility, and the local civilian trauma system to ensure that the civilian trauma system is not left short-handed under such circumstances.

C. Military Personnel in Civilian Facilities

1. Principles

- **Improve the access of military providers to civilian trauma patients.** DoD should consider sending their military providers to civilian trauma hospitals in markets where the local MTF does not have enough workload to either become a stand-alone DoD trauma center or form a joint military-civilian trauma center. Civilian facilities should be selected based on their trauma volume and composition (i.e., look for high penetrating trauma rates) and the ability of DoD providers to access workload (i.e., does the facility have a need for certain specialists, will DoD providers have to compete with residents, etc.).

[51] Eibner, *Maintaining Military Medical Skills During Peacetime*.

- **Expand and strengthen the local civilian trauma system**. DoD should look for partners that have provider shortages they need to fill or that are struggling to meet their local demand due to personnel or other resource shortages.
- **Build a lasting relationship between the military and private sectors**. When DoD places providers in a civilian facility, the arrangements should be designed to last through leadership changes at the MTF or civilian facility.

2. Benefits

Military personnel and civilian hospitals may also benefit from arrangements by which military personnel are placed in civilian facilities. We outline these benefits below:

- **Benefits to the Military:**
  - **Clinical skill maintenance.** Busy civilian trauma centers offer higher volumes of trauma cases and other high acuity surgical cases compared to the workload currently available in all but one or two MTFs. For instance, one study found that a one-month training experience at a civilian trauma center provided military general surgeons with more trauma experience than they receive in one year at their MTF stationing.[52] Stationing teams of DoD providers in these busy trauma environments would help them sustain their clinical skills and grow comfortable working to together in a trauma environment.
  - **Flexibility.** Stationing Active Duty personnel at civilian trauma centers could increase DoD's flexibility to employ a more desirable mix of medical specialties for the readiness mission. Currently DoD is somewhat constrained to employ specialties required to sustain the MTFs and deliver the beneficiary care mission.[53] While Reservists working in civilian facilities can also create this flexibility, Active Duty personnel may offer some strategic advantages, such as quicker deployment times (i.e., they can be ready to deploy more quickly than Reservists).
  - **Recruitment and retention.** Like the joint military-civilian-run trauma centers, stationing Active Duty personnel in civilian-run trauma centers may present opportunities for recruitment and retention. This will be true if military personnel value the opportunity to work in busier trauma environments or gain experience in the civilian sector. The opportunity to

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[52] Martin A. Schreiber et al., "Military trauma training performed in a civilian trauma center," *Journal of Surgical Research* 104, No. 1 (2002): 8–14, doi: 10.1006/jsre.2002.6391.

[53] Eibner, *Maintaining Military Medical Skills During Peacetime*.

work in the civilian sector may help ease military providers' concerns about their ability to transition to civilian employment after they leave the military. This option may also be valued if civilian worksites provide better employment opportunities for their spouses.[54]

  - **Cost savings.** Creating stand-alone DoD trauma centers or joint military-civilian trauma centers will entail many costs. While there will also be costs associated with placing military providers in civilian trauma centers (e.g., licensing and malpractice), these costs will be small in comparison and the military will likely receive partial reimbursement from the civilian facilities for personnel costs.

- **Benefits to Civilian Partners:**
  - **Reduced personnel costs.** Because the military's main goal is to gain access to civilian trauma workload, they will be willing to loan personnel to civilian centers at discounted rates (i.e., they may ask the facility to only cover some percentage of the personnel costs for the military providers).
  - **Staffing hard-to-fill vacancies.** Civilian facilities located in certain areas (most often rural areas) struggle to attract certain high-end surgical specialists. Military personnel can be assigned to such facilities to help fill provider gaps. Given that many military bases are located in rural/remote areas, providers may not need to travel far for these assignments.
  - **Learning.** Military medical personnel who worked in combat zones have experience in some of the world's most intense and austere trauma environments. By working side-by-side with civilian providers they can more easily share the knowledge and skills they picked up during military operations.

3. Challenges

The majority of the challenges associated with sending military personnel to work in civilian facilities are the same as those faced in forming joint military-civilian trauma centers (i.e., licensing and credentialing, malpractice, deployment risk, personnel matters, billing and reimbursement issues, etc.) As these were already discussed in Section 4.B.3, we will not reiterate them here. We will, however, discuss two additional challenges.

- **Loss of military culture.** At least one Service has expressed a potential concern that such arrangements may reduce the medical personnel's connection to the

[54] Ibid.

military.[55] As previously noted, evidence has suggested that Air Force physicians who do their residencies in civilian hospitals may be less likely to stay in the military.[56]

- **Difference in enlisted military and civilian occupations.** Eibner (2008) noted that enlisted military personnel are sometimes granted more authority and responsibility than their civilian counterparts are legally allowed. Military personnel in such professions would therefore either require an arrangement that allowed them to practice the full range of their military occupation's responsibilities in the civilian facility or receive clear instruction on what roles they may not perform in the civilian facilities.[57]

[55] Graser, Blum, and Brancato, *The Economics of Air Force Medical Service Readiness.*

[56] Keating et al., *Air Force Physician and Dentist Multiyear Special Pay*.

[57] Eibner, *Maintaining Military Medical Skills During Peacetime*.

5. Market Overviews

In this chapter, we provide overviews of the 12 markets identified in Section 3.C.2. Each overview includes a brief description of the facility's size, patient volume (including civilian emergency cases) and the share of the workload that is considered trauma. We then provide information on the surgical specialties, GME programs such as internships and residencies, and any special centers located at the facility (e.g., medical simulation and training centers or research centers). The discussion of the facility is followed by a discussion of the market area in which the facility is located. Here we discuss the local trauma system and document civilian trauma facilities in the region. We then provide a high-level assessment of the current system (whether the market is under/over served) based on population and injury data for the area.

We divide our markets into two groups: (1) current DoD trauma centers, and (2) other DoD medical centers and hospitals. Because trauma designation is controlled by the state and trauma centers must integrate into their regional trauma system, we organize our discussion around the state and local regional trauma systems in which these military trauma centers are located.

A. Current DoD Trauma Centers

There are currently five DoD trauma centers located in the United States—three in Texas, one in Washington State, and one in Maryland. They vary greatly in terms of size, staffing, and capability. The following discusses each of the existing DoD trauma centers. We begin with SAMMC to provide an example of what a fully functioning DoD trauma center looks like.

1. DoD Trauma Centers in the Texas Trauma System

Texas is home to three of DoD's five trauma centers: SAMMC (Level I), William Beaumont AMC (Level III), and Carl R. Darnall AMC (Level III). The trauma regulating system in the state of Texas is organized into 22 different RACs that are responsible for trauma system oversight within their region. Statewide, there are a total of 14 Level I trauma centers, 13 Level II centers, and 51 Level III centers. The 22 regions are shown in Figure 3, which provides a map of the Texas trauma system. The map depicts county populations as well as the location of the three Texas DoD trauma centers and Levels I, II, and III civilian trauma centers. The market areas that include a DoD trauma center are outlined in light blue.

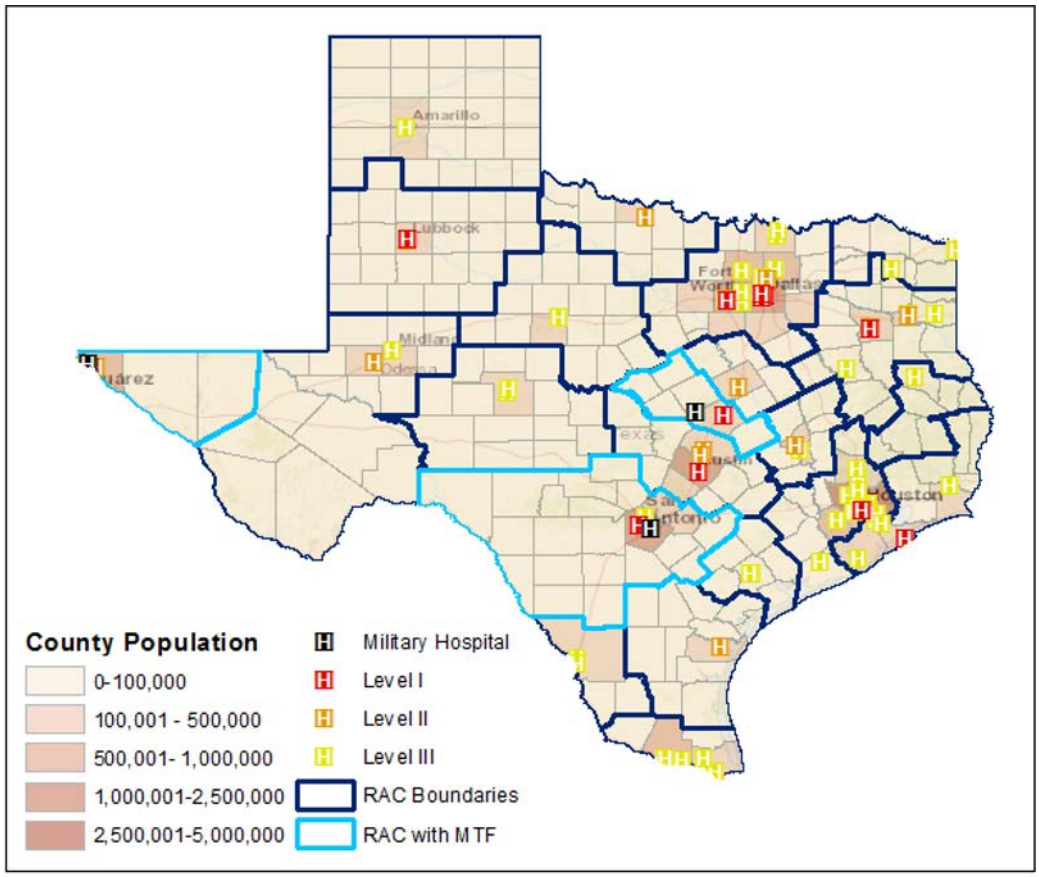

Figure 3. Texas Trauma System

From the map, it is clear that trauma centers are clustered in the most populous counties that include larger cities (San Antonio, Dallas, Houston, and Fort Worth). For less-populated regions, one lower-level center may serve many counties. Following, we provide further detail on each DoD trauma center and its local market area.

a. San Antonio MMC, San Antonio (SAMMC)

SAMMC is DoD's only Level I trauma center. It currently has 425 beds, 32 operating rooms, and an ADPL of about 254 (corresponding to a 60 percent daily occupancy rate). Of the nearly 25,000 inpatient admissions that occurred at the hospital in FY 2015, approximately 6 percent were civilian patients. While civilian admissions accounted for only 6 percent of total admissions, they accounted for nearly 40 percent of SAMMC's EMC workload, demonstrating the importance of assessing the ability to treat civilian trauma cases. Apart from examining the facility's EMC workload, we can also explore the portion of the facility's workload that is trauma-related. To identify trauma cases, we used

the NTDB's definition (described in Chapter 2) based on ICD-9-CM diagnosis codes.[58] To measure the workload associated with these trauma cases, we use Medicare Severity Diagnosis Related Group (MS-DRG) Relative Weighted Products (RWPs), which are a measure of workload intensity, i.e., the relative complexity of services and resources used to treat a patient. Table 10 shows SAMMC's inpatient workload measured in RWPs. The three columns show medical (non-surgical) workload, surgical workload, and total workload. The rows indicate how much of the workload for each of these categories was associated with trauma care. The data indicate that approximately 22 percent of SAMMC's overall inpatient workload is associated with trauma (27 percent of surgical and 16 percent of medical).

Table 10. SAMMC Trauma Workload

	MS-DRG RWPs		
	Medical	**Surgical**	**Total**
Trauma	2,241	4,713	6,954
Total	14,369	17,434	31,803
Percent Trauma	16%	27%	22%

Source: MHS Management Analysis and Reporting Tool (M2) SIDR table, FY 2015.

Consistent with their Level I status, SAMMC staffs all the surgical specialties required for verification. There are approximately 25 general surgeons on staff and an additional 40 surgical specialists (neuro, vascular, orthopaedic, cardiac/thoracic, etc.). SAMMC also has a large GME program that includes residencies in anesthesiology, dermatology, diagnostic radiology, emergency medicine, general surgery, internal medicine, neurology, OB/GYN, ophthalmology, orthopaedic surgery, otolaryngology, pathology, pediatrics, psychiatry, urology, and transitional year.[59] In addition to being a Level I trauma center, SAMMC is also a certified burn center and home to the Center for the Intrepid (CFI)—a state-of-the-art facility designed to provide rehabilitation for Service members who sustained amputations, burns, or functional loss of limbs in the Operation Iraqi Freedom/Operation Enduring Freedom (OIF/OEF) operations. The CFI also seeks to

[58] Trauma workload is identified with ICD-9-CM discharge diagnosis codes between 800.00 and 959.9 but excluding 905–909 (late effect of injury), 910–924 (blisters, contusions, abrasions, and insect bites), and 930–939 (foreign bodies).

[59] The Transitional Year Program is a one-year internship designed to meet the needs of interns who will be proceeding onto further residency specialty training as well as those who will be serving as general medical officers following their first year of training.

provide education and cutting edge rehabilitation, and produces research in the fields of orthopaedics, prosthetics, and various physical/occupational rehabilitation therapies.[60]

SAMMC is located on Joint Base San Antonio, a base shared by Fort Sam Houston (Army), Randolph Air Force Base, and Lackland Air Force Base, which were merged in 2010. The city of San Antonio has a population of approximately 1.4 million while the larger metropolitan statistical area (MSA) of Greater San Antonio has a population of 2.1 million. Finally, the entire Southwest Texas RAC in which SAMMC is located serves a population base of 2.4 million. The market is depicted in Figure 4. The civilian trauma infrastructure in San Antonio consists of one Level I facility, University Health System, and two Level III facilities, North Central Baptist Hospital in the North and Methodist Hospital adjacent to the Level I facility. Civilian emergency cases are also treated at SAMMC.

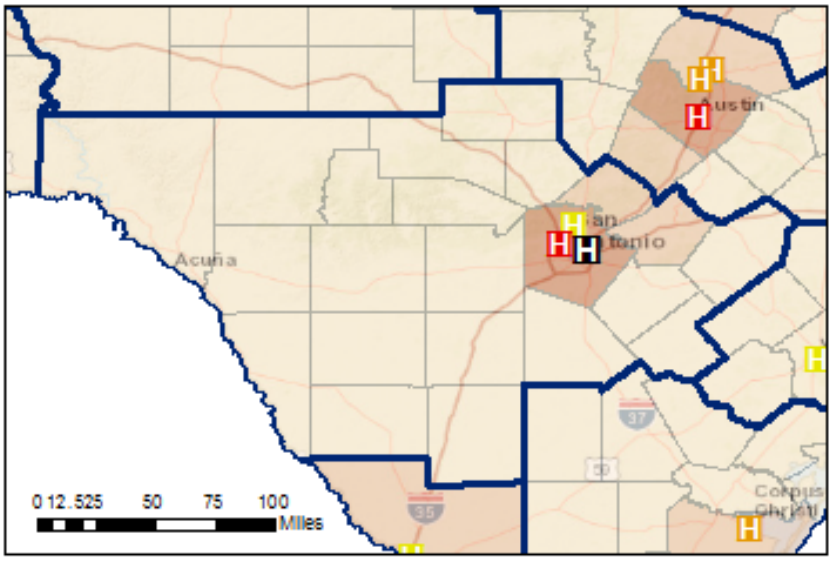

Figure 4. San Antonio Market Area

Based on the population in the San Antonio market area, the presence of two high level trauma centers seems consistent with the ACS's guidelines on the appropriate number of trauma centers (up to two per million residents). Table 11 formalizes this assessment by documenting the number of high-level trauma centers (Level I or II) serving the city and wider RAC, the population, and the ratio of trauma centers to millions of residents. We interpret a ratio between 1 and 2 to be generally consistent with ACS guidelines, but recognize that ratios less than 1 may be optimal in large rural regions and that ratios higher than 2 may be optimal in regions with higher than average trauma rates.

[60] "Center for the Intrepid," Brooke Army Medical Center, https://www.bamc.amedd.army.mil /departments/rehabilitation-medicine/cfi/.

Table 11. High-Level Trauma Centers per Million Residents in San Antonio Market Area

SAMMC	San Antonio	RAC
Number of Level I Trauma Centers	2	2
Number of Level II Trauma Centers	0	0
Population (in millions)	1.41	2.44
High-Level Trauma Centers Per Million	1.42	0.83

In addition to examining the area's population, we also examine its current rate of trauma cases. Injury data in Table 12 show there were over 14,000 trauma cases in SAMMC's RAC in 2014. Approximately 7 percent of that workload was composed of firearm or cut/pierce injuries, which we can classify as penetrating trauma.

Table 12. Injury Data Southwest RAC

	Firearm	Cut/Pierce	Burn	MVT	Other	Total	Penetrating Cases*
Trauma Cases	392	601	546	2,518	10,171	14,228	993
Cases per 100,000 Residents	16.09	24.67	22.42	103.37	417.56	584.11	40.76
Share of Trauma	2.8%	4.2%	3.8%	17.7%	71.5%	100.0%	7.0%

Source: Texas EMS & Trauma Registries, Injury Epidemiology & Surveillance Branch, Texas Department of State Health Services; 2014 data.

* Penetrating cases are defined as firearm and cut/pierce cases. This definition represents a lower bound on the penetrating trauma, as it misses penetrating cases classified as MVT or Other (which are more commonly blunt trauma but can also involve penetrating traumatic injuries).

SAMMC serves as a good example of what DoD can achieve. It has the infrastructure and staff required to function as a trauma center and is located in a market area that can provide the required case volume due to the size of its population and the fact that there are not a large number of competing civilian facilities in the vicinity.

b. William Beaumont, El Paso

The second largest military hospital in the state of Texas is William Beaumont AMC, located at Ft. Bliss. This facility is currently a state-designated Level III trauma center, although it had previously acquired Level II status in 1999. The facility's status was lowered during the OIF/OEF operations, which required continued deployments of hospital staff. William Beaumont currently has 209 beds and an ADPL of 71 (daily occupancy rate of 34 percent). While Beaumont has the ability to take civilian trauma patients, the hospital only admitted 26 civilian emergency cases in FY 2015—less than 1 percent of their

inpatient admissions. Table 13 shows William Beaumont's inpatient workload measured in RWPs. The data indicate that approximately 4 percent of its overall inpatient workload is associated with trauma (6 percent of surgical and 2 percent of medical). These trauma rates and volume are significantly lower than those found at SAMMC.

Table 13. William Beaumont Trauma Workload

	Inpatient MS-DRG RWPs		
	Medical	**Surgical**	**Total**
Trauma	74	242	316
Total	4,039	4,160	8,199
Percent Trauma	2%	6%	4%

Source: M2 SIDR table, FY 2015.

The surgical staff at William Beaumont includes general, orthopaedic, vascular, and oral and maxillofacial surgeons, but lacks other specialties, including trauma specialists, neurosurgeons, and colon/rectal surgeons. Like SAMMC, William Beaumont also runs GME residency programs, although the offerings are more limited. There are currently four programs: internal medicine, general surgery, orthopaedic surgery, and a transitional year residency (a broad education that includes 13 four-week rotations). The orthopaedics program is unique and of particular interest in that it is a true military-civilian combined program (combined with Texas Tech). It should be noted that the construction of a new hospital facility that will eventually replace the current one is ongoing.

