The Quality-Volume Relationship: Comparing Civilian and MHS Practice

Holly Brevig, Christina Colosimo, Ted Jaditz, Ramona Krauss, Kara Mandell, Robert Morrow, Jessica Oi, and Wilhelmina Tsang

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Dr. Eric Christensen, Research Team Leader
Health Research and Policy
Resource Analysis Division

Abstract

The literature shows that the best outcomes occur when patients get their health care in high-volume settings. High-volume surgeons are more proficient. High volume hospitals are safer. These findings have changed how civilian health care is delivered. Civilian hospitals, insurance companies, governments, and institutions all focus on volume as an indicator of quality.

The Military Health System (MHS) lags by comparison. Fewer MHS patients have their procedures in high-volume settings. MHS also misses opportunities to consolidate low-volume hospitals into higher-volume regional facilities. For many product lines, most operations are done by surgeons who perform the procedure infrequently.

There are nearly 10 million TRICARE beneficiaries, and thus ample opportunities for MHS to set up high-volume "center of excellence" programs to meet existing beneficiary demand for services. Such initiatives could improve average patient outcomes while supporting clinical currency for MHS physicians.

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Executive Summary

Peer-reviewed medical journals frequently publish articles that show that high volume is generally correlated with better outcomes. High volume surgeons have lower complication rates, lower re-operation rates, lower readmission rates, lower mortality rates, and are faster in the operating room. Patients who frequent high-volume hospitals have lower mortality rates, lower complication rates, lower re-admission rates, and shorter length of stay. For many procedures, particularly those with a high degree of risk, the literature provides guidance on how many procedures are enough to lower the likelihood of adverse events.

This report evaluates the Military Health System (MHS) according to the standards in the quality-volume literature. We start with a literature review of recent quality-volume studies to identify current accepted volume targets associated with the best patient outcomes. Next, we survey the literature to understand how civilian institutions, including hospitals, government agencies, non-profits, and insurance companies, respond to these findings. Finally, we analyze administrative data from the MHS and compared it to findings from the literature and civilian health systems.

These findings have a tremendous influence on how medicine is practiced. Hospitals advertise their procedure volumes to the public as a marketing strategy. The Leapfrog Group, a non-profit group focused on reducing medical errors and improving hospital safety, provides safety ratings based in part on volume information voluntarily provided by hospitals. Insurance companies encourage beneficiaries to have their surgeries performed in facilities that meet recommended volume targets. State governments provide hospital volume data to the public and encourage patients to frequent high-volume providers.

Military hospitals lag behind civilian hospitals. It is generally the case that most patients in civilian settings receive care in high volume settings, while most MHS patients receive care in low-volume settings. Few MHS clinicians meet the volume targets from the literature.

The MHS has the opportunity to change this. There are nearly 10 million TRICARE beneficiaries, so there is ample volume to support a system designed according to the principles of the quality-volume literature. High volume programs for major surgeries would improve average quality of care and allow MHS surgeons to achieve high levels of currency and proficiency.

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Contents

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List of Figures

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List of Tables

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Glossary

AAA	Abdominal Aortic Aneurysm
AHRQ	Agency for Healthcare Research and Quality
AMC	Army Medical Center
CABG	Coronary Artery Bypass Graft
C-section	Cesarean-Section
eMSM	enhanced Multi-Service Market
FY	Fiscal Year
GME	Graduate Medical Education
ICU	Intensive Care Unit
IQI	Inpatient Quality Indicators
MDR	MHS Data Repository
MHS	Military Health System
MTF	Military Treatment Facility
NH	Naval Hospital
NMC	Naval Medical Center
PCI	Percutaneous Coronary Intervention
THA	Total Hip Arthroplasty
TKA	Total Knee Arthroplasty

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Introduction

Starting in the 1970s, researchers have assessed how patient outcomes relate to the settings where care is provided. A review [1] written for an Institute of Medicine workshop concluded that for many different types of surgery, the more times a procedure is performed in a given hospital, and the more times a practitioner performed it, the better the health outcomes.

The literature has evolved. Studies continue to look at surgery using finer measures of surgeon performance, and conclude that higher-volume surgeons are more skilled [2]. Studies find volume effects for treatments other than surgery, too. While there are exceptions, the consensus of the literature is that higher procedure volumes are correlated with better patient outcomes.

This report provides a brief introduction to the current state of the literature on the relationship between the volume of services provided and the quality of that medical care. We review some areas where this literature has had a concrete impact on the practice of medicine. We provide examples of how civilian hospitals announce their procedure volume statistics on their corporate webpages. We note that the Leapfrog Group, a nonprofit group focused on reducing medical errors and improving hospital safety, uses procedure volume as part of its metrics to rate hospitals. We describe how insurance companies encourage beneficiaries to select "centers of excellence"—high-volume facilities staffed by high-volume surgeons who follow safe practices. We show how multiple states publish highly specific hospital procedure data on their websites and encourage patients to use these data as a quality signal. We also note the use of volume data as a quality measure by professional associations and by the U.S. Department of Health & Human Services' Agency for Healthcare Research and Quality (AHRQ).

Next we look at military medicine through the lens of the quality-volume literature. We compare Military Health System (MHS) facilities with their civilian counterparts. We find that for many product lines of surgery, civilian systems are much more highly centralized than is MHS. We also note examples where MHS misses opportunities to consolidate low-volume programs into regional centers; and that for many lines of surgery, most procedures are performed by low-volume surgeons.

We appreciate the difficulties in comparing the MHS direct care system with civilian facilities. The primary mission of MHS is operational support. Managers of the MHS

face constraints that are not present in civilian systems. As a result, MHS is not optimized for the secondary mission of providing care to its beneficiary population.

The Military Health System is missing an opportunity. There are nearly 10 million beneficiaries who are eligible to receive care in the direct care system. There is ample beneficiary demand to support high-volume programs for a variety of surgical services in many different locations. An MHS that was designed to be in accord with the principles and findings of the quality-volume literature would look very different from the current one.

The Literature on Volume and Quality

A 1979 paper in the *New England Journal of Medicine* [3] found a strong negative correlation between the number of surgeries performed in a hospital and the surgical mortality rate. Adjusting for case mix, high-volume facilities had death rates 25 to 40 percent lower than low-volume facilities. Luft et al. used the results to advocate for regionalization of many types of complex surgeries.

These policy recommendations were controversial. Many subsequent authors attempted to replicate the findings. Critics assailed both the study's methods and the generalizability of its results.

This section discusses the current literature relating volume of procedures to patient outcomes. Papers look at patient outcomes such as mortality, complications, and length of stay. Outcomes are related to the number of procedures performed at a location or by the provider, either cumulatively or per unit time. Researchers use a variety of strategies to control for differences across patients that contribute to outcomes and to control for other features of the hospital where treatment occurs or of the clinician or clinicians who provide treatment. The early papers addressed major surgery; more-recent papers have addressed nonsurgical treatment such as intensive care unit (ICU) ventilator support and pneumonia treatment.

This section begins with a review of various ways the findings have been criticized. We then lay out recent papers that attempt to address these criticisms.

The literature has reached broad consensus. The positive relationship between quality and volume is empirically robust. High-volume surgeons have lower complication rates, lower re-operation rates, lower readmission rates, and lower mortality rates and they are faster in the operating room. Patients who frequent high-volume hospitals have lower mortality rates, lower complication rates, lower readmission rates, and shorter lengths of stay.

Critiques of the literature

Luft et al. showed a strong correlation between procedure volumes and patient outcomes. The single most significant criticism is that the quality-volume effect is a statistical black box. While volume is correlated with quality of outcomes, we do not

know the mechanism, or limits, or even the direction of causation [4]. How does volume generate better outcomes? How many procedures are enough? Does volume cause quality, or is it that patients seek out high-quality providers and thus quality causes volume?

In addition, there are numerous criticisms of the methods used in this line of research. The key areas of contention are as follows:

- Early studies of the quality-volume effect focused on data from a few states. Data from a few large databases (notably from New York State) appear frequently in the earliest papers in the literature. As a result, many researchers questioned whether this was a local phenomenon or a general finding [1].
- The quality-volume relationship is criticized as highly variable, and many papers have poor methods [1]. For example, methods used to adjust for risk in different populations are frequently unsophisticated.
- There is a lack of proper adjustment for case mix [5]. Do hospitals "cherry pick" patients who are likely to do well? Proper adjustment for differences in disease burden and demographics between patient populations can have a large impact on the assessment of hospital and surgeon outcomes.
- The magnitude of any relationship between hospital volume and outcomes is uncertain [6]. Retrospective studies find that historical volume correlates with historical performance; however, the correlation between current volumes and future outcomes is much more uncertain. This suggests that the relationship is unstable.
- There is debate on whether volume has a large or small overall impact on outcomes, and on whether that impact is constant over time [7]. Evidence may suggest that the size of the effect is shrinking over time.

These are significant criticisms. While current studies address some aspects of these critiques, it is fair to say that no study fully addresses them all.

Recent findings in the peer-reviewed literature

The relationship between surgery volume and outcome quality remains an active area of research. In the following review, we focus on papers published since 2007. By that time, researchers are aware of the criticisms of the early work and take steps to address them.

Recent papers by and large confirm the quality-volume relationship. In most samples, surgeons and hospitals at the high end of the volume distribution tend to have better outcomes than surgeons and hospitals at the low end of the distribution.

We break out our findings by type of surgery:

- *Appendectomy*
  - Surgeons who are in the top half of the volume distribution (performing between 66 and 120 appendectomies per year) have better outcomes than do surgeons in the bottom half (who perform 65 or fewer) [8].
  - A 2013 paper [9] finds no influence of hospital volume on patient mortality rates.
- *Bariatric surgery*
  - There is a strong correlation between the average number of bariatric surgeries a surgeon performs annually and his or her level of surgical skill as rated by other surgeons. Surgical volume also is associated with lower mean operating room times [2].
- *Cataract surgery*
  - Surgeons who perform fewer than 250 cataract surgeries per year have double the complication rate of surgeons who perform 251 to 500 cataract surgeries per year. These surgeons, in turn, have double the complication rates of surgeons who perform 501 to 1,000 surgeries per year. Surgeons who perform more than 1,000 cataract surgeries per year have the lowest adverse event rate [10].
- *Cesarean section*
  - For low- and medium-risk patients, high-volume hospitals have significantly lower Cesarean-section rates than low-volume hospitals [11].
- *Cholecystectomy*
  - Surgeons who perform fewer than 12 procedures per year in facilities that perform fewer than 120 procedures per year have the highest rates of postsurgical complication, including acute myocardial infarction, pulmonary compromise, postoperative infection, deep vein thrombosis, pulmonary embolism, hemorrhage, and re-operation. Best outcomes are in facilities that perform more than 244 per year and with surgeons that perform more than 36 per year [12].

- Lowest rates of re-operation and readmission are in hospitals that perform more than 244 procedures per year [13].
- Length of stay is lower in facilities where more than 255 procedures are performed per year [14].

- *Colectomy*
  - Surgeons who perform more than 200 colectomies per year have shorter operating times than surgeons who perform fewer than 30 per year [15].

- *Hysterectomy*
  - Surgeons in the lowest third of the volume distribution have complication rates 50 percent higher than surgeons in the top third of the distribution. Women treated in high-volume centers are 18 percent less likely to experience a complication. Total costs of care are lower for high-volume surgeons and at high-volume hospitals [16].
  - A 2010 paper by Rogo-Gupta et al. finds that high-volume surgeons have a 30 percent lower chance of an operative injury and a significantly lower chance of complications or ICU admission compared with low-volume surgeons [17].

- *Knee replacement*
  - Readmission, re-operation, mortality, and length of stay are all more favorable in high-volume facilities than low-volume facilities [18].
  - A systematic review by Lau et al. [19] finds that low-volume surgeons have higher rates of infection, longer procedure times, longer lengths of stay, a greater probability of a transfusion, and worse reported patient outcomes.
  - Surgeons who perform more than 67 procedures per year have better outcomes than surgeons who perform fewer than 17 cases per year [20].
  - Hospitals where 200 knee replacements per year are performed have lower complications and lower one-year mortality rates compared with lower-volume hospitals [21].