The city of El Paso has a population of roughly 650,000, while the larger Border RAC, in which William Beaumont is located, serves a population of 806,000. In addition to William Beaumont, there are three civilian trauma centers in the area: El Paso University Medical Center (Level I), Del Sol Medical Center (Level II), and Las Palmes Medical Center (Level III). Figure 5 shows a map of the market area.

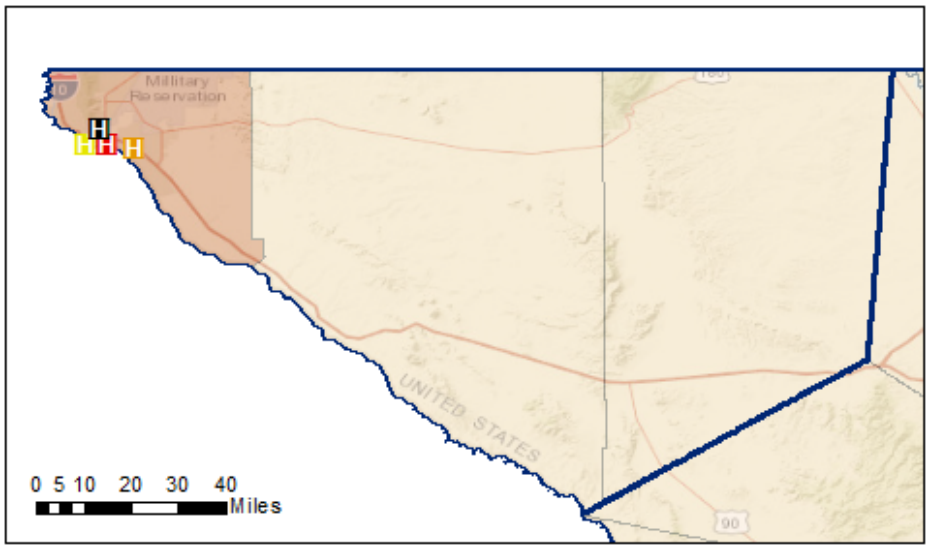

Figure 5. El Paso Market Area

The presence of multiple high-level civilian trauma centers in the El Paso market area suggests that the market is well served in terms of trauma care. Table 14 documents this fact by presenting the number of high-level trauma centers (Level I or II) serving the RAC, the population, and the ratio of trauma centers to millions of residents. The ratio of high-level trauma centers per million residents already exceeds 2 (without including William Beaumont).

Table 14. High-Level Trauma Centers per Million Residents

William Beaumont Border RAC	
Number of Level I Trauma Centers	1
Number of Level II Trauma Centers	1
Population (in millions)	.81
High-Level Trauma Centers Per Million	2.48

In addition to considering the area's population, we also consider data on traumatic injuries. Table 15 presents data on the region's trauma volume and rate. The trauma seen in the Border RAC appears significantly lower than the trauma seen in the RAC where SAMMC is located (especially firearm trauma cases, which occur at roughly half the rate).

Table 15. Injury Data, Border RAC

	Firearm	Cut/Pierce	Burn	MVT	Other	Total	Penetrating Cases*
Trauma Cases	65	192	77	762	2823	3919	257
Cases per 100,000 Residents	8.1	23.8	9.6	94.5	350.0	485.9	31.9
Share of Trauma	1.7%	4.9%	2.0%	19.4%	72.0%	100.0%	6.6%

Source: Texas EMS & Trauma Registries, Injury Epidemiology & Surveillance Branch, Texas Department of State Health Services; 2014 data.

* Penetrating cases are defined as firearm and cut/pierce cases. This definition represents a lower bound on the penetrating trauma, as it misses penetrating cases classified as MVT or Other (which are more commonly blunt trauma but can also involve penetrating traumatic injuries).

Based on these data and discussions with Texas EMS officials, it appears that elevating William Beaumont's role as part of the region's civilian trauma system could be difficult. The recent history of the facility has also demonstrated this fact. When Beaumont initially received its Level II status, it had hoped to become a premier trauma training site for DoD personnel and planned to treat at least 1,000 trauma cases annually. An assumption was made that Beaumont could attract care from the local civilian Level I center, Thomas Hospital (now University Medical Center), for patients who were uninsured and expensive to treat. This, however, turned out not to be the case, as Thomas had to maintain a high volume of trauma cases to keep their providers and residents busy and to meet their Level I volume requirement.[61] Attempting to return the facility to its prior Level II status and competing for civilian patients will likely not be the best option for this facility. However, there may be some strong partnership opportunities in this market area.

c. Carl Darnall, Fort Hood

The second Level III DoD trauma center in Texas is Carl Darnall AMC at Fort Hood. Darnall is much smaller than SAMMC and William Beaumont, with just over 100 beds and 7 operating rooms. The ADPL is approximately 62 (a 57 percent occupancy rate). While Darnall has the ability to take civilian trauma patients, the hospital admitted only 29 civilian emergency cases in FY 2015—under 1 percent of their inpatient admissions. Table 16 shows Darnall's inpatient workload measured in RWPs. The data indicate that approximately 3 percent of the overall inpatient workload is associated with trauma

[61] For a further discussion of William Beaumont's trauma history, see Peter Gerepka, *Cost Benefit Analysis of Providing Level II Trauma Care at William Beaumont Army Medical Center (WBAMC)* (El Paso, TX: William Beaumont Army Medical Center, August 2002).

(6 percent of surgical and 1 percent of medical). The volume of trauma workload at Darnall, measured in MS-DRG RWPs, is less than half that at William Beaumont.

Table 16. Darnall AMC Trauma Workload

Inpatient MS-DRG RWPs			
	Medical	**Surgical**	**Total**
Trauma	40	103	143
Total	3,495	1,686	5181
Percent Trauma	1%	6%	3%

Source: M2 SIDR table, FY 2015.

The surgical staff at Darnall is smaller than those at SAMMC and William Beaumont and includes fewer specialties. GME programs offered at Darnall include emergency medicine, family medicine, orthopaedics, pediatrics, general surgery, OB/GYN and psychiatry.

Fort Hood is situated in Killeen, Texas. The city of Killeen has a population of approximately 140,000, while the larger Killeen-Temple metropolitan area has a population of approximately 430,000. The population for the entire Central RAC, in which Killeen is located, is only slightly larger at just over 440,000. The Scott and White Memorial Hospital, a Level I facility approximately 30 miles to the east of Darnall, is the only high-level trauma center serving the RAC. In addition, two Level II trauma centers lie approximately 50 miles to the south in Round Rock, Texas, in the bordering Capital Area RAC. The RAC to the north also contains one Level II facility. Figure 6 depicts the market area.

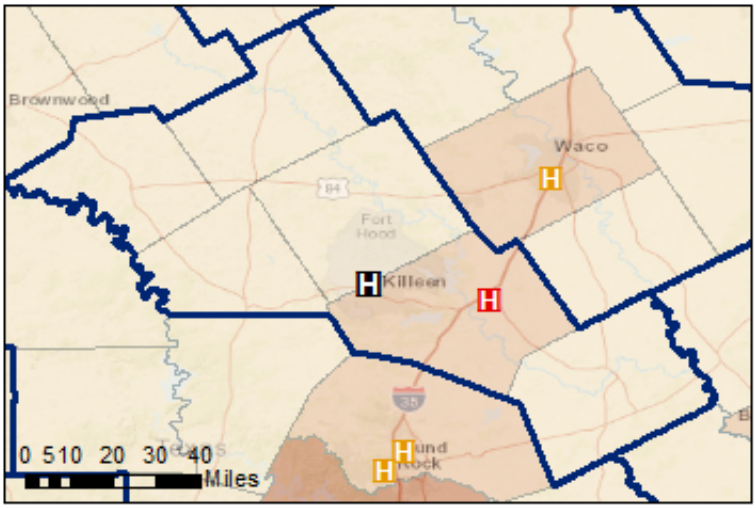

Figure 6. Fort Hood Market Area

The low area population, presence of multiple high-level civilian facilities, and smaller surgical staff at Darnall suggest the facility is not a strong candidate for trauma capability expansion. Table 17 documents this fact by presenting the number of high-level trauma centers (Level I or II) serving the RAC, the population, and the ratio of trauma centers to millions of residents.

Table 17. High-Level Trauma Centers per Million Residents

Darnall (Central RAC)	
Number of Level I Trauma Centers	1
Number of Level II Trauma Centers	0
Population (in millions)	.44
High-Level Trauma Centers Per Million	2.25

The ratio of high-level trauma centers per million residents exceeds 2 without including Darnall. Table 18 shows the area's trauma data. While the overall volume of trauma is fairly low, there is a relatively high rate of both firearm and cut/pierce injuries, suggesting a high rate of penetrating trauma.

Table 18. Injury Data, Central RAC

	Firearm	Cut/Pierce	Burn	MVT	Other	Total	Penetrating Cases*
Trauma Cases	127	110	111	546	1685	2579	237
Cases per 100,000 Residents	28.6	24.8	25.0	123.1	379.9	581.5	53.4
Share of Trauma	4.9%	4.3%	4.3%	21.2%	65.3%	100.0%	9.2%

Source: Texas EMS & Trauma Registries, Injury Epidemiology & Surveillance Branch, Texas Department of State Health Services; 2014 data.

* Penetrating cases are defined as firearm and cut/pierce cases. This definition represents a lower bound on the penetrating trauma, as it misses penetrating cases classified as MVT or Other (which are more commonly blunt trauma but can also involve penetrating traumatic injuries).

While Darnall does not appear to be a strong candidate for attracting more civilian trauma patients, it may have partnership potential, especially given that the rate of penetrating trauma in the area appears somewhat higher than average.

2. The Maryland Trauma System and Walter Reed National Military Medical Center, Bethesda

Walter Reed is a tri-Service Level II trauma center located in Bethesda, Maryland, just inside the Capital Beltway. The facility is the second largest DoD trauma center and often the first destination in the continental United States for Service members injured abroad. The facility has approximately 247 beds. The ADPL is approximately 168, which corresponds to an occupancy rate of 68 percent. While Walter Reed is an ACS-verified Level II trauma center, it has not received trauma designation from the state of Maryland. Very few civilian cases, only 7 in FY 2015, are currently treated at Walter Reed. Table 19 shows the facility's inpatient workload measured in RWPs. The data indicate that approximately 5 percent of the overall inpatient workload is associated with trauma (7 percent of surgical and 3 percent of medical). The volume of trauma workload, measured in MS-DRG RWPs, is approximately two and a half times greater than the volume of trauma recorded at William Beaumont, but less than 15 percent of the trauma volume recorded at SAMMC.

Table 19. Walter Reed NMMC Trauma Workload

Inpatient MS-DRG RWPs			
	Medical	**Surgical**	**Total**
Trauma	198	591	789
Total	7,870	8,426	16,296
Percent Trauma	3%	7%	5%

Source: M2 SIDR table, FY 2015.

Like SAMMC, the surgical staff at Walter Reed includes all specialties. The facility is also home to the military's most comprehensive center for GME, with over 75 medical and allied health programs. Residency programs include neurosurgery, OMFS, orthopaedic surgery, general surgery, and vascular surgery, among others. Walter Reed is also home to the Walter Reed Medical Simulation Center, a tertiary hospital-based simulation facility used to provide a state-of-the-art training environment for DoD interns, residents, and practitioners.

The Maryland Trauma system is divided into five RACs. The state's Level I and II trauma centers are clustered around the city of Baltimore and the DC metro area. Figure 7 shows an overview of the Maryland trauma system and a more focused view of the RAC that contains Walter Reed, RAC Region V. The DC/Northern Virginia area is also included due to its close proximity and numerous trauma centers.

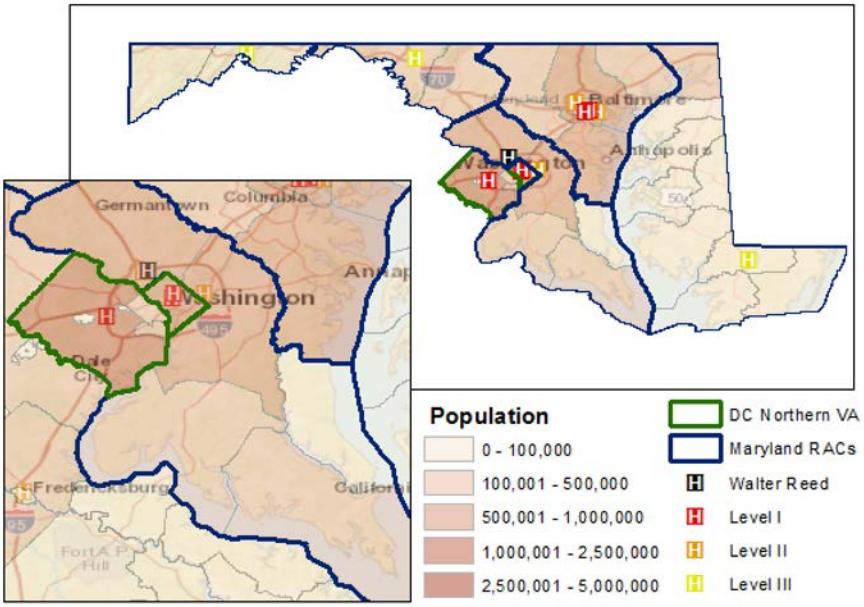

Figure 7. Walter Reed Market Area

RAC V consists of five counties and has a total population of just over 2 million. The adjacent Region III, which contains the city of Baltimore, has a population of 2.1 million. Lastly, the DC and Northern Virginia area to the southwest (outlined in green) also has a population of just over 2 million. The region containing Walter Reed has three Level II facilities (including Walter Reed), which is consistent with the ACS guidelines.

Table 20. High-Level Trauma Centers per Million Residents

Walter Reed (Region V RAC)	
Number of Level I Trauma Centers	0
Number of Level II Trauma Centers	3
Population	2.18
High-Level Trauma Centers Per Million	1.38

Region III, to the northwest, has two Level I facilities and two Level II facilities, and the DC/Northern Virginia area has three Level I facilities.

Overall the area appears to be well served in terms of trauma care. It would likely be difficult for Walter Reed to become a state-designated Level II trauma center at this time due to the fairly strict trauma center regulations imposed by the state of Maryland. For instance, in Maryland, Level II designation has a volume requirement of 400 trauma cases per year and 120 cases with an ISS > 13. Discussions with representatives from the Maryland Institute for EMS Systems (MIEMSS) also revealed that Maryland has criteria for the number and level of trauma centers than may be designated for an area. Specifically,

when considering a new hospital for trauma center designation, Maryland will consider whether the new center would be duplicating a service already available in the area and how it would affect other facilities' ability to sustain volume, cost efficiency, and outcomes.[62] While obtaining a state trauma designation may be challenging for Walter Reed, opportunities still exist for the facility to become more integrated into the civilian trauma system. For example, MIEMSS officials discussed the potential for the facility to take on a greater role in state disaster preparedness (the facility already participates in the Bethesda Hospitals Emergency Preparedness Partnership) and to provide rehabilitation for civilian trauma patients. Partnerships with the local Level II or other large trauma centers, such as Prince Georges Hospital Center, were also discussed.

Table 21 shows the injury data for the RAC in which Walter Reed is located. The rate of penetrating trauma is high in this RAC—nearly 10 percent. However, the RAC just to the North (Region III) has double the trauma case volume and an estimated penetrating trauma rate of nearly 17 percent. High rates of penetrating trauma in the area suggest a strong opportunity for partnerships.

Table 21. Injury Data, RAC V

	Firearm	Cut/ Pierce	Burn	MVT	Other	Total	Penetrating Cases*
Trauma Cases	146	133	59	1,096	1,498	2,932	279
Cases per 100,000 Residents	6.7	6.1	2.7	50.4	68.9	134.8	13
Share of Trauma	5.0%	4.5%	2.0%	37.4%	51.1%	100.0%	9.5%

Source: Maryland Institute for EMS Systems (MIEMSS) data from Maryland State Trauma Registry. Data are 'Patients that were Admitted to or Died at Maryland Trauma or Burn Specialty Referral Centers in 2015.'

* Penetrating cases are defined as firearm and cut/pierce cases. This definition represents a lower bound on the penetrating trauma, as it misses penetrating cases classified as MVT or Other (which are more commonly blunt trauma but can also involve penetrating traumatic injuries).

3. The Washington State Trauma System and Madigan Army Medical Center, Joint Base Lewis-McChord

Madigan AMC is a Level II trauma center located on Joint Base Lewis-McChord just outside of Lakewood, Washington. The facility currently has 227 beds. The ADPL is approximately 130, which corresponds to an occupancy rate of 57 percent. Although

[62] See Code of Maryland Regulations (COMAR), Title 30 (MIEMSS), 30.08.05.20, "Criteria for the Number and Level of Trauma Centers To Be Designated or Reverified," http://www.dsd.state.md.us /comar/comarhtml/30/30.08.05.20.htm.

Madigan is a state-designated trauma center participating in the regional trauma regulating system, it receives a low volume of civilian emergency cases. In FY 2015, 84 cases, or less than 1 percent of the facility's inpatient admissions, were civilians. Table 22 shows Madigan's inpatient workload measured in RWPs. The data indicate that approximately 5 percent of the overall inpatient workload is associated with trauma (7 percent of surgical and 3 percent of medical). The volume of trauma workload, measured in MS-DRG RWPs, is similar to the volume seen at Walter Reed.

Table 22. Madigan AMC Trauma Workload

Inpatient MS-DRG RWPs			
	Medical	**Surgical**	**Total**
Trauma	198	591	789
Total	7,870	8,426	16296
Percent Trauma	3%	7%	5%

Source: M2 SIDR table, FY 2015.

The surgical staff at Madigan includes a wide range of specialists including neurosurgeons and cardiac/thoracic surgeons. Madigan is also home to 21 medical residency programs, including emergency medicine, general surgery, orthopaedic surgery, and neurology. The Charles A. Anderson Simulation Center, which supports Continuing Medical Education (CME), GME, and nursing and operational medic training, is also located at Madigan. This center was the first DoD center to be accredited by the ACS as a Level I educational institution.

The Washington state trauma system is divided into eight regions. Only one Level I trauma center currently operates in the state. Figure 8 provides an overview of the Washington state trauma system and a more localized view of the trauma region in which Madigan is located.