- *Hip replacement*
  - Hospitals that perform more than 200 hip replacements per year have lower complication rates and lower mortality than lower-volume hospitals [21].
  - For hip replacements, low surgeon volume has a bigger impact on length of stay for hip replacements than do patient comorbidities; best outcomes are recorded with surgeons who perform 53 procedures per year or more [20].
  - Patients of surgeons who perform more than 35 hip replacements per year have lower risk for dislocation and early revision compared to patients whose surgeons perform 35 or fewer hip replacements per year [22].
- *Spinal surgery*
  - Patients of surgeons who perform 32 or more spinal decompressions and fusions per year have lower re-operation rates and higher rates of long-term survival compared to patients whose surgeons perform 31 or fewer hip replacements per year [23].
- *Mastectomy*
  - Patient survival rates are highest in hospitals that perform more than 70 mastectomies per year [24].
- *Prostatectomy*
  - A 2013 paper finds lowest length of stay for patients whose surgeons perform more than 17 radical prostatectomies per year and at hospitals where more than 49 are performed per year [25].
  - Surgeons who perform more than 24 radical prostatectomies a year have lower complication rates [26].
- *Intensive care units*
  - Hospitals with greater than 120 ICU admissions per year for sepsis have lower mortality rates than facilities with less than 40 admissions per year for sepsis [27].
  - Physicians who treat more than 315 pneumonia cases per year have lower mortality rates than physicians who treat fewer than 36 [28].

- Facilities with greater than 50 ICU admissions for cardiac-related conditions have better mortality rates than facilities with less than 20 admissions [29].
- Facilities that admit more than 282 cases per year requiring mechanical ventilation have lower mortality rates than facilities that admit fewer than 99 per year [30].

We found no papers that show that low-volume providers and hospitals had more favorable outcomes than high-volume providers and hospitals.

These references start to fill in the details of how volume leads to quality: Theory and recent empirical evidence suggest that performing a high volume of a single type of surgery may be associated with greater proficiency in that surgery [2, 31]. The best hospitals tend to have both high volume and better process standardization and adherence to evidence-based practices [17].

Impact on the Practice of Medicine

The quality-volume literature has had a major impact on the practice of medicine. In this section, we sketch out some of the ways that modern institutions apply volume data to their business activities.

- It is easy to find prominent civilian hospitals that publish procedure volumes on their websites, from which we infer that hospital managers believe procedure volume is important. Hospitals also voluntarily report procedure volume data to participate in civilian quality measurement programs.
- Insurance companies have programs to recognize high-volume providers and encourage their beneficiaries to have their procedures done at these sites.
- State health departments publish procedure volume information on hospitals and encourage patients to take this into account when selecting a facility.
- While most physician professional associations are reluctant to endorse the quality-volume literature, a small number acknowledge that volume is a valid indicator of quality of care. In addition, medical education has long emphasized the importance of repetition to build proficiency.
- The Agency for Healthcare Research and Quality publishes its Inpatient Quality Indicators resources based on hospital volume.

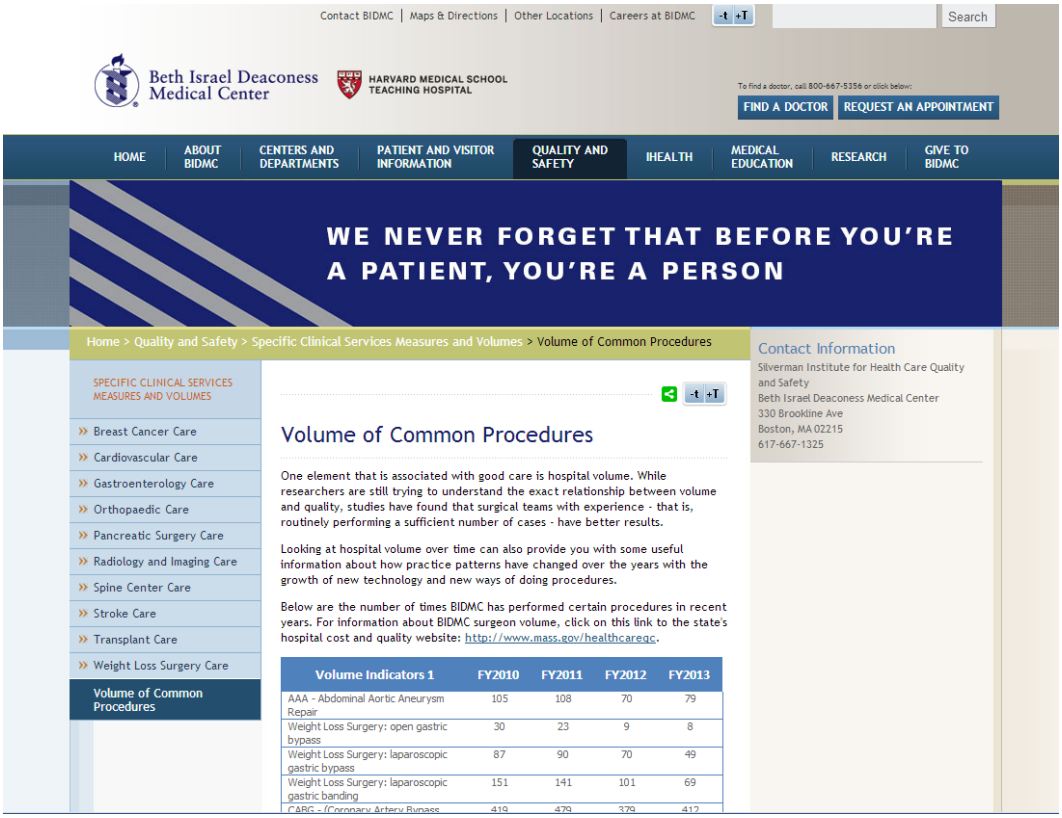
Civilian hospitals and the Leapfrog Group

Many civilian hospitals voluntarily report volume information on their corporate websites, and civilian groups use this information to calculate hospital safety ratings.