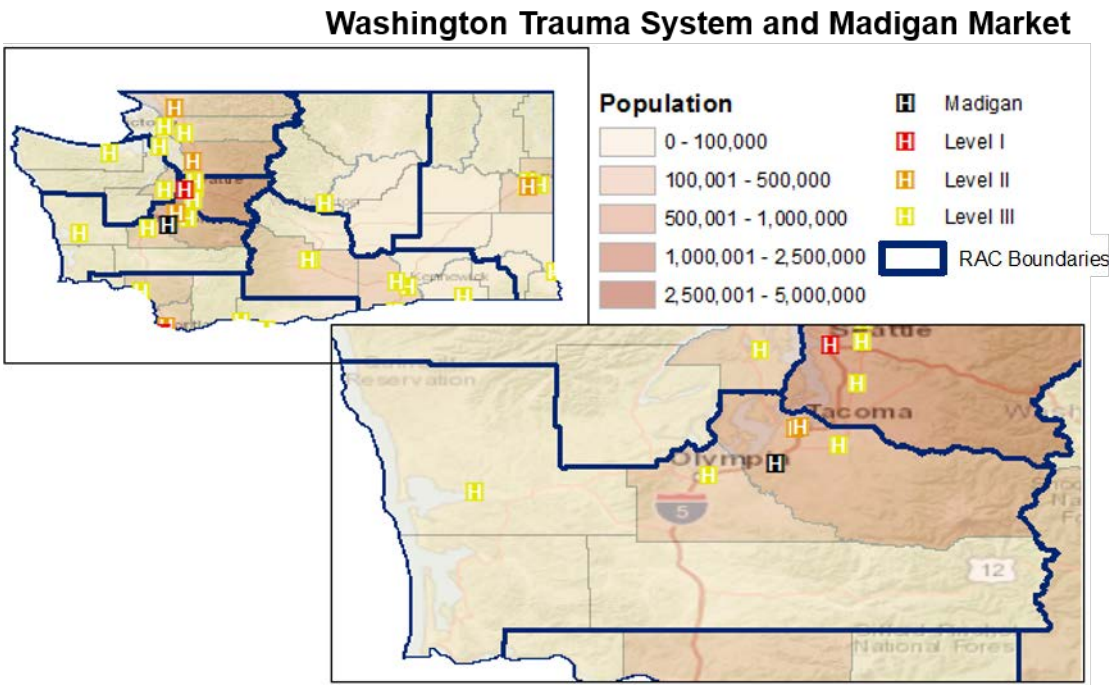

Figure 8. Washington Trauma System and Madigan Market Area

The state's only Level I facility is located in the Central trauma region, which includes the city of Seattle and four other Level III trauma centers. Approximately 1.9 million people live in this region. Madigan is located in the West trauma region and lies approximately 10 miles south-southwest of the city of Tacoma, which has a population of just under 200,000. The larger West region contains a population of approximately 1.2 million. Currently the region's highest level trauma capability is Level II and this capability is shared among three partners—Madigan, St. Joseph Medical Center, and MultiCare Tacoma General Hospital—forming the Tacoma Trauma Trust. Created to fill a gap in the area's trauma care needs, the collaboration has provided Level II trauma care for the Tacoma area since 2000. Under the arrangement, trauma care duty rotates every 24 hours between St. Joseph Medical Center and Tacoma General. Madigan provides trauma services around the clock for military personnel and, as needed, for civilian patients. From Madigan, one must travel approximately 50 miles north on Interstate I-5 to reach the state's only Level I facility. The second nearest Level I facility is approximately 130 miles south on Interstate I-5 in Portland, Oregon. Several other Level II and III facilities are also scattered up and down the I-5 corridor. Table 23 shows the number of high-level trauma centers per million residents.

Table 23. High-Level Trauma Centers per Million Residents

Madigan (West WA RAC)	
Number of Level I Trauma Centers	0
Number of Level II Trauma Centers	2
Population (in millions)	1.22
High-Level Trauma Centers Per Million	1.64

Note: The two civilian trauma centers that rotate trauma call are counted as one facility.

Based on the ACS population guidelines, a case could be made for increasing Madigan's role in the civilian trauma system. The trauma data shown in Table 24 indicate there were over 10,000 annual trauma cases in the region. However, the rates of firearm and cut/piece injuries were lower than average, suggesting the area may not see high rates of penetrating trauma.

Table 24. Injury Data, West RAC

	Firearm	Cut/Pierce	Burn	MVT	Other	Total	Penetrating Cases*
Trauma Cases	174	101	148	884	9,056	10,363	275
Cases per 100,000 Residents	14.3	8.3	12.16	72.66	744.33	851.76	22.6
Share of Trauma	1.7%	1.0%	1.4%	8.5%	87.4%	100.0%	2.7%

Source: Washington State Department of Health, http://www.doh.wa.gov/DataandStatisticalReports/InjuryViolenceandPoisoning/InjuryData/WashingtonStateInjuryDataTables; year is 2013.

* Penetrating cases are defined as firearm and cut/pierce cases. This definition represents a lower bound on the penetrating trauma, as it misses penetrating cases classified as MVT or Other (which are more commonly blunt trauma but can also involve penetrating traumatic injuries).

B. DoD Medical Centers and Hospitals

Only five of 12 candidate facilities examined in this report are already state-designated or ACS-verified trauma centers. Six of the remaining seven are classified as medical centers, whereas one facility, NH Camp Lejeune, is classified as a community hospital.[63] This section discusses these remaining candidate facilities. Again, we arrange our discussion around the state and local trauma systems where these facilities are located.

[63] While there is not an exact distinction between medical centers and hospitals, medical centers are usually large facilities that have large GME programs and typically offer more services.

1. DoD Hospitals in North Carolina

North Carolina is home to two of DoD's 12 candidate facilities, Womack AMC (located at Fort Bragg) and NH Camp Lejeune. Each of these facilities is located in a somewhat underserved area in terms of trauma care. The trauma regulating system in the state of North Carolina is organized into eight different RACs that are responsible for trauma system oversight within their regions. Statewide, there are a total of six Level 1 trauma centers, three Level II centers, and four Level III centers. The eight regions, which are drawn based on county boundaries, are depicted in Figure 9. The map shows county populations, the locations of the two DoD hospitals, and Level I, II, and III civilian trauma centers. The light blue lines highlight the relevant DoD market RACs.

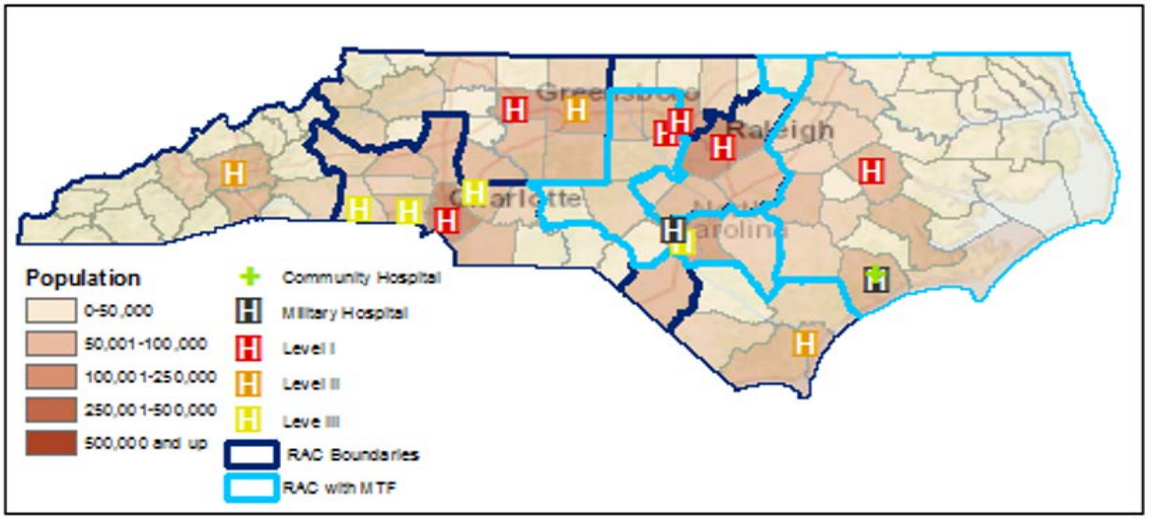

Figure 9. North Carolina Trauma System

The most populous areas in North Carolina, such as Raleigh and Charlotte, are home to multiple trauma centers, while large rural regions in the eastern and western part of the state have very few. The largest RAC in North Carolina is the Eastern RAC. This region is served by only one trauma center, Vidant Medical Center, a Level I facility in Greenville. Camp Lejeune, which is over an hour away from Vidant, also falls within this region. Fort Bragg is located in the Mid-Carolina RAC. This region also contains one Level I facility, University of North Carolina Hospitals, and one Level III, Cape Fear Valley Medical Center (CFVMS). Below we describe each market in further detail.

a. Womack Army Medical Center, Fayetteville

Womack AMC is the largest DoD hospital in North Carolina. Located at Fort Bragg in Fayetteville, NC, Womack has 156 beds. The ADPL is 79 (a 51 percent capacity rate). In FY 2015, there were 30 civilian emergency hospitalizations—less than 1 percent of total inpatient admissions. Table 25 shows Womack's inpatient workload measured in RWPs.

The data indicate that approximately 5 percent of the overall inpatient workload is associated with trauma (11 percent of surgical and 2 percent of medical). The volume of trauma workload at Womack is lower than that of DoD's two Level II facilities (Madigan and Walter Reed) but higher than the current Level III facilities (Darnall and William Beaumont). This may be partially due to the higher than average trauma rate present in the area's population.

Table 25. Womack Trauma Workload, FY 2015

Inpatient MS-DRG RWPs			
	Medical	**Surgical**	**Total**
Trauma	105	314	419
Total	5,008	2,843	7851
Percent Trauma	2%	11%	5%

Source: M2 SIDR table, FY 2015.

The surgical staff at Womack includes general, oral and maxillofacial, orthopaedic, and vascular surgeons. Several specialties, including neurosurgery and cardiothoracic surgery, are not currently represented. Residency programs in family medicine, OB/GYN, OMFS, pharmacy, and behavioral health are offered.

The city of Fayetteville has a population of approximately 200,000, while the larger metropolitan area has just over 375,000. The total RAC population is just over 900,000. The market is shown below in Figure 10.

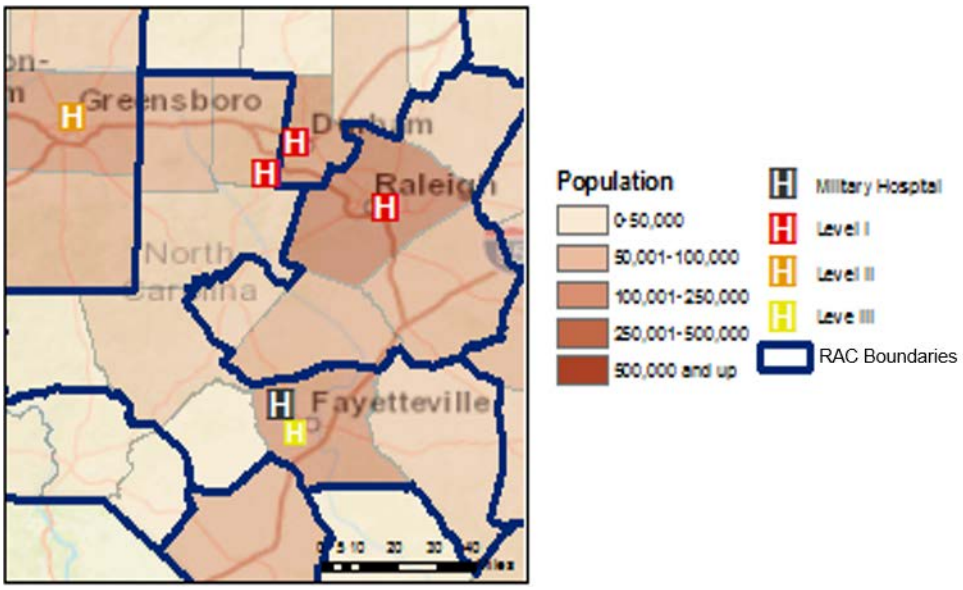

Figure 10. Fayetteville Market Area

Only one high-level trauma center, located in the Raleigh-Durham area, currently serves the RAC. The Level III trauma center, CFVMS, is located in Fayetteville, approximately 10 miles to the southeast of Womack. Table 26 shows the number of high-level trauma centers per million residents.

Table 26. High-Level Trauma Centers per Million Residents

Womack (Mid-Carolina RAC)	
Number of Level I Trauma Centers	1
Number of Level II Trauma Centers	0
Population (in millions)	.92
High-Level Trauma Centers Per Million	1.1

While the presence of only one high-level trauma center for the RAC is consistent with the ACS guidelines given the population, there is reason to believe the area might also be able to accommodate a second high-level center. While Fayetteville is not a dense population center, it does have a higher than average rate of trauma—especially penetrating trauma (i.e., gunshot wounds and stabbings). In 2014, these occurred at a rate of roughly 45 cases per 100,000 residents.

Table 27. Injury Data, Mid-Carolina RAC

	Firearm	Cut/Pierce	Burn	MVT	Other	Total	Penetrating Cases*
Trauma Cases	199	204	246	806		1455	403
Cases per 100,000 Residents	22	23	28	90	N/A	163	45
Share of Trauma	0.9%	1.0%	1.2%	3.8%		100.0%	N/A

Source: North Carolina Department of Health and Human Services. Data are for 2014. Other injury data were incompatible with other states' data—they included hospitalizations for disease and other non-trauma cases. Total includes first four categories.

* Penetrating cases are defined as firearm and cut/pierce cases. This definition represents a lower bound on the penetrating trauma, as it misses penetrating cases classified as MVT or Other (which are more commonly blunt trauma but can also involve penetrating traumatic injuries).

While CFVMC is designated as a Level III center, it sees a volume and case acuity level consistent with most Level II and even some Level I centers. In 2015, there were over 1,500 trauma admissions to the facility (1,200 is the minimum for Level I status). The Emergency Department (ED) at CFVMC was ranked as one of the top 15 busiest in the

country.[64] The facility is also very large compared to most Level IIIs, with over 800 beds (the median Level II has 233 beds). In addition to providing trauma care, CFVMC also runs the area's EMS.

One of the main factors that has prevented this facility from pursuing a Level II status is its struggle to recruit and retain a large enough pool of specialists. (Fayetteville is a largely military town in a rural area, which can make attracting talent difficult.) When the right specialists are on hand, CFVMC retains trauma cases and performs the required complex surgical procedures. When specialists are not available, patients are transferred to one of the three Level I facilities located to the north (University of North Carolina (UNC Medical Center), the Duke Trauma Center, or WakeMed). Transfers out typically involve cases requiring neurosurgery, OMFS, and orthopaedic injuries.

A recent agreement between CFVMC and Womack, which allows an orthopaedic trauma specialist from Womack to practice at CFVMC one day per week, highlights the potential for expanding the partnership between them. This has been a mutually beneficial arrangement for all those involved (the military provider gains access to a desired case mix, the patients do not have to be transferred out of the area, and CFVMC retains the workload). The military orthopaedic specialist has plans to help grow this arrangement to include other orthopaedic providers from Womack. In Section 6.A.1, we explore how this type of arrangement could be expanded even further.

b. Naval Hospital Camp Lejeune, Jacksonville

NH Camp Lejeune is located in Jacksonville, NC. This facility is the only community hospital considered in this analysis. The hospital has 117 beds and eight operating rooms. Four additional operating rooms are located at the Naval Health Clinic Cherry Point, which the Navy has recently begun using as an ambulatory surgery center. That facility is approximately 50 miles from the main hospital. The ADPL at NH Camp Lejeune is approximately 47 (a 40 percent capacity rate). In FY 2016, there were approximately 7,000 inpatient admissions, including 19 civilian emergencies. Table 28 shows the facility's inpatient workload. The data indicate that approximately 3 percent of the overall inpatient workload is associated with trauma (10 percent of surgical and 1 percent of medical). The volume of trauma workload, measured in MS-DRG RWPs, is similar to Carl Darnall's.

[64] This information was provided to the IDA team during a meeting with CFVMC staff.

Table 28. NH Camp Lejeune Trauma Workload

Inpatient MS-DRG RWPs			
	Medical	**Surgical**	**Total**
Trauma	31	99	130
Total	2,884	1,003	3,887
Percent Trauma	1%	10%	3%

Source: M2 SIDR table, FY 2015.

The surgical staff at NH Camp Lejeune includes multiple general and orthopaedic surgeons. Most surgical subspecialties, including cardiothoracic, neuro, vascular, and colon/rectal, are not typically represented. A residency program in family medicine was established at NH Camp Lejeune in 2003. The hospital is also home to a psychology residency program and a fellowship in OB/GYN, and is considering offering new programs in emergency medicine and general surgery along with training programs for nurse anesthetists and ultrasound technicians.

The Marine base and Naval Hospital are located in the city of Jacksonville. The city of Jacksonville has a population of approximately 70,000, while the population of the larger Jacksonville MSA is nearly 200,000. The Eastern Carolina RAC, in which Jacksonville is located, has a population of just over 1.4 million. Onslow Memorial Hospital is the main civilian healthcare facility serving the local Jacksonville population. The facility has 162 beds and four operating rooms and is not a designated trauma center, but it receives the area's local civilian emergency/trauma cases and has a busy ED (between 170 and 180 cases a day).[65] In addition to lacking a designated trauma center, Onslow County is also designated as a medically underserved area by the Health Resources and Services Administration (HRSA). When it comes to trauma care, Vidant Medical Center, a Level I center and the only trauma center serving the state's eastern RAC, takes most of the highest acuity cases. Vidant is located in Greenville, NC, roughly 80 miles from the NH. The market area is shown in Figure 11.

[65] Information provided by Onslow Memorial Hospital.

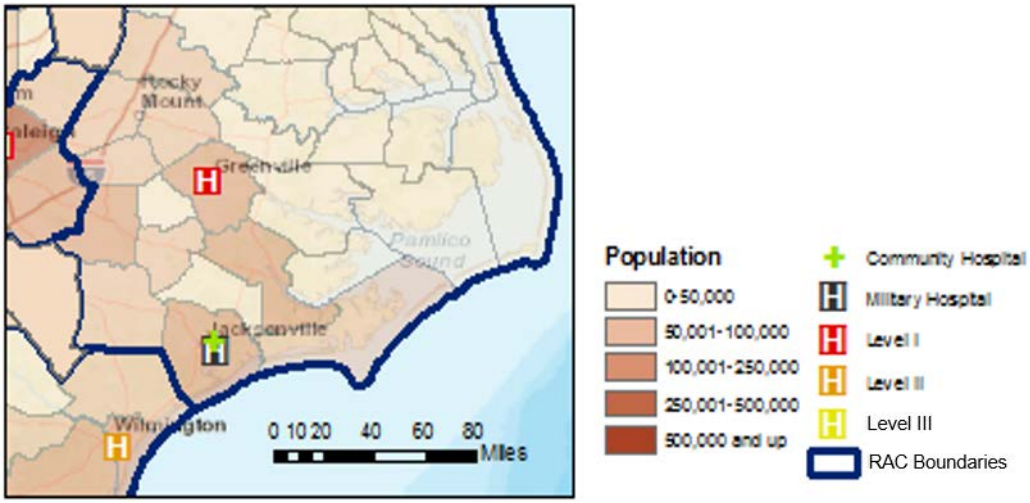

Figure 11. Jacksonville Market and Eastern RAC

Vidant has a close working relationship with Onslow Memorial Hospital, which receives and stabilizes local trauma cases before sending them to Vidant. New Hanover Regional Medical Center, a Level II facility in Wilmington, NC, also takes trauma cases from the Jacksonville area. Table 29 shows the number of high-level trauma centers and the number of trauma centers per million residents for the RAC.

Table 29. High-Level Trauma Centers per Million Residents

Camp Lejeune (Eastern Carolina RAC)	
Number of Level I Trauma Centers	1
Number of Level II Trauma Centers	0
Population (in millions)	1.4
High-Level Trauma Centers Per Million	.71

Based on the ACS guidelines, the RAC could potentially support a second high-level trauma center in the Jacksonville area, although a Level III trauma capability might be more appropriate. The rural nature of the region and the relatively high rate of penetrating trauma should factor into analyzing which trauma center level could be supported. The data shown in Table 30 illustrate the number, rate, and composition of trauma cases in the area.

Table 30. Injury Data, Eastern Carolina RAC

	Firearm	Cut/Pierce	Burn	MVT	Other	Total	Penetrating Cases*
Trauma Cases	411	434	411	1247		2503	845
Cases per 100,000 Residents	26	28	26	80	N/A	160	54
Share of Trauma	1.2%	1.2%	1.2%	3.5%		100.0%	N/A

Source: North Carolina Department of Health and Human Services. Data are for 2014. Other injury data were incompatible with other states' data—they included hospitalizations for disease and other non-trauma cases. Total includes first four categories.

* Penetrating cases are defined as firearm and cut/pierce cases. This definition represents a lower bound on the penetrating trauma, as it misses penetrating cases classified as MVT or Other (which are more commonly blunt trauma but can also involve penetrating traumatic injuries).

Like Womack, NH Camp Lejeune seems like an ideal candidate for a joint military-civilian trauma partnership. By working closely with the Level I facility in Greenville and the local community hospital, NH Camp Lejeune could help fill a gap in civilian trauma care. NH Camp Lejeune could also consider partnering with the local EMS system in Jacksonville, which has been stressed over the last few years as the number of medical transport companies has decreased from three to only one. Such partnerships could benefit both the military and the local civilian trauma system. In Section 6.A.2, we provide a further discussion of how this arrangement could work.

2. DoD Hospitals in California

Like North Carolina, California is also home to two of the DoD candidate facilities identified in Table 9—NMC San Diego and the David Grant USAF Medical Center. The trauma regulating system in the state of California is organized into five RACs, each responsible for trauma system oversight within its individual region. Figure 12 depicts county population as well as the location of the two DoD facilities and Level I, II, and III civilian trauma centers. The light blue lines highlight the relevant DoD market RACs.

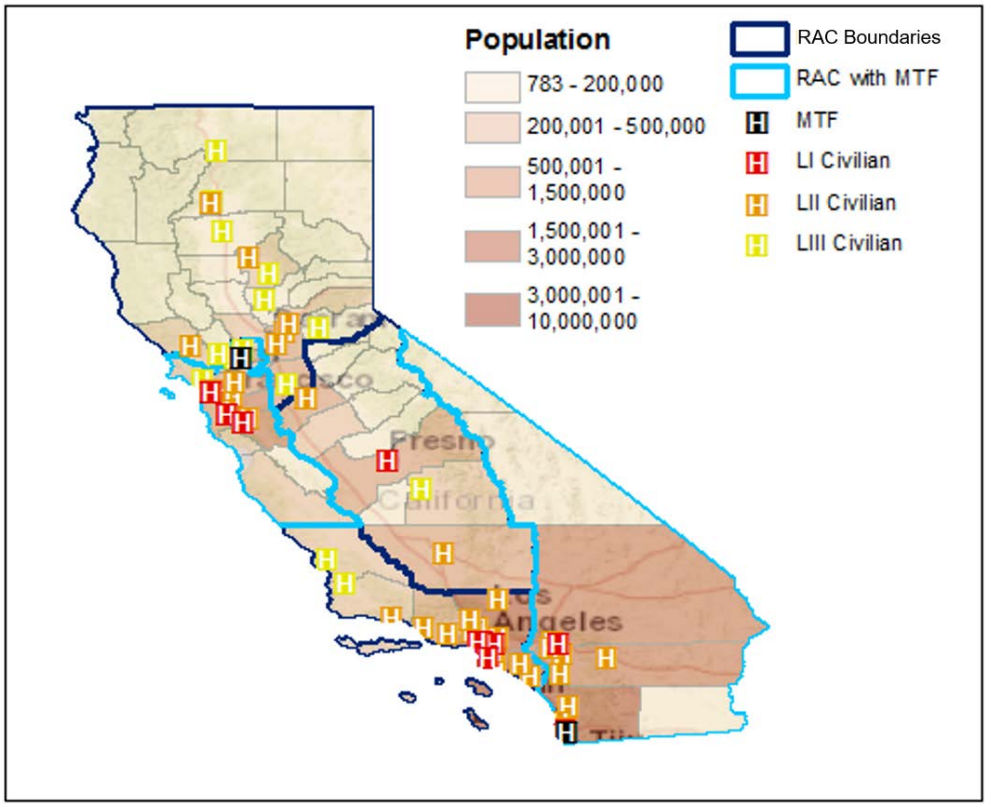

Figure 12. California Trauma System

The more populous areas in California (Los Angeles, San Diego, and the Bay Area) are home to a multitude of high-level trauma centers, while less populated areas have lower access to trauma care. Below we discuss the markets containing the candidate facilities in further detail.

a. Naval Medical Center San Diego, San Diego

NMC San Diego is the Navy's largest hospital. The hospital has 285 beds, 18 operating rooms, and an ADPL of 162 (a 57 percent capacity rate). In FY 2015, the facility had over 19,000 inpatient admissions, which included 26 civilian emergencies. Examining the inpatient workload using MS-DRG RWPs reveals that approximately 4 percent of the overall inpatient workload can be considered trauma care (6 percent of surgical and 2 percent of medical). The data are shown in Table 31.

Table 31. NMC San Diego Trauma Workload

Inpatient MS-DRG RWPs			
	Medical	**Surgical**	**Total**
Trauma	243	471	714
Total	9,772	7,824	17,596
Percent Trauma	2%	6%	4%

Source: M2 SIDR table, FY 2015.

The NMC is located in the South East California RAC, which includes the city of San Diego. San Diego's population is approximately 3.1 million, while the total RAC population is just over 7.5 million. Four Level I trauma centers serve the region; three are located in San Diego (University of California San Diego Health System, Scripps Mercy Hospital, and Rady Children's Hospital) while the fourth is located in Loma Linda (Loma Linda University Medical Center), approximately 100 miles north of San Diego. In addition to the Level I trauma centers, eleven Level II centers also serve the region (three in the San Diego area). The market area is shown in Figure 13.

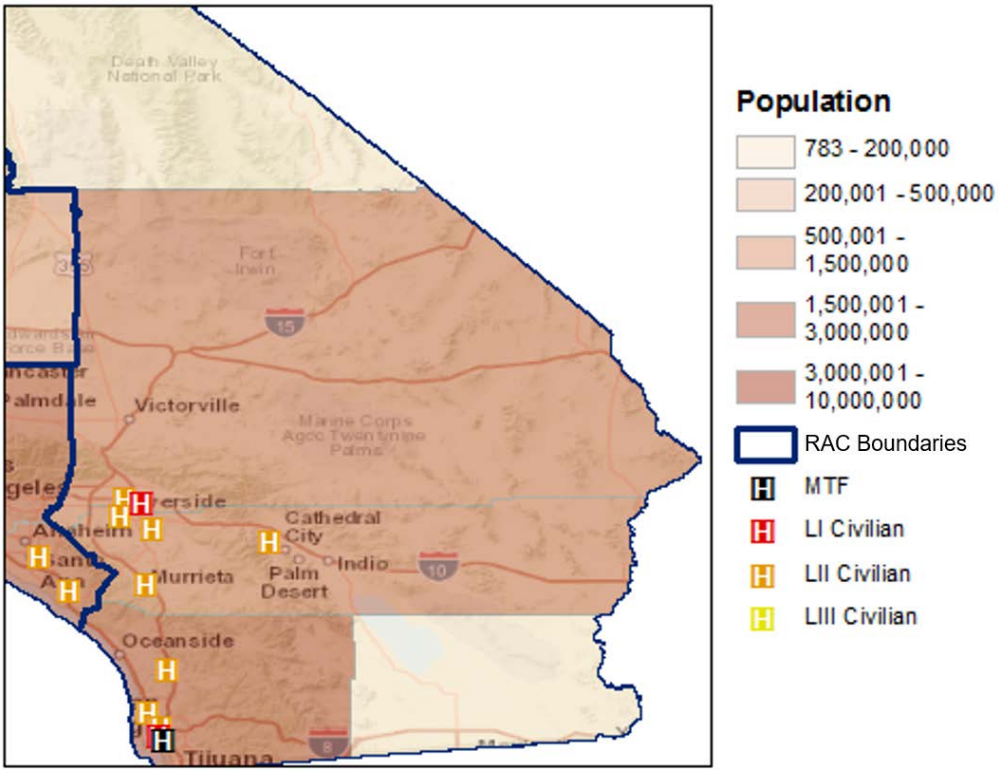

Figure 13. South East California RAC

The population figures indicate there are roughly 1.7 trauma centers per million residents in the South East California RAC and 1.9 per million residents in San Diego County.

Table 32. High-Level Trauma Centers per Million Residents

NMC San Diego	San Diego County	RAC
Number of Level I Trauma Centers	3	3
Number of Level II Trauma Centers	3	11
Population (in millions)	3.1	7.5
High-Level Trauma Centers Per Million	1.9	1.7

Note: Includes Pediatric Trauma Center.

Based on these data, the RAC seems well served in terms of trauma care. To evaluate whether the area might have a higher than average demand for trauma care, we present injury data in Table 33. While there were over 55,000 total cases reported, that does not correspond to a higher than average rate of trauma.

Table 33. Injury Data, South East California RAC

	Firearm	Cut/ Pierce	Burn	MVT	Other	Total	Penetrating Cases*
Trauma Cases	975	1,973	793	7,824	45,273	56,838	2,948
Cases per 100,000 Residents	13.0	26.2	10.5	104.0	601.4	755.1	39.2
Share of Trauma	1.7%	3.5%	1.4%	13.8%	79.7%	100.0%	5.2%

Source: California Department of Public Health, EpiCenter California Injury Data Online http://epicenter.cdph.ca.gov/ReportMenus/CustomTables.aspx; Data are for 2012.

* Penetrating cases are defined as firearm and cut/pierce cases. This definition represents a lower bound on the penetrating trauma, as it misses penetrating cases classified as MVT or Other (which are more commonly blunt trauma but can also involve penetrating traumatic injuries).

This suggests NMC San Diego should focus on creating partnerships with the local civilian trauma centers rather than attempting to become a stand-alone DoD trauma center. While NMC San Diego currently has several resident-level partnerships, there are no formal arrangements for currency maintenance programs. Given that there are six high-level trauma centers operating in the area, it is likely NMC San Diego could find one (or more) trauma partners if they offer the appropriate incentives to potential civilian partners.

b. David Grant USAF Medical Center, Fairfield

The David Grant USAF Medical Center is located at Travis Air Force Base (AFB) in Fairfield, California, which is in the Bay Area RAC. David Grant has 116 beds. The ADPL is 63 (a 55 percent capacity rate). In FY 2015, there were two civilian emergency hospitalizations. Table 34 shows the facility's inpatient workload measured in RWPs. The data indicate that approximately 3 percent of the overall inpatient workload is associated with trauma (4 percent of surgical and 2 percent of medical).

Table 34. David Grant Trauma Workload

	Inpatient MS-DRG RWPs		
	Medical	**Surgical**	**Total**
Trauma	72	159	231
Total	3,113	3,901	7,014
Percent Trauma	2%	4%	3%

Source: M2 SIDR table, FY 2015.

The surgical staff at David Grant includes general, orthopaedic, vascular, and oral and maxillofacial surgeons, but lacks other specialties, including trauma specialists, neurosurgeons, and cardiothoracic and colon/rectal surgeons. Residency programs are offered in internal medicine, family medicine, diagnostic radiology, general surgery/vascular surgery, OMFS, and Transitional Year.

Figure 14 provides an overview of the Bay Area RAC.

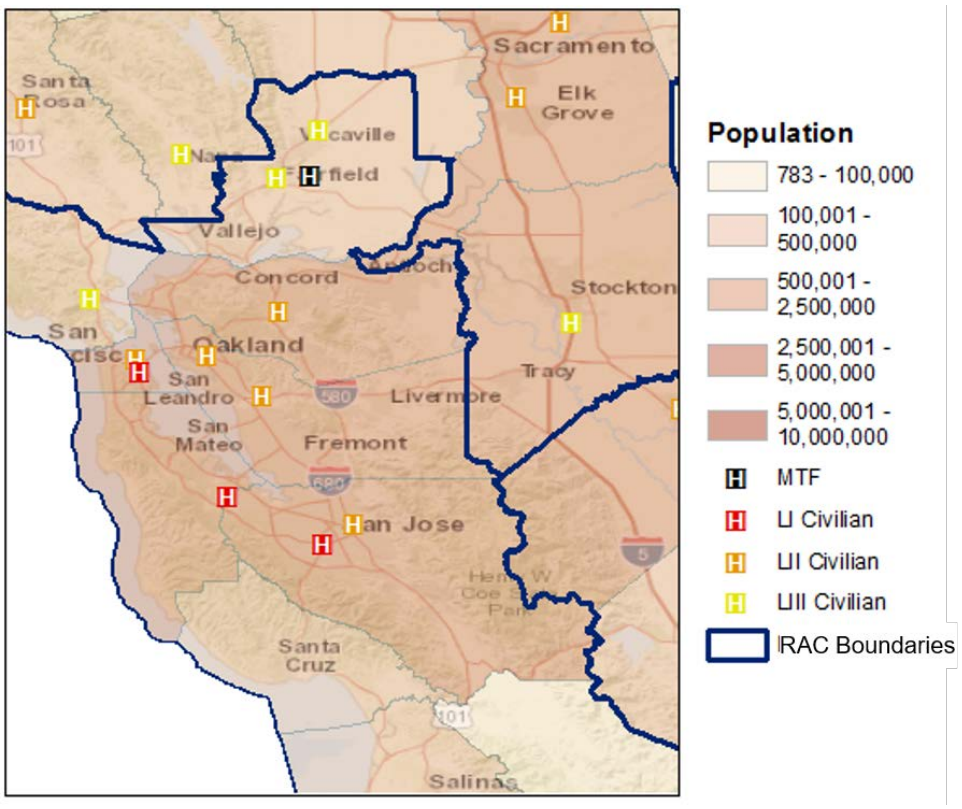

Figure 14. Bay Area RAC

Travis AFB is located in the northern part of the Bay Area RAC, which has approximately 7.3 million residents. Fairfield, the city in which Travis is located, has a population of approximately 108,000 and is the county seat of Solano County, which comprises the Vallejo-Fairfield MSA and has a total population of just over 400,000. Two Level III facilities are located within the county. Three Level I and four Level II trauma centers serve the RAC, but they are all located to the south, largely clustered around the larger population centers of San Francisco, Oakland, and San Jose. Applying the ACS guideline of up to two Level I or II trauma centers per million residents suggests the area is not overly saturated in terms of trauma care. From David Grant, the closest Level II center is the John Muir Medical Center just over 30 miles to the north. The nearest Level I center is over 50 miles away in San Francisco. The Northern California RAC, which borders the Bay Area RAC, has no Level I trauma center, although Level II and III centers are scattered up and down the I-5 corridor.

Table 35. High-Level Trauma Centers per Million Residents

David Grant (Bay Area RAC)	Bay Area RAC
Number of Level I Trauma Centers	3
Number of Level II Trauma Centers	4
Population	7.3
High-Level Trauma Centers Per Million	.96

Using the ACS guideline, it appears the region could potentially support another high-level trauma center. Given the presence of two civilian Level III facilities in the area surrounding Travis, a joint military-civilian trauma partnership might be a viable option. Table 36 shows the RAC's trauma volume, rate, and composition. It is similar to the trauma seen in the South East RAC.

Table 36. Injury Data, Bay Area RAC

	Firearm	Cut/ Pierce	Burn	MVT	Other	Total	Penetrating Cases*
Trauma Cases	1,099	1,236	506	5,383	38,270	46,494	2,335
Cases per 100,000 Residents	15.1	17.0	7.0	74.1	526.9	640.1	32.2
Share of Trauma	2.4%	2.7%	1.7%	11.6%	82.3%	100.0%	5.0%

Source: California Department of Public Health, EpiCenter California Injury Data Online http://epicenter.cdph.ca.gov/ReportMenus/CustomTables.aspx; Data are for 2012.

* Penetrating cases are defined as firearm and cut/pierce cases. This definition represents a lower bound on the penetrating trauma, as it misses penetrating cases classified as MVT or Other (which are more commonly blunt trauma but can also involve penetrating traumatic injuries).

Solano County, where Travis AFB is located, has a slightly higher rate of penetrating trauma than the overall RAC.

3. The Virginia Trauma System and Naval Medical Center Portsmouth, Portsmouth

NMC Portsmouth has 274 beds and an ADPL of 148 (an occupancy rate of approximately 54 percent). In FY 2015, the facility had over 16,000 inpatient admissions, including 65 civilian emergencies. Examining the inpatient workload using RWPs reveals that approximately 3 percent of the overall inpatient workload could be considered trauma care (4 percent of surgical and 2 percent of medical). The data are shown in Table 37.

Table 37. Trauma Workload NMC Portsmouth

Inpatient MS-DRG RWPs			
	Medical	**Surgical**	**Total**
Trauma	115	273	388
Total	7,428	6,940	14,368
Percent Trauma	2%	4%	3%

Source: M2 SIDR table, FY 2015.

The surgical staff at NMC Portsmouth includes all surgical specialties. The facility is also home to a large GME program and the Navy's largest and most comprehensive medical simulation center.

The Virginia trauma system is divided into 11 RACs. The city of Portsmouth is located in the Tidewater RAC in the southeast part of the state. As of the 2010 census, the city of Portsmouth had a population of approximately 95,000. Portsmouth and the nearby city of Norfolk had a combined population of just over 338,000, while the entire Tidewater RAC had a population of nearly 1.2 million. Two civilian trauma centers operate in the RAC. A third trauma center is also nearby in the neighboring Peninsula RAC, which serves approximately 600,000 residents. The market area is displayed in Figure 15.