The Beth Israel Deaconess Medical Center website is a convenient example of the kinds of information that hospitals make public. This teaching hospital, located in Boston, Massachusetts, is part of the Harvard University Medical School. On its website (Figure 1), Beth Israel Deaconess currently publishes its fiscal year (FY) 2010,

FY 2011, FY 2012, and FY 2013 procedure volumes for 15 common types of surgery, including various types of heart surgery, gastric bypass, hip and knee replacement, and prostatectomy. Reports are clear and comprehensive. In the knee replacement section, for example, reports include the number of primary knee replacements (317 in FY 2012), the number of revisions (62), and the number of patients undergoing bilateral knee replacement (9).

Figure 1. Screen shot, Beth Israel Deaconess Medical Center, volume of common procedures



Source: Beth Israel Deaconess Medical Center [32]

Beth Israel Deaconess explicitly calls out the link between quality and volume. As shown in the screen shot in Figure 1, text provided with the report table states:

> One element that is associated with good care is hospital volume. While researchers are still trying to understand the exact relationship between volume and quality, studies have found that surgical teams with experience—that is, routinely performing a sufficient number of cases—have better results. [32]

The Leapfrog Group is a nonprofit group that compiles safety ratings based on data provided by hospitals. The member organizations (corporations and public agencies that buy health benefits) that comprise Leapfrog represent about 34 million beneficiaries and more than $60 billion in health care expenditures. Leapfrog publishes safety ratings for hospitals that volunteer to participate in its program. Data provided by participating hospitals include process measures and procedure volume for select procedures, as well as hospital staffing and safety practices. These data are used to calculate a safety score for each hospital. Hospital safety scores are publicly available on Leapfrog's website. The hospitals are rated on whether they have appropriate safety processes in place and on patient outcomes. Hospitals also are rated on whether they perform select procedures in sufficient volume. Figure 2 shows a screen shot from a part of the survey data that is reported for hospitals in Maryland.

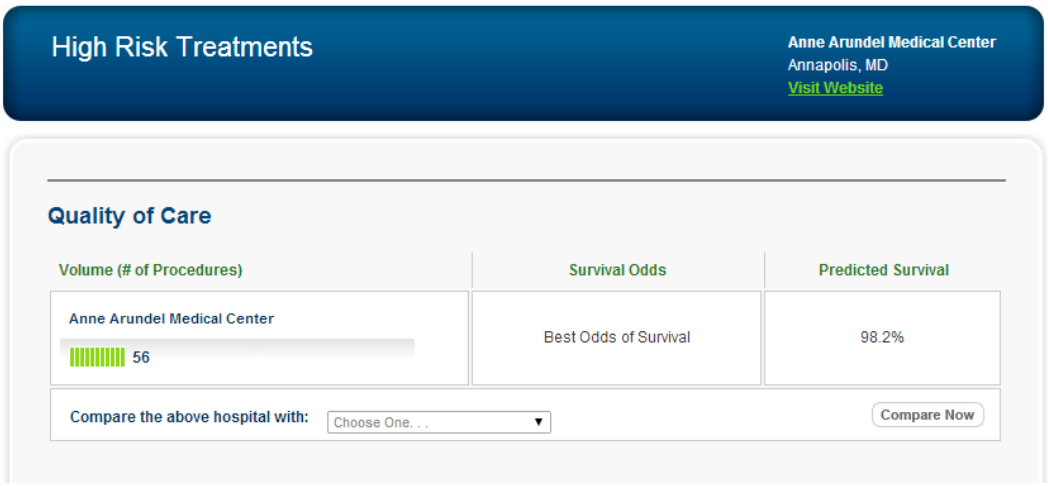
Figure 2. Screen shot, Leapfrog Group Hospital Survey results

Source: Leapfrog Group, retrieved November 17, 2014 [33]

The Leapfrog report provides summary assessments of hospital safety, with grades ranging from a low of "willing to report" to a high of "fully meets standards." The

screen shot shows the section of the report that provides information on high-risk surgeries. Patients who want additional information can click on the question mark symbol. For example, when we click on the link for Anne Arundel Medical Center for Abdominal Aortic Aneurysm Repair, we see that the facility performed 56 procedures and that the estimated probability of patient survival was 98.2 percent (Figure 3).

Figure 3. Detail: Anne Arundel Medical Center abdominal aortic aneurysm repair scores from Leapfrog Group



Source: Leapfrog Group, retrieved November 17, 2014 [33]

Its 2014 Leapfrog Hospital Survey Results include rating scores based on volume for five procedures: aortic valve replacement, abdominal aortic aneurysm (AAA) repair, pancreatic resection, esophageal resection, and high-risk births. In addition to these five, Leapfrog also publishes minimum volume targets which are not included in the rating scores for three additional procedures: coronary artery bypass graft (CABG), percutaneous coronary intervention (PCI), and bariatric surgery. The Leapfrog surgeon and hospital volume targets for all eight procedures are given in Table 1.

Table 1. Leapfrog hospital volume targets

Operation	Surgeon Volume Per Year	Facility Volume Per Year
***CABG**	100[a]	500[a], ≥450[b]
***PCI**	75[a]	≥400[a]
Aortic valve replacement	22[a]	≥50[a], ≥120[b,c]
***Elective abdominal aortic aneurysm (AAA) repair**	8[a]	30[a], ≥50
***Pancreatic resection**	2[a]	≥11[a]
***Esophagectomy**	2[a]	6[a], ≥13[b]
Bariatric surgery	20[a], 50[b]	>125[a]
High-risk births	N/A	≥50[b,c]

*Allareddy et al. [34] showed that meeting Leapfrog Group minimum hospital volumes for CABG, PCI, AAA, pancreatectomy, and esophagectomy correlated with **lower in-hospital mortality rates.**

Sources: (a) Leapfrog Group [35]; (b) Leapfrog Group [36]; (c) Leapfrog Group [37].

These volume targets have been validated in the literature. Allareddy et al. [38] shows that meeting Leapfrog Group minimum hospital volumes for CABG, PCI, AAA, pancreatectomy, and esophagectomy is correlated with lower in-hospital mortality rates for these surgeries.

Insurance companies

In this subsection, we describe how Aetna and Blue Cross Blue Shield use volume criteria to recognize networks of facilities that "demonstrate expertise in delivering quality specialty care safely and effectively" [39].