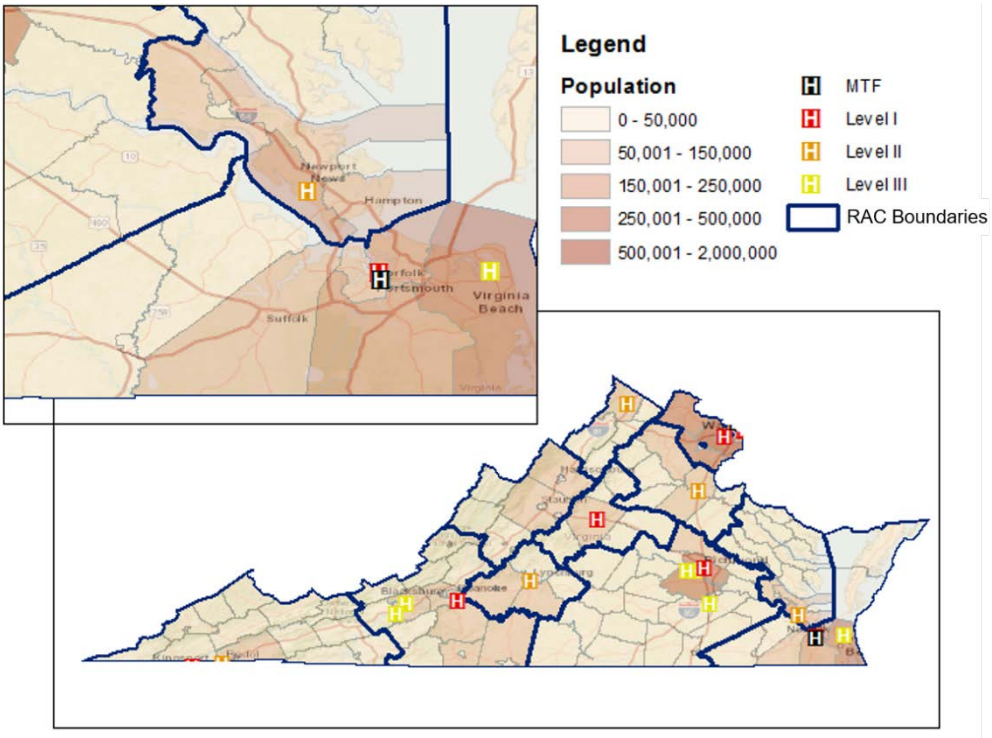

Figure 15. Virginia Trauma System and Tidewater RAC

Sentara Norfolk General Hospital is the closest civilian facility to NMC Portsmouth (approximately six miles away) and the Tidewater RAC's only Level I trauma center. The facility has 525 beds and serves as the primary teaching institution for Eastern Virginia Medical School. Sentara is also home to the Nightingale Regional Air Ambulance service, which provides medical transport services to critically ill and injured patients from all around the region. Sentara receives an average of 300 transfers a month from surrounding facilities. The second trauma center in the Tidewater RAC is Sentara Virginia Beach General, a 276-bed facility and the region's only Level III facility. It is located approximately 20 miles east of NMC Portsmouth. River Side Regional Medical Center is the third trauma center operating in the area, although it is in the Peninsula RAC, approximately 25 miles from NMC Portsmouth. This 450-bed facility with a Level II trauma capability is the only trauma center in the Peninsula RAC. Table 38 shows the number of high-level trauma centers per million residents.

Table 38. High-Level Trauma Centers per Million Residents

NMC Portsmouth	Portsmouth-Norfolk	Tidewater RAC
Number of Level I Trauma Centers	1	1
Number of Level II Trauma Centers	0	0
Population	.95	1.2
High-Level Trauma Centers Per Million	2.96	0.84

While the Portsmouth-Norfolk area appears somewhat saturated in terms of trauma care, the RAC as a whole could potentially support a greater trauma capability. To further investigate this possibility, we explore the area's trauma data. Table 39 shows data on the region's traumatic injuries.

Table 39. Injury Data, Tidewater RAC

	Firearm	Cut/ Pierce	Burn	MVT	Other	Total	Penetrating Cases*
Trauma Cases	313	72	108	838	4,063	5,394	385
Cases per 100,000 Residents	26.3	6.0	9.1	70.36	341.1	452.9	32.3
Share of Trauma	5.8%	1.3%	2.0%	15.5%	75.3%	100.0%	7.1%

Source: Virginia Department of Health http://www.vdh.virginia.gov/livewell/voirs/deathRates.aspx and http://www.vdh.virginia.gov/livewell/voirs/injuryrates.aspx; Data are for 2014.

* Penetrating cases are defined as firearm and cut/pierce cases. This definition represents a lower bound on the penetrating trauma, as it misses penetrating cases classified as MVT or Other (which are more commonly blunt trauma but can also involve penetrating traumatic injuries).

While the RAC's rate of trauma is not particularly high overall, there is a much higher than average rate of firearm injuries, offering greater opportunities for penetrating trauma workload.

4. The Hawaii Trauma System and Tripler Army Medical Center, Honolulu County

Tripler AMC is located on the island of Oahu, Hawaii's most populated island. Tripler has 194 beds. The ADPL is 134 (a 63 percent capacity rate). In FY 2015, there were 19 civilian emergency hospitalizations—a negligible percentage of total inpatient admissions. Table 40 shows the facility's inpatient workload measured in RWPs. The data indicate that approximately 5 percent of the overall inpatient workload is associated with trauma (2 percent of surgical and 8 percent of medical).

Table 40. Tripler Trauma Workload (RWPs)

	Inpatient MS-DRG RWPs		
	Medical	**Surgical**	**Total**
Trauma	144	459	603
Total	6,173	6,027	12,200
Percent Trauma	2%	8%	5%

Source: M2 SIDR table, FY 2015.

Nearly all surgical specialties are represented at Tripler (trauma specialists and colon/rectal surgeons are the exception). The facility also offers a large number of GME programs with residencies in diagnostic radiology, family medicine, general surgery, internal medicine, OB/GYN, orthopaedic surgery, otolaryngology, pediatrics, pharmacy, psychiatry, urology, and Transitional Year.

Tripler is located in Honolulu County, which includes the city of Honolulu and the remainder of the island of Oahu. The city and county of Honolulu have a population of just under 1 million. Figure 16 depicts the Hawaiian trauma system along with a closer look at the island of Oahu.

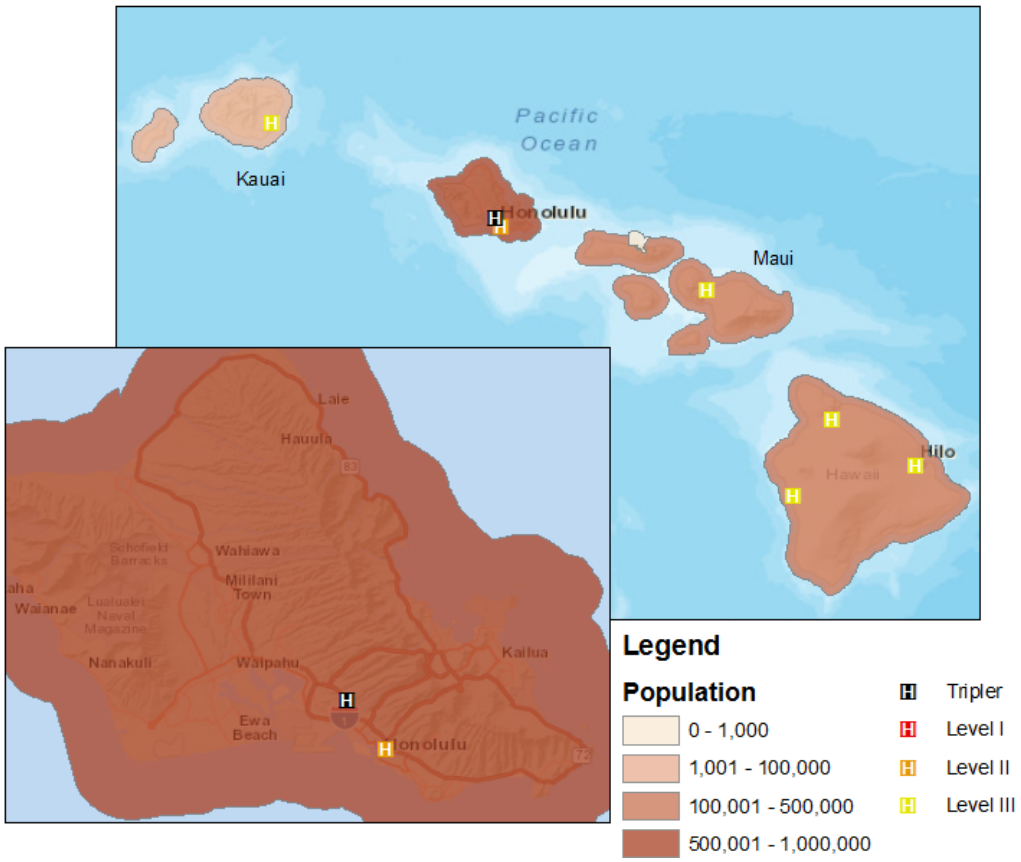

Figure 16. Hawaii and Honolulu Market Area

The Hawaii trauma system does not include any Level I facilities. The only Level II center in the state, Queens Medical Center, is located in Honolulu, approximately five miles southeast of Tripler. The island of Maui, with a population of just over 150,000, is served by a Level III trauma center, while the island of Hawai'i has three Level III centers to serve its population of 185,000. The island of Kauai, with a population of 67,000, also has a Level III trauma center. Table 41 shows the number of high-level trauma centers per million residents for the island of Oahu and the state of Hawaii.

Table 41. High-Level Trauma Centers per Million Residents

Hawaii	Oahu Only	All Islands
Number of Level I Trauma Centers	0	0
Number of Level II Trauma Centers	1	1
Population (in millions)	.95	1.4
High-Level Trauma Centers Per Million	1.05	0.74

The data indicate there may be enough workload to support another high-level trauma center in the Honolulu market area, especially considering it would receive patients from

all over Hawaii, since many islands do not have their own high-level center. However, injury data and discussions with experts revealed that the trauma caseload in Hawaii involves very little penetrating trauma. While there is more need for trauma care and certain surgical specialists, the demand is often located on the other islands. For example, discussions with state EMS officials revealed a shortage of orthopaedic surgeons in the state-especially on the smaller islands. Patients from these areas must be transported by air to the big island for treatment. One possible solution might involve having teams of military providers that could deploy to provide treatment to patients in their local market areas. In the past, the military did run a helicopter program for transporting patients, but it ended once OEF/OIF deployments began.

Table 42 provides data on the volume, rate, and composition of trauma cases in Hawaii.

Table 42. Injury Data, Hawaii (All Islands)

	Firearm	Cut/ Pierce	Burn	MVT	Other	Total	Penetrating Cases*
Trauma Cases	73	122	90	1,340	4,708	6,333	195
Cases per 100,000 Residents	5.4	9.0	6.6	98.5	346.1	465.6	14.3
Share of Trauma	1.2%	1.9%	1.4%	21.2%	74.3%	100.0%	3.1%

Source: Death data came from the Hawaii Health Data Warehouse, while hospitalization data came from the Hawaii Health Information Corporation. Both are for year 2015.

* Penetrating cases are defined as firearm and cut/pierce cases. This definition represents a lower bound on the penetrating trauma, as it misses penetrating cases classified as MVT or Other (which are more commonly blunt trauma but can also involve penetrating traumatic injuries).

5. The Georgia Trauma System and Eisenhower Army Medical Center, Fort Gordon

Eisenhower AMC is located at Fort Gordon near the city of Augusta, Georgia. The facility is currently one of the smallest medical centers, with only 107 beds. The ADPL is approximately 63, corresponding to an occupancy rate of 59 percent. In FY 2015, only eight civilian emergency cases were treated on base. Table 43 shows Eisenhower's inpatient workload measured in RWPs. The data indicate that approximately 3 percent of the overall inpatient workload is associated with trauma (3 percent of surgical and 2 percent of medical). The volume of trauma workload, measured in MS-DRG RWPs, is similar to the volume seen at Carl Darnall.

Table 43. Eisenhower AMC Trauma Workload

Inpatient MS-DRG RWPs			
	Medical	**Surgical**	**Total**
Trauma	46	101	147
Total	2,622	2,921	5,543
Percent Trauma	2%	3%	3%

Source: M2 SIDR table, FY 2015.

The surgical staff at Eisenhower includes general, orthopaedic, vascular, and oral and maxillofacial surgeons, but lacks other specialties, including trauma specialists, neurosurgeons, and colon/rectal surgeons. The residency programs offered at Eisenhower include family medicine, internal medicine, general surgery, OMFS, orthopaedic surgery, and Transitional Year. A simulation center is also present at Eisenhower for medical training.

The Georgia trauma system is divided into 10 regional trauma advisory committees (RTACs). Eisenhower is located in RTAC VI, which includes the city of Augusta. The city of Augusta has a population of just under 200,000, while the entire RTAC has a population of just over 460,000. Figure 17 shows an overview of the Georgia trauma system and RTAC VI.

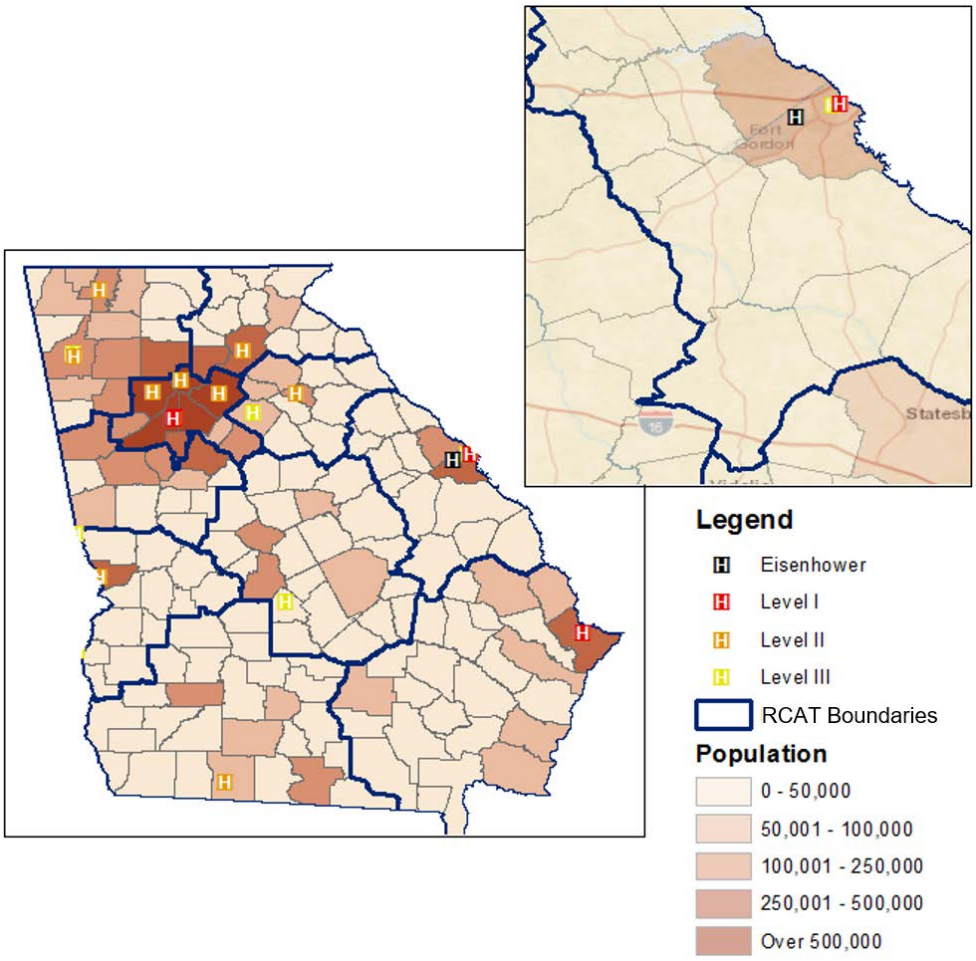

Figure 17. Georgia Trauma System and Eisenhower Market Area

There are two civilian trauma centers in the area—a 408-bed Level I facility, Georgia Regents Medical Center, and a 231-bed Level III facility, Trinity Hospital of Augusta. Given that the RTAC has a population of under 500,000 people, it seems unlikely that Eisenhower could increase its role as a provider of civilian trauma care. Trauma partnerships with local civilian facilities, however, may be possible.

Table 44. High-Level Trauma Centers per Million Residents

Eisenhower (RTAC VI)	
Number of Level I Trauma Centers	1
Number of Level II Trauma Centers	0
Population (in millions)	.46
High-Level Trauma Centers Per Million	2.17

Table 45 shows the data on traumatic injuries for the area. We were unable to obtain the injury data by the same E-code-based injury mechanisms that are presented for the

other states. The Georgia data had some injury mechanisms data but was largely reported by intent (accidental/homicide/suicide). Here we report “Accidental Firearm” injuries and “Homicide/Suicide” injuries rather than “firearm” and “cut/pierce.” The remaining categories are roughly equivalent.

Table 45. Injury Data, RTAC VI

	Firearm Accident	Homicide/ Suicide	Burn	MVC	Other	Total	Penetrating Cases
Trauma Cases	16	359	59	384	1,605	2,423	NA
Cases per 100,000 Residents	3.5	79.0	13.0	84.5	353.3	533.3	NA
Share of Trauma	0.7%	14.8%	2.4%	15.9%	66.2%	100.0%	NA

Source: Georgia Department of Public Health's Data Warehouse https://oasis.state.ga.us/. Data are Mortality and Hospital Discharges for 2015. Instead of usual Firearm, Cut/Pierce, and Burn, we have Accidental Shooting, Homicide/Suicide, and Smoke and Fire Exposure to mean 'Burn.' 'MVC' is equivalent to 'MVT' here but does not have other blunt trauma included.

6. Market Assessments

We now discuss which option—(1) stand-alone DoD trauma center investment or (2) joint military-civilian trauma center investment—seems best suited to each of the markets reviewed in the previous section, given the relevant market condition. Because there are no current joint military-civilian trauma centers, we begin with two case studies that illustrate how such arrangements might take shape. SAMMC, which was discussed in detail in Section 5.A.1.a, serves as our case study for a stand-alone DoD trauma center.

Following the joint military-civilian trauma case studies, we present our market assessments. A summary table is used to review each market's relevant data and indicate which option ((1) stand-alone DoD trauma center investment or (2) joint military-civilian trauma center investment) seems preferable. Some markets are recommended for more than one option. After presenting our summary assessments we attempt to estimate how much the MHS workload gap could be reduced if the recommendations were implemented.

A. Select Case Studies: Joint Military-Civilian Trauma Centers

Joint military-civilian trauma centers will likely take different forms depending on their local market circumstances. In some cases, the military may partner with large Level I or II medical centers while in other cases, partnerships with smaller Level III or even non-trauma-designated hospitals may be more advantageous. We use the North Carolina (NC) markets to illustrate how such partnerships might be structured in two different markets. The IDA team traveled to the NC market and met with representatives from the civilian and military facilities discussed below. However, the partnership options described below are still meant to be illustrative and should not be considered final market recommendations. Many details and challenges would have to be worked out prior to their formation.

1. Womack Army Medical Center, Fayetteville, NC

The Womack overview, beginning on page 65, highlighted an existing mutually beneficial arrangement between Womack and CFVMC and the potential for larger military-civilian trauma partnership. When looking at the population, trauma data, and civilian trauma infrastructure in the Fayetteville area, it appears there is likely enough trauma workload to support a Level II capability. Given that CFVMC is much larger than Womack (over 800 beds versus 156) and already a state-designated Level III facility, it would make more sense for Womack to combine their resources with CFVMC to form a

joint trauma venture than to pursue their own trauma capability and compete with a larger, more established facility.