Depending on the area of medicine, a hospital or other facility can obtain membership in the Aetna Institutes of Quality® or in the Aetna Institutes of Excellence® program. Procedure volume (both for the facility and its surgeons) is one of the criteria for membership. Table 2, below, lists the volume targets required to achieve institute status for each class of surgery. These volume standards generally are taken directly from the peer-reviewed literature or from a Leapfrog Group report.

Table 2. Aetna Institutes of Quality and Institutes of Excellence annual volume standards

Procedure	Required Surgeon Annual Volume	Required Facility Annual Volume
Bariatric surgery:		
Inpatient facilities	100	125
Ambulatory facility		75
Cardiac care (all of the following):		
Open heart procedures		200
Angioplasty or stent		200
Cardiac re-synchronization (pacemakers, implantable defibrillator)		125
Orthopedic care (all of the following):		
Knee replacement surgeries	50	200
Hip replacement surgeries	50	100
Spinal surgery	50	200
Transplants (select examples)		
Adult kidney		40
Adult bone marrow transplant		40
Adult liver transplant		30
Infertility clinics (implants)	20	

Source: Aetna Institutes of Quality® Fact Book [40]

Blue Cross Blue Shield has a similar program that identifies Blue Distinction Centers that meet "quality-focused criteria that emphasize patient safety and outcomes," as well as Blue Distinction Centers that also meet cost-of-care targets [41]. The volume targets in the following table are "Required Metrics," which both facilities and their surgeons must attain in order to achieve the designation.

Table 3. Blue Cross Blue Shield Blue Distinction Centers

Procedure	Required Surgeon Annual Volume	Required Annual Facility Volume
Total joint (knee plus hip)	At least 21% of the program's active surgeons performed at least 50 total joint replacements	250
Spine surgery	At least 32% of the program's active surgeons performed at least 50 total spine surgeries	100
Bariatric surgery	Primary surgeon performed 50 in last 12 months, at least 125 in career	
Cardiac care		10 episodes
Bone marrow transplant		24

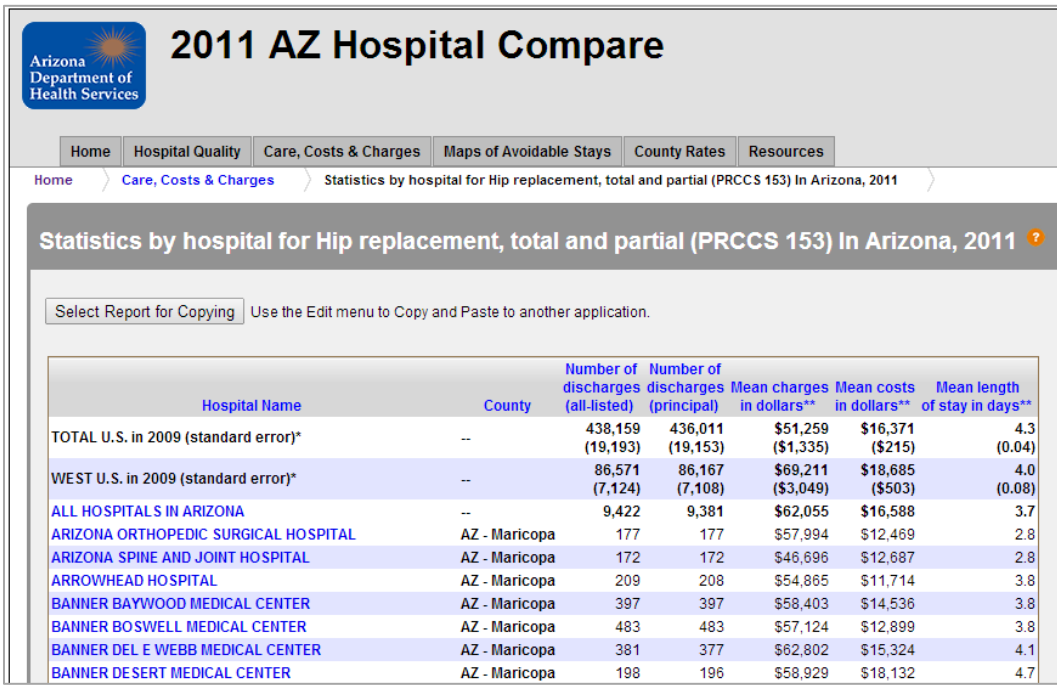
Source: Blue Cross Blue Shield Association [39, 41],

State government programs

Eleven states have created websites to provide information about hospital quality and costs. The data elements and organization are quite similar across states, due to technical support provided by the Agency for Healthcare Research and Quality.

The Arizona website is typical of these state programs. The Arizona program is run by the state Department of Health Services under the title "AZ Hospital Compare." Figure 4 shows a screen shot from the AZ Compare website's report on hip replacement. The site provides detailed data on hospital discharge volume, costs, and length of stay. Discharge volume is reported for all hospitals in the state performing the procedure. Hospitals with fewer than five discharges are identified, but the number of discharges is censored.

Figure 4. Hospital volume for hip replacements in Arizona (2011)



Hospital Name	County	Number of discharges (all-listed)	Number of discharges (principal)	Mean charges in dollars**	Mean costs in dollars**	Mean length of stay in days**
TOTAL U.S. in 2009 (standard error)*	--	438,159 (19,193)	436,011 (19,153)	$51,259 ($1,335)	$16,371 ($215)	4.3 (0.04)
WEST U.S. in 2009 (standard error)*	--	86,571 (7,124)	86,167 (7,108)	$69,211 ($3,049)	$18,685 ($503)	4.0 (0.08)
ALL HOSPITALS IN ARIZONA	--	9,422	9,381	$62,055	$16,588	3.7
ARIZONA ORTHOPEDIC SURGICAL HOSPITAL	AZ - Maricopa	177	177	$57,994	$12,469	2.8
ARIZONA SPINE AND JOINT HOSPITAL	AZ - Maricopa	172	172	$46,696	$12,687	2.8
ARROWHEAD HOSPITAL	AZ - Maricopa	209	208	$54,865	$11,714	3.8
BANNER BAYWOOD MEDICAL CENTER	AZ - Maricopa	397	397	$58,403	$14,536	3.8
BANNER BOSWELL MEDICAL CENTER	AZ - Maricopa	483	483	$57,124	$12,899	3.8
BANNER DEL E WEBB MEDICAL CENTER	AZ - Maricopa	381	377	$62,802	$15,324	4.1
BANNER DESERT MEDICAL CENTER	AZ - Maricopa	198	196	$58,929	$18,132	4.7

Source: Arizona Department of Health Services [42]

The Arizona Department of Health Services advises patients that hospital volume is an important indicator of quality. The methods section of the website states:

> You may be interested in a specific medical condition or procedure and would like to get details. For example, you or a loved one may need hip replacement surgery. You may want to look at … [the] numbers of hip replacement surgeries done at hospitals in your area. You may want to choose a hospital that performs many hip replacements, because hospitals that do procedures frequently may do them better. [43]

Professional associations

Most professional associations do not address volume as a potential marker of surgeon or facility quality. Exceptions are infrequent and tentative; however, policy statements that recognize the importance of procedure volume do exist.

For example, the American College of Cardiology (ACC) has a practice guideline for coronary artery bypass graft surgery [44]. It recommends that all programs participate in registries and focus on risk-adjusted outcomes measures. The ACC guidelines state:

- When credible risk-adjusted outcomes data are not available, volume can be useful as a structural metric of CABG quality; and
- Affiliation with a high-volume tertiary center might be considered by cardiac surgery programs that perform fewer than 125 CABG procedures annually [44].

In addition, medical education has long recognized the importance of repetition in proficiency. The Accreditation Council for Graduate Medical Education not only requires minimum case volumes by procedure for residents (e.g., Orthopedic, Gynecology, Ophthalmology), but it also tracks and publishes resident procedure volume every year by hospital [31].

AHRQ inpatient quality indicators

The Inpatient Quality Indicators metrics are published by the Agency for Healthcare Research and Quality. Their stated purpose is to provide a perspective on quality of hospital care and to identify potential problem areas that might need further attention.

The metrics are calculated from hospital administrative records. From the universe of all inpatient admissions, AHRQ research identifies select conditions and events that it believes are informative on the quality of care provided at the hospital.

There are 34 measures in the Inpatient Quality Indicators (IQI) program:

- Of them, 17 are mortality rates for various classes of surgery and conditions. An example is IQI 12, "Coronary Artery Bypass Graft (CABG) Mortality Rate," which measures the rate of in-hospital deaths for age 40 and older CABG patients. High-quality facilities have lower mortality rates.

- Another 11 are population procedure rates. For example, IQI 21 is "Cesarean Delivery Rate, Uncomplicated." High-quality facilities perform fewer C-sections on uncomplicated patients.

- The remaining 6 metrics are simple counts of the number of procedures performed at the institution. *The more of these surgeries a facility performs, the higher its quality score.* AHRQ characterizes these procedures as "procedures for which there is some evidence that a higher volume of procedures is associated with lower mortality" [45]. The procedures in this class are:

    - IQI 01, Esophageal Resection Volume
    - IQI 02, Pancreatic Resection Volume
    - IQI 04, Abdominal Aortic Aneurysm (AAA) Repair Volume
    - IQI 05, Coronary Artery Bypass Graft (CABG) Volume
    - IQI 06, Percutaneous Coronary Intervention (PCI) Volume
    - IQI 07, Carotid Endarterectomy Volume

Features of Military Medicine

How well do military hospitals meet civilian quality-volume standards? In this section, we look at operating statistics for military hospitals through the lens of the quality-volume literature.

As part of this assessment, we compare performance of the Military Health System with civilian data provided by state health departments. AHRQ provides technical assistance to states to allow them to readily generate websites that make public information on their health care utilization. States that participate in this program use software provided by AHRQ to produce websites that provide comparable information in a common format. Twelve states participate in this program, called MONAHRQ®.

Of these, we include in the section that follows data from the four states that have the longest history of program participation. We use the most current data available from each site. The four states are Kentucky, Maine, Nevada, and Utah. Combined, their patient population is about the same as the total MHS beneficiary population.

Many surgeries are performed in low-volume settings

In this section, we calculate the proportion of surgeries performed in hospitals of different size classes, looking specifically at the procedures major joint arthroplasty, CABG, and spinal fusion. We chose these procedures because they are prominent in the quality-volume literature. These are complex surgeries with moderate risk of high consequence complications, including mortality. Here, papers with strong methodologies have produced robust evidence of the impact of volume on quality.

State MONAHRQ websites provide tabulations of the number of procedures performed, by hospital, for every facility in the selected states, based on AHRQ coding guidelines. We derived MHS facility counts from MHS administrative data using these same coding guidelines.

We placed the hospitals into size classes that are derived with reference to the target volume levels in the literature, as well as with reference to civilian practice. For MHS

and for each state, we tabulated the percentage of procedures performed in hospitals in each size class.

Major joint arthroplasty

The quality-volume literature says that the best outcomes are observed in facilities that perform 200 knee replacements or more per year or more [20-21].

In FY 2013, MHS beneficiaries received 8,828 knee replacements and 4,943 hip replacements. Of these totals, 1,721 knees and 943 hips were performed in the direct care system. The largest MHS arthroplasty program and the only one that performs more than 200 procedures per year is at Brooke Army Medical Center (AMC), where 224 knee arthroplasty procedures were performed in 2013. About 13 percent of all direct care knee replacements were performed at Brooke AMC in FY 2013.

In the civilian systems, the percentage of knee replacements performed in high-volume settings ranges from a low of 65 percent in Maine to 96 percent in Utah. In Utah, 90 percent of procedures are performed in hospitals that perform more than ***400*** knee replacements per year. The highest-volume facility in these four MONAHRQ states performs almost 2,400 procedures per year, or more than 10 times as many procedures as at Brooke AMC.

Table 4. Where do patients get a knee replacement?