Once created, the new joint trauma center at CFVMC would generally take responsibility for trauma cases occurring within its catchment area—the same region that CFVMC currently serves—but the goal would be to retain a larger number of severely injured patients than was possible before. The most severe trauma cases that required a higher level of care would still be transferred to UNC, Duke, or WakeMed. Figure 18 illustrates the potential catchment area that the joint trauma center might serve.

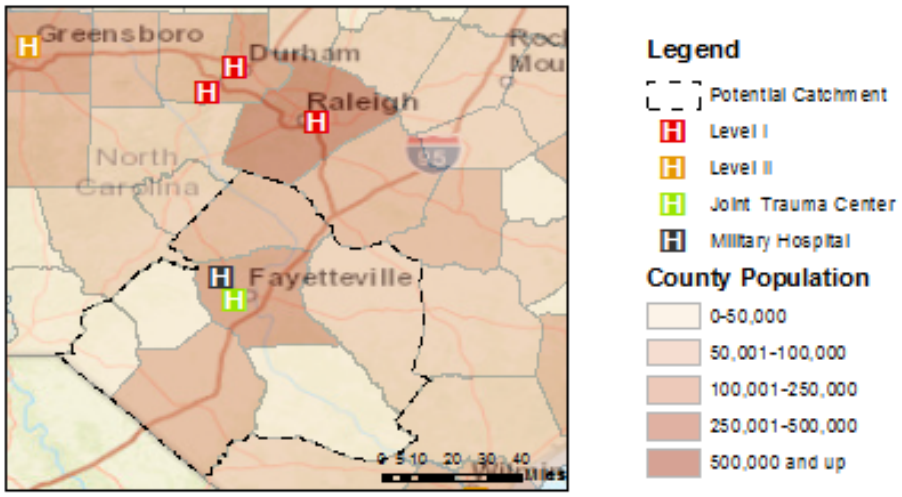

Figure 18. Womack AMC-Cape Fear Valley Potential Catchment Area

The partnership could take on multiple forms, including a jointly administered trauma center or a lesser arrangement under which DoD would provide military personnel to work at CFVMC.

a. Jointly Administered Trauma Center

Under this option, Womack and CFVMC would combine resources to form a joint trauma venture—the "Cape Fear/Womack Trauma Center." The CFVMC would serve as the main campus for the new venture (one reason being that the state of NC currently will not designate trauma centers behind gates).[66] In the joint facility, teams of military providers would work side-by-side with CFVMC personnel delivering trauma care. The infusion of military personnel in key specialties would allow CFVMC to expand their trauma capabilities and to retain a larger number of the area's civilian trauma cases. For instance, CFVMC noted that they have a need for OMFS and often have to transfer these cases to UNC or other Level I facilities. Womack, just few miles away, has OMFS

[66] Under current NC state law, facilities located behind gates (i.e., military installations) may not be state-designated trauma centers. It may be possible to seek legislative relief from this stipulation.

specialists and an OMFS residency program. By teaming up, the military providers would gain better access to complex cases and the local civilian trauma system would see its capabilities grow. By having the center jointly administered, the military could play a role in setting the schedule and determining how its providers would be used. For example, military personnel could be responsible for manning the ED several days a week. On those days, teams of military providers (i.e., surgeons, critical care nurses, nurse anesthetists, and medics) would work together on any trauma cases that came through the door.

This type of arrangement could also include DoD making capital investments in CFVMC and combining additional programs such as education and training (e.g., residency). During a visit to Womack, the leadership indicated that it planned to expand Womack's residency programs and hire additional civilian physicians to assist in maintaining these programs. But with low-volume challenges already at the facility, it is difficult to understand how this would work. Partnering with a high-volume facility like CFVMC could provide a more economical way to expand residency programs (better training and lower cost).

Ultimately, this sort of resource sharing should result in a stronger overall trauma system. The new joint trauma center at CFVMC, for instance, could be upgraded from a Level III trauma facility to a Level II facility. There would obviously be many important programmatic details that would need to be worked out between the Army and CFVMC in order for such a venture to succeed.

b. DoD Provides Personnel to CFVMC

Under this option, Womack would provide several providers or teams of providers to CFVMC. These personnel might work at CFVMC once or twice a week, or rotate through for a few months at a time. A standing arrangement could be put in place between the two facilities that would make it easier for military providers to obtain the necessary hospital privileges and malpractice coverage they would need to work at CFVMC.

2. Naval Hospital Camp Lejeune, Jacksonville, NC

The Camp Lejeune market overview demonstrated that the Jacksonville area was underserved in terms of trauma care and that there was a strong potential for this gap to be addressed through a joint military-civilian trauma partnership. Here, we discuss how such a partnership might work. When looking at the population and trauma case data for the area surrounding Camp Lejeune, it appears that the area could sustain a Level III or perhaps even a Level II trauma center if it partnered closely with Vidant to ensure enough workload for certain specialists (e.g., neurosurgeons, vascular surgeons). The new trauma center could work with Vidant to establish a catchment area within the Eastern RAC—such as Onslow County and the five adjacent counties. Once established, the trauma center in Onslow would generally take responsibility for trauma cases occurring within its catchment

area. The most severe trauma cases that required a higher level of care would be transferred to Vidant. Figure 19 illustrates the potential catchment area that the Onslow-Camp Lejeune trauma center might serve.

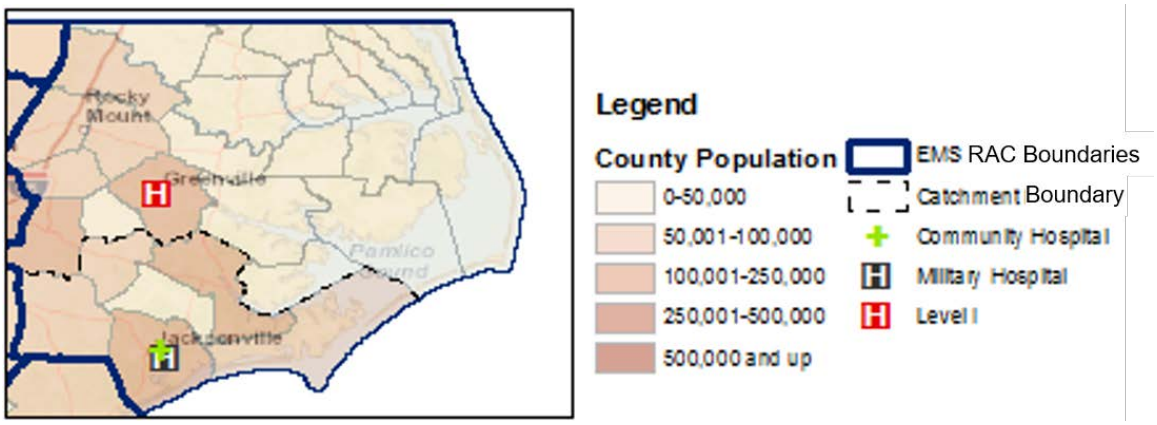

Figure 19. Camp Lejeune-Onslow County Trauma Center Potential Catchment Area

Under this division, just over 475,000 people would reside in the new trauma center's catchment area (below the dashed line), leaving over 925,000 in the remaining region of the Eastern RAC. A difficulty is that the new center would likely need to capture the large majority of its catchment's emergency/trauma workload (military, civilian, and veteran) to ensure enough volume to sustain itself. This workload should probably not be split across two facilities (Onslow Memorial and the NH) as it currently is. Partnering with the local facility to ensure the right case volume is met is therefore likely to be crucial. Several arrangements could be possible. Below we outline three options. We also discuss how Camp Lejeune could play a role in the local EMS system.

a. Trauma Center at Camp Lejeune

One approach would be for Camp Lejeune to pursue trauma designation for the NH on base. Under this scenario, the NH would be the Level III trauma center responsible for trauma patients in the catchment area. They would need to work closely with Onslow Memorial and Vidant to develop a patient regulating system in which the area's severe trauma patients would be taken to Camp Lejeune, while more minor injuries were regulated to Onslow. While the most severely injured patients might still have to be transferred to Vidant for tertiary care, as a designated Level III or Level II trauma center, Camp Lejeune would have a higher trauma capability than the local community hospital and could therefore retain a larger share of the local trauma cases. Once patients had undergone the lifesaving surgical care they required and were in stable condition, Camp Lejeune would work closely with Onslow to ensure follow-on care was arranged in the community. Providers from Camp Lejeune could also do rotations at Vidant to gain experience in the Level I trauma setting. Providers from Onslow and Vidant might also spend time working

at Camp Lejeune to help maintain 24-hour coverage of certain specialties and to create knowledge spillovers. Camp Lejeune might also work to build joint GME programs with Vidant.

One concern with this model would be ensuring the local community hospital was not negatively affected by having the NH take the more serious emergency cases. Another concern would be getting patients on base. As previously mentioned, the state of North Carolina will not currently designate a trauma center located behind gates. This could be overcome by building a separate entrance to the hospital and gating it off from the rest of the base or by seeking legislative relief.

b. Trauma Center at Onslow Memorial

An alternative arrangement might be to expand Onslow's trauma capability by creating a joint military-civilian trauma center at Onslow. In this case, Onslow would become a Level III or Level II trauma center—the "Camp Lejeune-Onslow Memorial Trauma Center"—and the Navy would embed teams of providers to work in the joint facility. This would be similar to the partnership between CFVMC and Womack discussed previously. The main difference would be that Onslow is a smaller hospital than CFVMC and may require new infrastructure or renovation to become a trauma center. One advantage of the Onslow Memorial location is that it would avoid the obstacles that would have to be overcome with respect to security and access issues associated with having a trauma center behind gates in North Carolina.

c. Rotating Trauma Call Duty

A third option might be to rotate trauma call duty between Onslow Memorial and the NH in a manner similar to the Tacoma Trauma Trust partnership described in Section 5.A.3. Under this arrangement, both facilities would have to be designated as Level III trauma facilities, which may not be optimal in this area.

d. Military-Civilian EMS Systems

Prehospital care and patient transport is a critical aspect of combat casualty care and should thus be an important focus area for readiness training. Today EMS services on military installations are delivered through a variety of models. At some installations, military personnel still deliver EMS, but at others, EMS is delivered by the fire department, contracts with civilian EMS companies, or through local volunteer organizations often under the leadership of the fire department.[67] The movement towards outsourcing EMS services has largely been efficiency driven—many bases do not have the volume of

[67] Robert A. De Lorenzo, Julio Lairet, and Jerry L. Mothershead, Section B, Chapter 25, "Military EMS Systems," 307–318, University of Pittsburgh, http://emergencymedicine.pitt.edu/sites/default/files/2_B_25_307-318_unlocked.pdf.

emergency calls necessary to warrant their own service and civilian EMS infrastructure can accommodate the demand. Partnering with civilian EMS providers may therefore be an ideal arrangement, as it would provide training for military personnel without requiring DoD to have to run its own EMS system. However, such partnerships are not always welcomed by civilian organizations—typically due to unionized labor forces.[68] This is not the case in Onslow County, where the local EMS system, Onslow County Emergency Medical Services (OCEMS), is a volunteer-based service. Two other private ambulance companies previously operated in the region but they have since closed, leaving the area somewhat underserved. OCEMS receives over 16,000 emergency calls per year and has nine advanced life support ambulances.[69] Partnerships in which military personnel work with the local EMS system could fill the county's EMS shortage and provide readiness training.

B. Summary Assessments

SAMMC provides a model of what a stand-alone DoD trauma center should look like. Similarly, the case studies provided above were meant to demonstrate how joint military-civilian trauma arrangements might take shape. We now revisit each of our 12 candidate facilities and present summary assessments of which facilities seem better suited to each option. The assessments are presented in Table 46, which includes data on the three investment criteria identified in Section 3.C.2: (1) facility size and volume (bed count and ADPL); (2) the market's trauma demand (population, trauma cases, and penetrating trauma rate); (3) and the market's trauma supply (number of trauma centers and ratio of trauma centers per million). Comments on each market and final recommendations are also presented. The recommendations include an indication of which option the facility is best suited for—a stand-alone (SA) DoD trauma center or a joint military-civilian (JMC) trauma center—and the trauma center level (i.e., whether would the DoD trauma center or joint trauma center would operate as a Level II or a Level I facility). We also rank facilities into three tiers that indicate the strength of their candidacy for trauma investment. Tier 1 facilities are the facilities we believe are the strongest candidates to become stand-alone or joint military-civilian trauma centers and the facilities that could help fill gaps in the civilian trauma infrastructure. These facilities might also serve well as pilots or test models on which additional trauma investments could be modeled. Tier 2 facilities are also strong candidates with fairly clear opportunities and partners. Tier 3 facilities could also be

[68] For instance, Christine Eibner, in *Maintaining Military Medical Skills During Peacetime*, surveyed civilian organizations about their willingness to use military medical personnel and generally found very positive responses. The exception was a fire department that felt it would be unfeasible to station DoD personnel with the EMS team on a permanent basis due to labor unions and other personnel matters. They did support ride-along training programs.

[69] "Emergency Medical Services," Onslow County, NC website, http://www.onslowcountync.gov /793/Emergency-Medical-Services.

candidates for partnerships but they are generally smaller facilities in more crowded trauma markets with smaller populations making the potential gains to the military or civilian population smaller.

Table 46. Summary Assessment

		Facility Size and Volume		Trauma Demand Factors (by RAC)	Trauma Supply Factors (by RAC) # of High-Level Trauma Centers			
Tier	Facility Name	Beds (ADPL)	Surgical Workload Classified Trauma	Population (Trauma Cases/ %penetrating)	Count	Per Million	Comments	SA or JMC Trauma Center
NA	San Antonio MMC (LI)	425 (254)	27%	2.4 mil (14,228/7%)	2	1.42	Facility provides model case for stand-alone DoD trauma center	SA-LI
1	NH Camp Lejeune	117 (47)	10%	1.4 mil (35,292/ 2%)	1	0.71	Lacking civilian infrastructure makes Lejeune a strong candidate for trauma capability investment.	JMC-LII
	Womack AMC	156 (79)	11%	915 K (21,233/2%)	1	1.09	The presence of a busy civilian trauma center with provider shortages makes this an ideal partnership market.	JMC-LII
	Madigan AMC (LII)	227 (130)	7%	1.2 mil (10,363/3%)	2	1.6	Madigan is currently part of the Tacoma Trauma Trust Partnership but does not currently treat many civilian trauma cases. If civilian partners were willing to let SAMMC take over some of the civilian trauma care (that they currently require a partnership to treat), Madigan may be able to reach Level I status. Otherwise a Level I partnership could be formed.	SA/JMC-LI

		Facility Size and Volume		Trauma Demand Factors (by RAC)	Trauma Supply Factors (by RAC) # of High-Level Trauma Centers			
Tier	Facility Name	Beds (ADPL)	Surgical Workload Classified Trauma	Population (Trauma Cases/ %penetrating)	Count	Per Million	Comments	SA or JMC Trauma Center
2	David Grant USAF Medical Center	116 (63)	4%	7.3 mil (46,494/5%)	7	0.96	The Solano County area is not saturated in terms of trauma care. The nearest high-level facility is 30 miles away. Partnering with a busy Level III such as North Bay may present a strong opportunity.	JMC-LII
	Tripler AMC	194 (134)	8%	1.4 mil (6,333/3.1%)	1	1.05*	While there does appear to be a need for additional trauma care in HI, the demand is spread across multiple islands and is largely blunt trauma. This, combined with the close proximity of Queens Medical Center, suggests partnerships may be more advantageous. Alternatively, Tripler may be able to gain Level II status if they used a model that involved sending their providers out to the different islands where trauma care is scarcer.	SA/JMC-LI/II

		Facility Size and Volume		Trauma Demand Factors (by RAC)	Trauma Supply Factors (by RAC) # of High-Level Trauma Centers			
Tier	Facility Name	Beds (ADPL)	Surgical Workload Classified Trauma	Population (Trauma Cases/ %penetrating)	Count	Per Million	Comments	SA or JMC Trauma Center
	Walter Reed National MMC (LII)	247 (168)	7%	2.2 mil (2,932/10%)	3	1.38	The state of Maryland has strict regulations on the number of trauma facilities that may operate in a region to ensure appropriate volume requirements. SA status may therefore be too difficult to achieve.	JMC-LII
2	NMC San Diego	285 (162)	6%	7.5 mil (56,838/5%)	11	1.73	NMC San Diego is located in a very saturated trauma market. It is unlikely they could bring more trauma workload into their facility. Partnering with a local civilian trauma center would be preferable.	JMC-LI
	NMC Portsmouth	274 (148)	4%	1.9 mil (5,394/7%)	1	2.94 (city) .84 (RAC)	NMC Portsmouth is also in a crowded market; partnering would be a good option in this market - especially given high rate of penetrating trauma.	JMC-LI

		Facility Size and Volume		Trauma Demand Factors (by RAC)	Trauma Supply Factors (by RAC) # of High-Level Trauma Centers			
Tier	Facility Name	Beds (ADPL)	Surgical Workload Classified Trauma	Population (Trauma Cases/ %penetrating)	Count	Per Million	Comments	SA or JMC Trauma Center
3	Dwight D. Eisenhower AMC	107 (63)	3%	461 K (2,423/NA)	1	2.17	Low population and presence of civilian facility make this market better for partnership options.	JMC-LI
	Carl R. Darnall AMC (LIII)	109 (62)	6%	444 K (2,579/9%)	1	2.25	Low population and presence of civilian facility make this market better for partnership options.	JMC-LII
	William Beaumont AMC (LIII)	209 (71)	6%	807 K (3,919/7%)	2	2.48	William Beaumont is in a fairly crowded trauma market. The facility is unique in that it already has a joint GME program.	JMC-LII

C. Workload Gap Improvement

Chapter 2 of this report identified workload gaps by provider specialty using two workload benchmarks developed from SAMMC data: an EMC-based benchmark and a major trauma-based benchmark. To better understand how creating stand-alone DoD trauma centers or joint military-civilian trauma centers would affect these workload gaps, we conduct several analytical excursions based on a range of assumptions about the number of trauma centers or joint military-civilian trauma centers DoD could form and the number of providers these arrangements could support.

The analysis is based on the assumption that each partnership or stand-alone DoD facility would have enough trauma workload to support its providers with trauma workload at the same level that SAMMC currently achieves. To illustrate this concept, Table 47 shows an example using the orthopaedic surgery specialty. The first column of the table shows the number of orthopaedic surgeons at SAMMC and each of our 11 candidate facilities measured in FTEs. The second column shows the number that are supported with trauma workload using the major trauma benchmark developed in Chapter 2. The third column shows the percentage of providers supported (supported providers over FTEs) for each facility. SAMMC's percentage is 55 percent, which is greater than all but one of the candidate facilities. In the fourth column, we show how many orthopaedic surgeons each facility could support if they achieved the same 55 percent support rate that SAMMC currently achieves. The analysis indicates that these 11 facilities currently employ 82 orthopaedic surgeons but that there is currently only enough trauma workload to support 21 of them (using the major trauma benchmark). However, if each of these facilities could achieve the 55 percent support rate observed at SAMMC, 45 could be supported.