Facility Volume per Year	MHS Direct Care FY13	Kentucky 2012	Maine 2009	Nevada 2011	Utah 2011
0–49	13%	3%	9%	6%	1%
50–99	38%	6%	16%	6%	1%
100–199	36%	14%	11%	21%	2%
200–399	13%	32%	32%	23%	6%
400+	0%	46%	33%	44%	90%

Source: CNA calculations based on state publically available data and MHS data from the MHS Data Repository (MDR)

There are several standards for volume for hip replacement, including Katz, Singh and Stryon [20-21, 46]. For purposes of comparison, we use the Aetna evidence-based standard for hip replacement volume is 100 procedures per year [40, 46].

Table 5 summarizes our comparisons for hips. Brooke AMC is again the MHS volume leader, with 157 procedures in FY 2013. Brooke is one of three facilities that meet the evidence-based volume standard. For comparison, the highest-volume civilian facility in these four states performed 1,363 procedures. Forty-five hospitals in these four states had higher annual volume than Brooke did.

Forty-three (43) percent of MHS direct care patients had a hip replacement in a high-volume facility. In these four states, the comparable totals range from 73 percent to 96 percent. The majority of civilian patients receive care in facilities with annual volume at least double the quality-volume standard.

Table 5. Where do patients get a hip replacement?

Facility Volume per Year	MHS Direct Care FY13	Kentucky 2012	Maine 2009	Nevada 2011	Utah 2011
0–24	21%	4%	7%	1%	1%
25–49	21%	4%	10%	5%	1%
50–99	14%	10%	10%	7%	2%
100–199	43%	31%	27%	33%	10%
200+	0%	51%	46%	54%	86%

Source: CNA calculations based on state publically available data and MHS data from the MDR

CABG

To get the Aetna Institute of Quality certification, a facility must perform at least 200 open heart surgeries per year. The literature says that the best chance of a good outcome is in a facility that performs 250 CABGs per year. The Leapfrog volume target is 450 per year.

About 1,700 CABGs were performed on TRICARE beneficiaries in FY 2013. Of these, 338 were performed in the direct care system. The highest-volume hospital in the MHS system is Eisenhower AMC, which performed 64 procedures in FY 2013. In the four states, the highest-volume facility performs 720 CABGs per year. In each of the states, more than 90 percent of patients receive their CABG in facilities that perform more than 100 per year. In Maine and Utah, a majority of CABGs are done at facilities that perform more than 450 per year.

Table 6. Where do patients get a CABG?

Facility Volume per Year	FY13 All MHS Facilities	Kentucky 2012	Maine 2009	Nevada 2011	Utah 2011
0–49	66%	2%	0%	0%	0%
50–99	34%	6%	0%	7%	2%
100–199	0%	18%	13%	64%	6%
200–249	0%	10%	0%	29%	0%
250–449	0%	38%	30%	0%	16%
450+	0%	27%	57%	0%	76%

Source: CNA calculations based on state publically available data and MHS data from the MDR

Spinal fusion

The published literature finds that the best outcomes are observed in facilities that perform at least 100 spinal fusions per year. The Blue Cross Blue Shield Blue Distinction volume requirement is 100 procedures per year. The Aetna Institute of Quality volume standard is 200 procedures per year.

In FY 2013, MHS beneficiaries received 7,449 spinal fusions. Of these, 1,665 were performed in the direct care system. Spinal fusions were performed at 21 different military treatment facilities (MTFs). Brooke AMC is the highest-volume site in the direct care system. In FY 2013, 266 spinal fusions were performed there. The highest-volume civilian hospital in our sample performed 2,150 spinal fusions. Five hospitals in these states performed more than 1,000 spinal fusions.

In the direct care system, 63 percent of procedures were performed in a facility that did 100 fusions per year, and 29 percent were performed in facilities that meet the standard of 200 per year. Of the four states, the lowest numbers are in Kentucky, where 83 percent of patients receive a spinal fusion in a facility that performs more than 100 per year and 65 percent in a facility that performs more than 200 per year. In Utah, the comparable numbers are 98 percent and 93 percent. In Nevada and Utah, most patients receive their spinal fusion in facilities with volume that is at least double the quality-volume target.

Table 7. Where do patients get a spinal fusion?

Facility Volume per Year	FY13 All MHS Facilities	Kentucky 2012	Maine 2009	Nevada 2011	Utah 2011
0–49	8%	4%	5%	0%	0%
50–99	29%	13%	6%	3%	1%
100–199	34%	18%	24%	11%	6%
200–399	29%	36%	18%	10%	13%
400+	0%	29%	47%	77%	80%

Source: CNA calculations based on state publically available data and MHS data from the MDR

Many complex surgical procedures are performed by low-volume providers

Some studies suggest that the number of surgeries performed by an individual surgeon may be equally or more important than facility volume [47]. Many MHS

surgeons are performing complex surgeries at volumes that are low relative to the standards in the literature.

In this section, we report on surgeon procedure volumes for spinal fusion, knee arthroplasty, and hip arthroplasty. For these procedures, the quality-volume literature provides recommended target volumes per surgeon that are associated with the best patient outcomes. We compare the actual experience of MHS surgeons with the recommended volume targets.

Our data come from FY 2013 MHS administrative records. We calculated the number of surgeries performed per surgeon at direct care facilities using the pseudo-provider ID. For many of these surgeries, there are frequently multiple surgeons participating, each performing and getting coding credit for some part of the procedure.

This data has limitations. First, depending on the year, a significant number of procedures performed in direct care are not recorded in the administrative data. Second, due to various administrative issues, we may occasionally be missing data from some hospitals for some time periods. Even so, the available data provide insight into MHS operating practices.