Table 47. Orthopaedic Surgery Example (Major Trauma)

	FTE	Supported	Percent Supported	Supported (at SAMMC level)
SAMMC	26.5	14.7	55%	N/A
60th Med Grp-Travis	2.0	0.4	18%	1.1
NMC San Diego	19.3	4.6	24%	10.7
Eisenhower AMC	7.2	4.3	59%	4.0
Tripler AMC	2.4	0.7	29%	1.3
Walter Reed NMMC	18.6	5.9	32%	10.3
Womack AMC	4.0	0.4	10%	2.2
NH Camp Lejeune	6.0	0.4	6%	3.3
William Beaumont AMC	6.6	1.0	15%	3.6
Darnall AMC	4.0	0.4	10%	2.2
NMC Portsmouth	8.0	1.4	18%	4.4
Madigan AMC	4.8	1.6	33%	2.6
Total	**82.8**	**21.0**	**25%**	**45.8**

Using this methodology, we compute the workload gap improvement across the MHS under two excursions, each containing several alternative scenarios. In the first excursion, we assume DoD invests in either a subset of, or all of, the 11 candidate facilities, so that their current providers will be supported by trauma workload at the same level as the providers at SAMMC. The remaining MTFs are unchanged. The specific scenarios are:

- DoD invests in only the Tier 1 candidates so that they have enough workload to support their surgical providers at the same level as SAMMC
- DoD invests in the Tier 1 and Tier 2 candidates so that they have enough workload to support their surgical providers at the same level as SAMMC
- DoD invests in all 11 candidates (Tiers 1, 2, and 3) so that they have enough workload to support their surgical providers at the same level as SAMMC

For each of these scenarios, we report the current gap in supported providers, the gap that would exist if the set of facilities under consideration could support their surgical specialists with trauma care at the same rate as SAMMC, the resulting gain in supported providers, and the new share of supported providers. Results are presented at the MHS level rather than by specialty type and facility. We perform the analysis using both the EMC and major trauma benchmarks. Results are presented in Table 48.

Table 48. Workload Gap Improvement by Facility Tier

Tier	Current Gap	New Gap	Gain in Supported Providers	Percentage of MHS Providers Supported
EMC-Based Benchmark				
1	557.6	541.8	15.8	16.6%
1 & 2	557.6	486.8	70.8	25.0%
1, 2, & 3	557.6	476.5	81.1	26.6%
Major Trauma-Based Benchmark				
1	605.3	580.1	25.3	31.2%
1 & 2	605.3	485.4	119.9	42.4%
1, 2, & 3	605.3	471.3	134.0	44.1%

Using the EMC benchmark, our estimates indicate that investing in the selected facilities so that they could support their providers at the same level as SAMMC would close the supported provider gap by 15 to 80 providers depending on how many facilities were upgraded. Similarly, using the major trauma benchmark, our estimates indicate that investing in the selected facilities so that they could support their providers at the same level at SAMMC would close the supported provider gap by 25 to 134.

In the second excursion, we assume that DoD chooses to invest in all 11 facilities (Tier 1, 2, and 3 facilities) and that the investments not only allow each facility to achieve support for their surgical specialists at the same rate as SAMMC, but that they also allow the facilities to support additional providers. Surgical specialists from the remaining MTFs would be reallocated to the larger DoD trauma centers that now require more providers. We then consider the scenarios where our 11 candidate facilities are able to support 5, 10, or 15 percent more of each surgical specialty. Results are presented in Table 49.

Table 49. Workload Gap Improvement by Provider Increase

Provider Increase	Current Gap	New Gap	Gain in Supported Providers	Percentage of MHS Providers Supported
EMC-Based Benchmark				
5%	557.6	473.2	84.4	27.1%
10%	557.6	469.8	87.8	27.6%
15%	557.6	466.5	91.1	28.2%
Major Trauma-Based Benchmark				
5%	605.3	466.4	138.9	44.7%
10%	605.3	461.4	143.9	45.3%
15%	605.3	456.4	148.9	45.9%

Using the EMC benchmark, the percentage of MHS providers supported would increase from the 14 percent baseline (i.e., the current percentage of providers supported by EMC workload) to between 27 and 28 percent. Likewise, using the major trauma benchmark, the percentage of MHS providers supported would increase from 28 percent to between 45 and 46 percent.

7. Supplementary Actions

In the preceding chapters, we discussed the predominant options for addressing readiness-related workload gaps. In this chapter, we briefly discuss two supplemental, if unconventional, actions DoD could consider to enhance the availability of operationally ready medical providers. These actions are not meant to be alternatives to the options discussed in the preceding chapters; rather, they could be used in conjunction with them.

The first action we consider could be deemed a "surgical team" approach. It would be modeled along the lines of the Sponsored Reserves (SR) concept[70] currently in place in the United Kingdom (UK), although not used by the UK in a medical context. Sponsored Reserves are a category of reserve forces in the UK that allows for certain support or specialist tasks to be carried out by trained civilian professionals under contract with a participating employer. The government contracts for services on condition the contractor retains individuals in their workforce who have volunteered to become members of a reserve force that can be activated at the government's discretion. Members of the SRs can be mobilized to meet operational requirements at any time and have no legal right to refuse deployment. Though serving as civilians, they are nevertheless subject to military doctrine and rules of conduct. Some examples of the use of SRs in the UK are the Royal Fleet Auxiliary, which supplies the Royal Navy with fuel, ammunition, and supplies at sea; the Mobile Meteorological Unit, which provides meteorological and environmental support to deployed elements of the UK's joint forces; and the British Army's Heavy Equipment Transporter program, which provides for tanks to be moved to destinations around the globe. A more recent development is the Joint Cyber Reserve, which recruits civilian experts for defending the UK against cyberwarfare attacks.

There is precedent in the United States for a program along the lines of the SR. Called the Civil Reserve Air Fleet (CRAF), the program, in existence since 1951, is a collaborative effort between the DOT, DoD, and the civil air carrier industry to augment DoD aircraft capability during a national defense-related crisis. In return for volunteering their aircraft to the CRAF program through contractual agreements with the Air Force's Air Mobility Command (including aeromedical evacuation), the participating carriers are given preference in carrying commercial peacetime cargo and passenger traffic for DoD.

Although the SR concept has not been applied to medical personnel, it might be worthwhile for DoD to consider contracting with civilian hospitals to constitute a

[70] The UK Defence Forum, Fact Sheet 56, "Sponsored Reserves," November 12, 2010. http://www.ukdf.org.uk/assets/downloads/FS56Sponsoredreserves.pdf.

deployable surgical team. The team, including clinicians, nurses, technicians, etc., would work together on a daily basis as civilians but could be called to active duty at any time and deploy as a group. Because participating civilian hospitals would be contractually bound to supply the surgical team when called up, the contract would need to include financial benefits for the hospitals to offset that loss. Although an SR surgical team could be deployed in any context, their best use may be under surge conditions at the beginning of a conflict, as they have already worked together as a group and could "hit the ground running" immediately after deployment.

The other option we consider is the National Language Service Corps (NLSC) model, which is more of an individual, rather than a team, approach. The NLSC consists of volunteers who offer their language skills to support federal agencies, particularly during surge conditions that occur during times of crisis or urgent national need. In the medical context, such a model could possibly be used to backfill DoD hospitals, allowing longer deployments of Active Duty and Reserve personnel. A drawback to this approach is that individuals are not contractually obligated to offer their services when needed. However, that issue could possibly be rectified by tying financial incentives to a commitment to serve.

8. Conclusions

The MHS currently lacks the case volume and mix required to sustain the skills of a subset of providers whose readiness is crucial to the combat casualty care mission. This subset of providers includes surgical specialists (trauma surgeons, general surgeons, orthopaedic surgeons, vascular surgeons, etc.) and other providers of critical care such as the critical care nurses, operating room nurses, nurse anesthetists, and medics who work together with the surgeons to save life and limb. In the past, the lack of readiness workload has been illustrated by highlighting the mismatch in the diagnoses and procedures performed in theater with those seen in garrison. This analysis, which developed a methodology for quantifying the extent of the workload shortage facing surgical providers, found that the MHS's inpatient platforms can currently support only 14 percent of its surgical providers with EMC workload and 28 percent with major trauma workload.

While the workload gap appears large, there are means to address it. The primary avenue for closing the workload gap is to increase DoD's role in the civilian trauma system, thereby tapping into the trauma workload generated by a much larger patient base. We considered three strategies through which DoD could achieve this goal: (1) upgrading DoD medical centers to DoD trauma centers that treat civilian trauma cases, (2) forming joint military-civilian trauma centers, and (3) sending DoD providers to work in busy civilian trauma centers. Our analysis found that the optimal path for the MHS will probably be to employ a mix of those strategies and that a careful assessment of each market area is needed to determine the best market-specific approach.

While the market overviews and assessments presented in analysis were performed at a high level and should therefore not be taken as final recommendations, they do provide a useful framework for evaluating markets. For instance, they revealed that only a few MTFs would be strong candidates for becoming large DoD trauma centers based on local demand for trauma care and the current trauma care supply. They also demonstrated the potential for mutually beneficial military-civilian joint trauma partnerships in several markets. Finally, based on our market assessments, we were able to create a rough estimate of the extent to which new DoD trauma centers and joint military-civilian trauma centers may be able to close the workload gap. Specifically, we found that DoD could increase the percentage of its surgical providers supported by EMC workload from 14 percent to nearly 30 percent if DoD invested in all Tier 1, 2, and 3 facilities—potentially more if DoD chose to reallocate providers from smaller MTFs to those facilities. When using the major trauma benchmark, we found the percentage of providers supported could increase from 28 percent to nearly 45 percent. While we estimate these investments would approximately double the

percentage of providers supported by EMC or major trauma workload across the MHS inpatient platforms, a sizeable gap would still remain. That gap could be addressed through the third option—sending DoD providers to work in civilian-run trauma centers.

Each option considered in this analysis offered several benefits but also presented challenges. We reviewed these challenges and found that none seemed insurmountable. Most of them, such as the challenges associated with licensing, credentialing, and malpractice, have already been addressed through one or more local TAA- or MOA-type agreements. Interviews with civilian EMS personnel and civilian trauma centers/hospitals in the DoD markets considered also demonstrated a general willingness of the civilian trauma system to form further partnerships with DoD.

Appendix A.
Mapping of EMCs and Major Trauma Procedures into KSA Domains

Table A-1 displays the list of EMCs and major trauma (MT) procedures used in our analyses. For economy of space, we assigned numerical values to each Knowledge, Skills, and Abilities (KSA) category as indicated in Figure A-1. In some cases, a procedure can be mapped into more than one KSA, as shown in the final three columns of Table A-1.

Wound & Amputation /Fx Mgt	Head and Spine Injury	Torso Trauma
1. Management of War Wounds	7. Cervical and TL Spine Injury	12. Pelvic Fracture Care
2. Compartment Syndrome and Fasciotomy	8. Concussion / mTBI Management	13. Blunt Abdominal Trauma
3. Amputation	9. Neurosurgical Management	14. Damage Control Surgery (ABD)
4. Burn Care	10. Cervical Spine Evaluation	15. Damage Control Surgery (Chest)
5. High Bilateral Amputations	11. Management of Severe Head Injury	16. Damage Control Surgery (Neck)
6. Additional Extremities		17. Thoracic Trauma
		18. Wartime Vascular Injury
Transfusion and Resuscitation	**Airway and Breathing**	**Critical Care/Prevention**
19. Frozen Blood	25. Trauma Airway Management	29. Hypothermia Prevention
20. Damage Control Resuscitation	26. Acute Respiratory Failure	30. Prevention of Venous Thromboembolism
21. Fresh Whole Blood	27. Trauma Anesthesia	31. Catastrophic Care
22. Inj Doc Resus Record	28. Inhalational Injury	32. Infection Control
23. REBOA for Hemorrhagic Shock		33. Management of Pain/Anxiety/Delerium
24. Emergency Thoracotomy		34. Critical Care additional
Military Other	**Universal Domains**	**Emergency War Surgery**
35. UXO Management	44. Systems Based Practice	48. EWS Amputation
36. TCCC/ Prehospital Care	45. Practice Based Learning and Improvement	49. EWS Hands and Foot
37. EPW & Detainee Care	46. Interpersonal and Communication Skills	50. EWS OBGYN Emergencies
38. Pediatric Trauma	47. Professionalism	51. EWS Extremity Fractures
39. Intratheater Transport		
40. Clinical Mgt of Mil Working Dogs		
41. Initial Care of occular/adnexal injuries		
42. Joint Trauma System		
43. Urologic Trauma		

Figure A-1. KSAs and Numerical Values

Table A-1. EMCs and Major Trauma Procedures

ICD-9 Code	Description	EMC	MT	Category	KSA 1	KSA 2	KSA 3
0118	Other diagnostic procedures on brain and cerebral meninges	Y	Y	Major Diagnostic	9	11	
0123	Reopening of craniotomy site	N	Y	Major Therapeutic	9	11	
0124	Other craniotomy	Y	Y	Major Therapeutic	9	11	
0125	Other craniectomy	Y	Y	Major Therapeutic	9	11	
0131	Incision of cerebral meninges	Y	Y	Major Therapeutic	9	11	
0139	Other incision of brain	Y	Y	Major Therapeutic	9	11	
0153	Lobectomy of brain	Y	Y	Major Therapeutic	9		
0202	Elevation of skull fracture fragments	Y	Y	Major Therapeutic	9	11	
0203	Formation of cranial bone flap	Y	Y	Major Therapeutic	9	11	
0205	Insertion of skull plate	N	Y	Major Therapeutic	9	11	
0206	Other cranial osteoplasty	Y	Y	Major Therapeutic	9	11	
0211	Simple suture of dura mater of brain	N	Y	Major Therapeutic	9	11	
0212	Other repair of cerebral meninges	Y	Y	Major Therapeutic	9	11	
0221	Insertion or replacement of external ventricular drain	Y	Y	Major Therapeutic	9	11	34
0222	Intracranial ventricular shunt or anastomosis	Y	Y	Major Therapeutic	9	11	
0309	Other exploration and decompression of spinal canal	N	Y	Major Therapeutic	7	9	10
0353	Repair of vertebral fracture	N	Y	Major Therapeutic	7	9	
043	Suture of cranial and peripheral nerves	N	Y	Major Therapeutic	9		
0443	Release of carpal tunnel	N	Y	Major Therapeutic	9		
0609	Other incision of thyroid field	Y	Y	Major Therapeutic	16	18	25
0851	Canthotomy	Y	Y	Major Therapeutic	41		
0852	Blepharorrhaphy	N	Y	Major Therapeutic	41	1	
0870	Reconstruction of eyelid, not otherwise specified	N	Y	Major Therapeutic	41	1	
0874	Other reconstruction of eyelid, full-thickness	N	Y	Major Therapeutic	41	1	

ICD-9 Code	Description	EMC	MT	Category	KSA 1	KSA 2	KSA 3
1609	Other orbitotomy	N	Y	Major Therapeutic	41		
1631	Removal of ocular contents with synchronous implant into scleral shell	N	Y	Major Therapeutic	41	1	
1642	Enucleation of eyeball with other synchronous implant	Y	N	Major Therapeutic	41	1	
1649	Other enucleation of eyeball	Y	N	Major Therapeutic	41	1	
1669	Other secondary procedures after removal of eyeball	N	Y	Major Therapeutic	41	1	
1682	Repair of rupture of eyeball	N	Y	Major Therapeutic	41	1	
1689	Other repair of injury of eyeball or orbit	Y	Y	Major Therapeutic	41	1	
1879	Other plastic repair of external ear	N	Y	Major Therapeutic	1		
2172	Open reduction of nasal fracture	N	Y	Major Therapeutic	N/A		
2759	Other plastic repair of mouth	N	Y	Major Therapeutic	1		
2761	Suture of laceration of palate	N	Y	Major Therapeutic	1		
3129	Other permanent tracheostomy	N	Y	Major Therapeutic	25		
3161	Suture of laceration of larynx	N	Y	Major Therapeutic	1	25	
3171	Suture of laceration of trachea	N	Y	Major Therapeutic	1	25	
3174	Revision of tracheostomy	N	Y	Major Therapeutic	25		
3229	Other local excision or destruction of lesion or tissue of lung	Y	N	Major Therapeutic	17		
3239	Other and unspecified segmental resection of lung	Y	Y	Major Therapeutic	17		
3249	Other lobectomy of lung	Y	N	Major Therapeutic	17		
3343	Closure of laceration of lung	Y	Y	Major Therapeutic	17		
3402	Exploratory thoracotomy	Y	Y	Major Therapeutic	15	17	
3421	Transpleural thoracoscopy	N	Y	Major Diagnostic	17		
344	Excision or destruction of lesion of chest wall	N	Y	Major Therapeutic	N/A	-	-
3452	Thoracoscopic decortication of lung	N	Y	Major Therapeutic	17		
3479	Other repair of chest wall	N	Y	Major Therapeutic	17		

ICD-9 Code	Description	EMC	MT	Category	KSA 1	KSA 2	KSA 3
3482	Suture of laceration of diaphragm	Y	Y	Major Therapeutic	17		
3484	Other repair of diaphragm	Y	Y	Major Therapeutic	17		
3609	Other removal of coronary artery obstruction	N	Y	Major Therapeutic	N/A	-	-
3699	Other operations on vessels of heart	N	Y	Major Therapeutic	17		
3712	Pericardiotomy	Y	Y	Major Therapeutic	17		
3749	Other repair of heart and pericardium	Y	Y	Major Therapeutic	17		
3791	Open chest cardiac massage	Y	Y	Major Therapeutic	15	17	24
3795	Implantation of automatic cardioverter/defibrillator lead(s) only	N	Y	Major Therapeutic	N/A	-	-
3803	Incision of vessel, upper limb vessels	N	Y	Major Therapeutic	6	18	22
3808	Incision of vessel, lower limb arteries	N	Y	Major Therapeutic	6	18	22
3838	Resection of vessel with anastomosis, lower limb arteries	N	Y	Major Therapeutic	6	18	22
387	Interruption of the vena cava	N	Y	Major Therapeutic	13	14	18
3880	Other surgical occlusion of vessels, unspecified site	Y	Y	Major Therapeutic	18	22	
3882	Other surgical occlusion of vessels, other vessels of head and neck	Y	N	Major Therapeutic	18	22	
3883	Other surgical occlusion of vessels, upper limb vessels	Y	N	Major Therapeutic	6	18	22
3884	Other surgical occlusion of vessels, aorta, abdominal	Y	N	Major Therapeutic	14	18	22
3885	Other surgical occlusion of vessels, thoracic vessels	Y	N	Major Therapeutic	17	18	22
3886	Other surgical occlusion of vessels, abdominal arteries	Y	Y	Major Therapeutic	14	18	22
3887	Other surgical occlusion of vessels, abdominal veins	Y	N	Major Therapeutic	12	14	22
3888	Other surgical occlusion of vessels, lower limb arteries	Y	Y	Major Therapeutic	6	18	22
3889	Other surgical occlusion of vessels, lower limb veins	Y	N	Major Therapeutic	6	18	22
3929	Other (peripheral) vascular shunt or bypass	Y	Y	Major Therapeutic	18	22	
3931	Suture of artery	Y	Y	Major Therapeutic	18	22	
3932	Suture of vein	N	Y	Major Therapeutic	18	22	

ICD-9 Code	Description	EMC	MT	Category	KSA 1	KSA 2	KSA 3
3950	Angioplasty of other non-coronary vessel(s)	N	Y	Major Therapeutic	18	22	
3956	Repair of blood vessel with tissue patch graft	Y	N	Major Therapeutic	18	22	
3957	Repair of blood vessel with synthetic patch graft	N	Y	Major Therapeutic	18	22	
3958	Repair of blood vessel with unspecified type of patch graft	N	Y	Major Therapeutic	18	22	
3959	Other repair of vessel	N	Y	Major Therapeutic	18	22	
3971	Endovascular implantation of other graft in abdominal aorta	N	Y	Major Therapeutic	18	22	
3973	Endovascular implantation of graft in thoracic aorta	N	Y	Major Therapeutic	18	22	
3978	Endovascular implantation of branching or fenestrated graft(s) in aorta	N	Y	Major Therapeutic	18	22	
3979	Other endovascular procedures on other vessels	N	Y	Major Therapeutic	18	22	
3998	Control of hemorrhage, not otherwise specified	Y	Y	Major Therapeutic	18	22	
3999	Other operations on vessels	N	Y	Major Therapeutic	18	22	
415	Total splenectomy	Y	Y	Major Therapeutic	20	22	
4195	Repair and plastic operations on spleen	N	Y	Major Therapeutic	13		
4199	Other operations on spleen	N	Y	Major Therapeutic	13	14	
4439	Other gastroenterostomy without gastrectomy	N	Y	Major Therapeutic	13		
4461	Suture of laceration of stomach	Y	N	Major Therapeutic	13	14	
4501	Incision of duodenum	N	Y	Major Therapeutic	13		
4503	Incision of large intestine	N	Y	Major Therapeutic	13		
4551	Isolation of segment of small intestine	N	Y	Major Therapeutic	13	14	
4561	Multiple segmental resection of small intestine	Y	N	Major Therapeutic	13	14	
4562	Other partial resection of small intestine	Y	Y	Major Therapeutic	13	14	
4573	Open and other right hemicolectomy	Y	Y	Major Therapeutic	13	14	
4574	Open and other resection of transverse colon	Y	Y	Major Therapeutic	13	14	
4575	Open and other left hemicolectomy	Y	Y	Major Therapeutic	13	14	

ICD-9 Code	Description	EMC	MT	Category	KSA 1	KSA 2	KSA 3
4576	Open and other sigmoidectomy	Y	Y	Major Therapeutic	13	14	
4579	Other and unspecified partial excision of large intestine	Y	Y	Major Therapeutic	13	14	
4582	Open total intra-abdominal colectomy	N	Y	Major Therapeutic	13		
4590	Intestinal anastomosis, not otherwise specified	N	Y	Major Therapeutic	13		
4591	Small-to-small intestinal anastomosis	Y	Y	Major Therapeutic	13		
4592	Anastomosis of small intestine to rectal stump	N	Y	Major Therapeutic	13		
4593	Other small-to-large intestinal anastomosis	Y	Y	Major Therapeutic	13		
4594	Large-to-large intestinal anastomosis	N	Y	Major Therapeutic	13	14	
4603	Exteriorization of large intestine	N	Y	Major Therapeutic	13		
4610	Colostomy, not otherwise specified	Y	Y	Major Therapeutic	13		
4613	Permanent colostomy	N	Y	Major Therapeutic	13		
4620	Ileostomy, not otherwise specified	N	Y	Major Therapeutic	13		
4673	Suture of laceration of small intestine, except duodenum	Y	Y	Major Therapeutic	13		
4675	Suture of laceration of large intestine	Y	Y	Major Therapeutic	13		
4679	Other repair of intestine	N	Y	Major Therapeutic	13		
5022	Partial hepatectomy	Y	Y	Major Therapeutic	13		
5061	Closure of laceration of liver	Y	Y	Major Therapeutic	13		
5122	Cholecystectomy	N	Y	Major Therapeutic	13		
5252	Distal pancreatectomy	N	Y	Major Therapeutic	13		
5375	Repair of diaphragmatic hernia, abdominal approach, not otherwise specified	N	Y	Major Therapeutic	13		
540	Incision of abdominal wall	Y	N	Major Therapeutic	12	13	14
5411	Exploratory laparotomy	Y	Y	Major Therapeutic	12	13	14
5412	Reopening of recent laparotomy site	Y	Y	Major Therapeutic	12	13	14
5419	Other laparotomy	N	Y	Major Therapeutic	12	13	14

ICD-9 Code	Description	EMC	MT	Category	KSA 1	KSA 2	KSA 3
5421	Laparoscopy	N	Y	Major Diagnostic	13		
5459	Other lysis of peritoneal adhesions	N	Y	Major Therapeutic	N/A		
5462	Delayed closure of granulating abdominal wound	Y	Y	Major Therapeutic	1	13	14
5463	Other suture of abdominal wall	Y	Y	Major Therapeutic	12	13	14
5472	Other repair of abdominal wall	N	Y	Major Therapeutic	1	13	14
5475	Other repair of mesentery	N	Y	Major Therapeutic	13		
5492	Removal of foreign body from peritoneal cavity	N	Y	Major Therapeutic	13	14	
554	Partial nephrectomy	N	Y	Major Therapeutic	13	43	
5551	Nephroureterectomy	Y	Y	Major Therapeutic	13	43	
5718	Other suprapubic cystostomy	Y	N	Major Therapeutic	12	43	
5781	Suture of laceration of bladder	Y	Y	Major Therapeutic	12	13	
5789	Other repair of bladder	N	Y	Major Therapeutic	12	13	
7665	Segmental osteoplasty [osteotomy] of maxilla	N	Y	Major Therapeutic	1		
7672	Open reduction of malar and zygomatic fracture	N	Y	Major Therapeutic	1		
7674	Open reduction of maxillary fracture	N	Y	Major Therapeutic	1		
7676	Open reduction of mandibular fracture	N	Y	Major Therapeutic	1		
7679	Other open reduction of facial fracture	N	Y	Major Therapeutic	1		
7692	Insertion of synthetic implant in facial bone	N	Y	Major Therapeutic	1		
7715	Other incision of bone without division, femur	N	Y	Major Therapeutic	1		
7768	Local excision of lesion or tissue of bone, tarsals and metatarsals	N	Y	Major Therapeutic	N/A		
7769	Local excision of lesion or tissue of bone, other bones	N	Y	Major Therapeutic	N/A		
7770	Excision of bone for graft, unspecified site	N	Y	Major Therapeutic	51		
7779	Excision of bone for graft, other bones	N	Y	Major Therapeutic	51		

ICD-9 Code	Description	EMC	MT	Category	KSA 1	KSA 2	KSA 3
7791	Total ostectomy, scapula, clavicle, and thorax [ribs and sternum]	N	Y	Major Therapeutic	17		
7812	Application of external fixator device, humerus	Y	N	Major Therapeutic	51		
7813	Application of external fixator device, radius and ulna	N	Y	Major Therapeutic	51		
7815	Application of external fixator device, femur	Y	Y	Major Therapeutic	51		
7816	Application of external fixator device, patella	N	Y	Major Therapeutic	51		
7817	Application of external fixator device, tibia and fibula	Y	Y	Major Therapeutic	51		
7819	Application of external fixator device, other bones	N	Y	Major Therapeutic	51		
7845	Other repair or plastic operations on bone, femur	N	Y	Major Therapeutic	51		
7854	Internal fixation of bone without fracture reduction, carpals and metacarpals	N	Y	Major Therapeutic	49	51	
7855	Internal fixation of bone without fracture reduction, femur	N	Y	Major Therapeutic	51		
7857	Internal fixation of bone without fracture reduction, tibia and fibula	N	Y	Major Therapeutic	51		
7859	Internal fixation of bone without fracture reduction, other bones	Y	Y	Major Therapeutic	51		
7863	Removal of implanted devices from bone, radius and ulna	N	Y	Major Therapeutic	51		
7865	Removal of implanted devices from bone, femur	N	Y	Major Therapeutic	51		
7867	Removal of implanted devices from bone, tibia and fibula	N	Y	Major Therapeutic	51		
7911	Closed reduction of fracture with internal fixation, humerus	N	Y	Major Therapeutic	51		
7912	Closed reduction of fracture with internal fixation, radius and ulna	N	Y	Major Therapeutic	51		
7913	Closed reduction of fracture with internal fixation, carpals and metacarpals	N	Y	Major Therapeutic	49	51	
7914	Closed reduction of fracture with internal fixation, phalanges of hand	N	Y	Major Therapeutic	49	51	

ICD-9 Code	Description	EMC	MT	Category	KSA 1	KSA 2	KSA 3
7915	Closed reduction of fracture with internal fixation, femur	N	Y	Major Therapeutic	51		
7916	Closed reduction of fracture with internal fixation, tibia and fibula	N	Y	Major Therapeutic	51		
7919	Closed reduction of fracture with internal fixation, other specified bone	N	Y	Major Therapeutic	51		
7925	Open reduction of fracture without internal fixation, femur	N	Y	Major Therapeutic	51		
7926	Open reduction of fracture without internal fixation, tibia and fibula	N	Y	Major Therapeutic	51		
7931	Open reduction of fracture with internal fixation, humerus	Y	Y	Major Therapeutic	51		
7932	Open reduction of fracture with internal fixation, radius and ulna	Y	Y	Major Therapeutic	51		
7933	Open reduction of fracture with internal fixation, carpals and metacarpals	N	Y	Major Therapeutic	49	51	
7935	Open reduction of fracture with internal fixation, femur	N	Y	Major Therapeutic	49	51	
7936	Open reduction of fracture with internal fixation, tibia and fibula	Y	Y	Major Therapeutic	51		
7939	Open reduction of fracture with internal fixation, other specified bone	Y	Y	Major Therapeutic	51		
7961	Debridement of open fracture site, humerus	Y	Y	Major Therapeutic	51		
7962	Debridement of open fracture site, radius and ulna	Y	Y	Major Therapeutic	51		
7963	Debridement of open fracture site, carpals and metacarpals	Y	N	Major Therapeutic	51	49	
7964	Debridement of open fracture site, phalanges of hand	Y	N	Major Therapeutic	51	49	
7965	Debridement of open fracture site, femur	Y	Y	Major Therapeutic	51		
7966	Debridement of open fracture site, tibia and fibula	Y	Y	Major Therapeutic	51		
7967	Debridement of open fracture site, tarsals and metatarsals	Y	N	Major Therapeutic	51	49	
7969	Debridement of open fracture site, other specified bone	Y	Y	Major Therapeutic	51		

ICD-9 Code	Description	EMC	MT	Category	KSA 1	KSA 2	KSA 3
7989	Open reduction of dislocation of other specified sites	N	Y	Major Therapeutic	51		
8016	Other arthrotomy, knee	Y	N	Major Therapeutic	51		
8051	Excision of intervertebral disc	N	Y	Major Therapeutic	7		
8082	Other local excision or destruction of lesion of joint, elbow	N	Y	Major Therapeutic	51		
8086	Other local excision or destruction of lesion of joint, knee	N	Y	Major Therapeutic	51		
8099	Other excision of joint, other specified sites	N	Y	Major Therapeutic	51		
8100	Spinal fusion, not otherwise specified	N	Y	Major Therapeutic	7		
8101	Atlas-axis spinal fusion	N	Y	Major Therapeutic	7		
8102	Other cervical fusion of the anterior column, anterior technique	N	Y	Major Therapeutic	7		
8103	Other cervical fusion of the posterior column, posterior technique	N	Y	Major Therapeutic	7		
8105	Dorsal and dorsolumbar fusion of the posterior column, posterior technique	N	Y	Major Therapeutic	7		
8106	Lumbar and lumbosacral fusion of the anterior column, anterior technique	N	Y	Major Therapeutic	7		
8107	Lumbar and lumbosacral fusion of the posterior column, posterior technique	N	Y	Major Therapeutic	7		
8108	Lumbar and lumbosacral fusion of the anterior column, posterior technique	N	Y	Major Therapeutic	7		
8145	Other repair of the cruciate ligaments	N	Y	Major Therapeutic	N/A		
8149	Other repair of ankle	N	Y	Major Therapeutic	51		
8152	Partial hip replacement	N	Y	Major Therapeutic	N/A		
8162	Fusion or refusion of 2-3 vertebrae	N	Y	Major Therapeutic	7		
8163	Fusion or refusion of 4-8 vertebrae	N	Y	Major Therapeutic	7		
8164	Fusion or refusion of 9 or more vertebrae	N	Y	Major Therapeutic	7		

ICD-9 Code	Description	EMC	MT	Category	KSA 1	KSA 2	KSA 3
8165	Percutaneous vertebroplasty	N	Y	Major Therapeutic	7		
8166	Percutaneous vertebral augmentation	N	Y	Major Therapeutic	7		
8175	Arthroplasty of carpocarpal or carpometacarpal joint without implant	N	Y	Major Therapeutic	49		
8309	Other incision of soft tissue	Y	Y	Major Therapeutic	1		
8314	Fasciotomy	Y	Y	Major Therapeutic	1	2	
8344	Other fasciectomy	N	Y	Major Therapeutic	1		
8345	Other myectomy	Y	Y	Major Therapeutic	1		
8364	Other suture of tendon	N	Y	Major Therapeutic	1	49	
8365	Other suture of muscle or fascia	Y	Y	Major Therapeutic	1		
8382	Graft of muscle or fascia	N	Y	Major Therapeutic	1		
8388	Other plastic operations on tendon	N	Y	Major Therapeutic	1	49	
8401	Amputation and disarticulation of finger	Y	Y	Major Therapeutic	3	6	
8415	Other amputation below knee	Y	N	Major Therapeutic	3	6	
8416	Disarticulation of knee	N	Y	Major Therapeutic	3		
8417	Amputation above knee	Y	Y	Major Therapeutic	3	5	6
843	Revision of amputation stump	Y	Y	Major Therapeutic	1	6	
8459	Insertion of other spinal devices	N	Y	Major Therapeutic	7		
8622	Excisional debridement of wound, infection, or burn	Y	Y	Major Therapeutic	1	4	
8662	Other skin graft to hand	N	Y	Major Therapeutic	1	4	
8663	Full-thickness skin graft to other sites	N	Y	Major Therapeutic	1	4	
8665	Heterograft to skin	N	Y	Major Therapeutic	1	4	
8666	Homograft to skin	N	Y	Major Therapeutic	1	4	
8669	Other skin graft to other sites	Y	Y	Major Therapeutic	1	4	
8670	Pedicle or flap graft, not otherwise specified	N	Y	Major Therapeutic	1		

ICD-9 Code	Description	EMC	MT	Category	KSA 1	KSA 2	KSA 3
8674	Attachment of pedicle or flap graft to other sites	N	Y	Major Therapeutic	1		
9504	Eye examination under anesthesia	Y	N	Major Diagnostic	41		

Illustrations

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Abbreviations

ACGME	Accreditation Council for Graduate Medical Education
ACH	Army Community Hospital
ACS	American College of Surgeons
ADPL	Average Daily Patient Load
AFB	Air Force Base
AMC	Army Medical Center
ASD(HA)	Assistant Secretary of Defense for Health Affairs
ATTC	Army Trauma Training Center
CAPE	Cost Assessment and Program Evaluation
CCATT	Critical Care Air Transport Team
CFI	Center for the Intrepid
CFVMC	Cape Fear Valley Medical Center
CME	Continuing Medical Education
CNA	Center for Naval Analyses
CPT	Current Procedural Terminology
CRAF	Civil Reserve Air Fleet
CRNA	Certified Registered Nurse Anesthetist
C-STARS	Centers for the Sustainment of Trauma and Readiness Skills
DHS	Department of Homeland Security
DoD	Department of Defense
DOT	Department of Transportation
ED	Emergency Department
EMC	Essential Medical Capability
EMS	Emergency Medical Services
FRSS	Forward Resuscitating Surgical Suite
FST	Forward Surgical Team
FTCA	Federal Tort Claims Act
FTE	Full-Time Equivalent
FY	Fiscal Year
GME	Graduate Medical Education
HHS	Department of Health and Human Services
HIPAA	Health Insurance Portability and Accountability Act
HRSA	Health Resources and Services Administration
ICD-9-CM	International Classification of Diseases, Ninth Revision, Clinical Modification

ICDPIC	ICD Programs for Injury Categorization
IDA	Institute for Defense Analyses
ISS	Injury Severity Score
JMC	Joint Military-Civilian
KSA	Knowledge, Skills, and Abilities
M2	MHS Management Analysis and Reporting Tool
MCRMC	Military Compensation and Retirement Modernization Commission
MDR	MHS Data Repository
MHS	Military Health System
MIEMSS	Maryland Institute for EMS Systems
MMC	Military Medical Center
MOA	Memorandum of Agreement
MOU	Memorandum of Understanding
MSA	Metropolitan Statistical Area
MS-DRG	Medicare Severity Diagnosis Related Group
MT	Major Trauma
MTF	Military Treatment Facility
MVT	Motor Vehicle Traffic
NAS	National Academies of Sciences, Engineering, and Medicine
NDAA	National Defense Authorization Act
NH	Naval Hospital
NHTSA	National Highway and Traffic Safety Administration
NLSC	National Language Service Corps
NMC	Naval Medical Center
NMMC	National Military Medical Center
NPI	National Provider Identifier
NSP	National Sample Program
NTDB	National Trauma Data Bank
NTTC	Navy Trauma Training Center
OB/GYN	Obstetrics/Gynecology
OCEMS	Onslow County Emergency Medical Services
OEF	Operation Enduring Freedom
OIF	Operation Iraqi Freedom
OMFS	Oral and Maxillofacial Surgery
PCS	Permanent Change of Station
RAC	Regional Advisory Council
RMD	Resource Management Decision
RTAC	Regional Trauma Advisory Committee
RWP	Relative Weighted Product
SA	Stand-Alone

SAMMC	San Antonio Military Medical Center
SIDR	Standard Inpatient Data Record
SOST-SOCCET	Special Operations Surgical Team-Special Operations Critical Care Evacuation Team
SR	Sponsored Reserves
SSM	Saint Louis University School of Medicine
TAA	Training Affiliation Agreement
TCAA	Trauma Center Association of America
TDY	Temporary Duty
TIEP	Trauma Information Exchange Program
UAB	University of Alabama at Birmingham
UK	United Kingdom
UNC	University of North Carolina
USAF	United States Air Force
VA	Department of Veterans Affairs

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Lurie, Philip, M.
Burns, Sarah, K.
Whitley, John, E.
Bishop, James, M.
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The readiness of the military medical force to provide care in an operational environment has been a subject of particular concern to the Congress, as reflected in the National Defense Authorization Act for Fiscal Year 2017. Studies have suggested there may be an insufficient volume and diversity of inpatient care at military treatment facilities (MTFs) to sustain the readiness-related clinical skills needed by providers when deployed to a conflict zone. This paper attempts to measure the extent to which MTF inpatient workload volume and diversity of care are sufficient to sustain the readiness-related skills of military surgeons and identifies and evaluates potential solutions to reduce or eliminate any identified gaps.

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