Spinal fusion

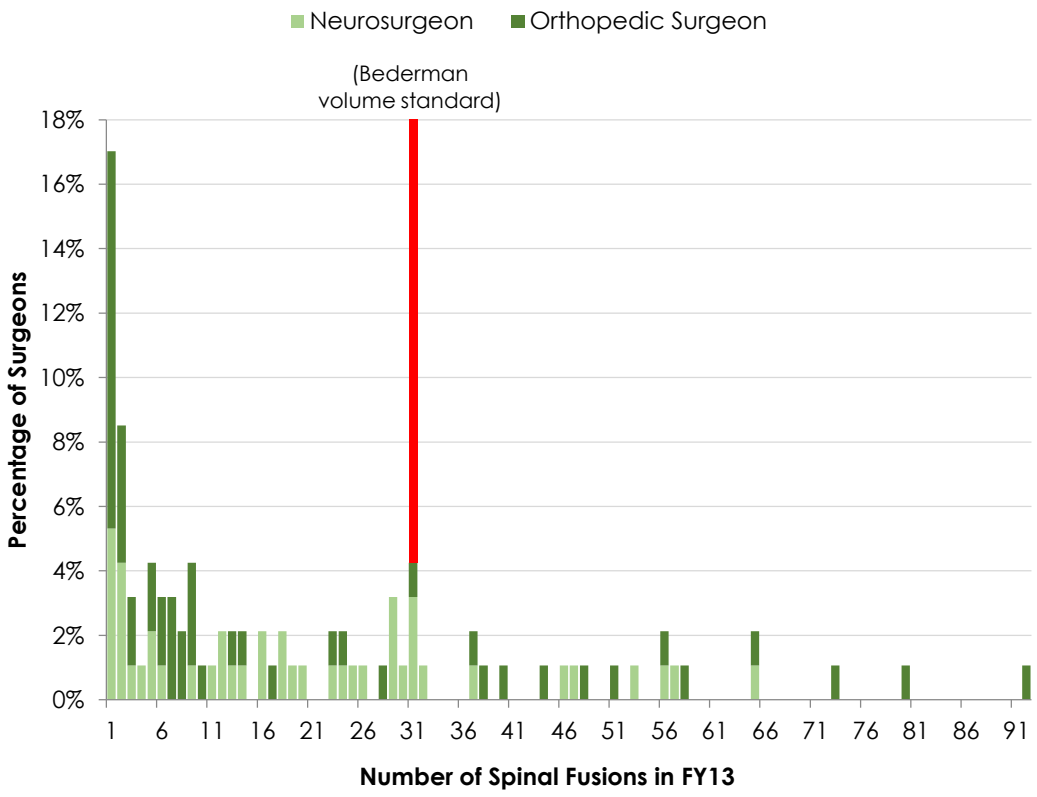
Target volumes for spine surgeons are in the range of 32 to 50 yearly. Bederman et al. found that among patients who received spine surgery (either decompression surgery or fusion) from low-volume providers (those who performed 32) had a higher re-operation rate than high-volume providers [23]. Aetna and Blue Cross Blue Shield require a candidate for their facility recognition programs to have a surgeon who performs at least 50 spinal fusions per year.

In FY 2013, some 1,665 spinal fusions were performed in the MHS, where spinal fusions are performed either by neurosurgeons or by orthopedic surgeons who have completed the appropriate fellowships. Ninety-five neurosurgeons and orthopedic surgeons recorded 1,914 different procedure codes associated with these fusions.

Most surgeons perform a small number of procedures. The median volume per surgeon was 9 spinal fusions in FY13. Twenty-three percent performed a single spinal fusion in FY13.

The majority of patients have their procedure performed by a high volume surgeon. Twenty-five percent recorded 32 or more fusions in FY13. These surgeons performed 58 percent of all spinal fusions in MHS.

Figure 5. Distribution of spinal fusion volume, by key provider type (FY13)



Source: CNA calculations from MDR data

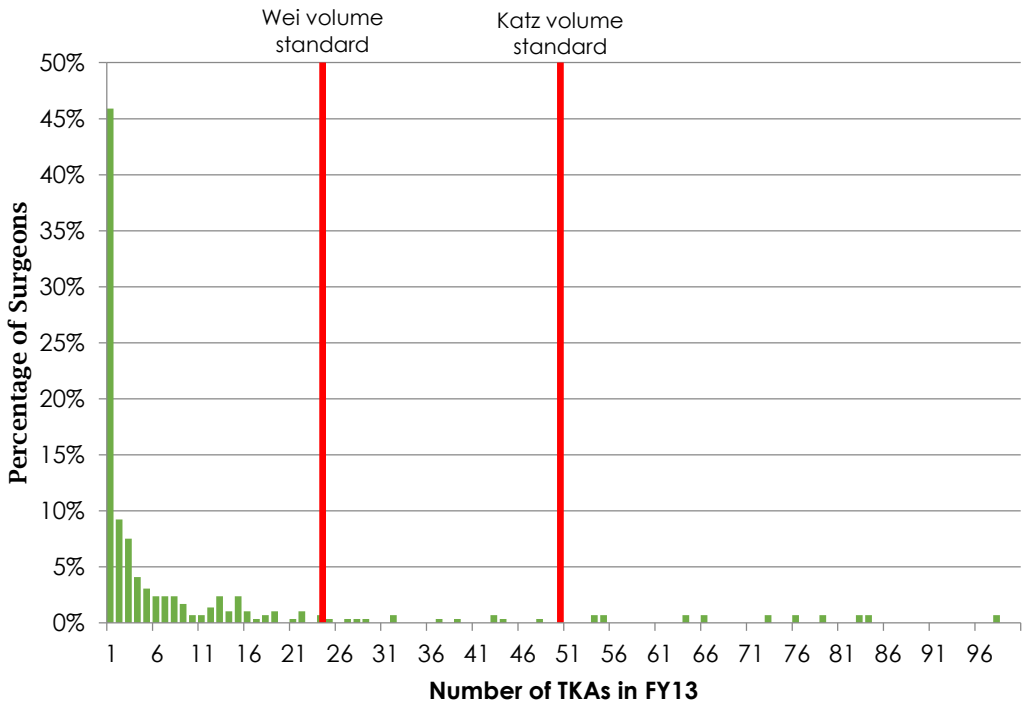
Total knee arthroplasty

Katz et al. [48] found that patients of surgeons who perform 50 or more knee replacements per year have lower rates of surgical site infection and shorter lengths of stay compared with the patients of surgeons who perform fewer than 50. Wei et al. [49] found similar results among patients of surgeons who perform 24 or more knee replacements per year.

In FY 2013, some 1,721 total knee arthroplasties (TKAs) were performed across all MHS facilities; 292 orthopedic surgeons (including subspecialists) recorded 2,319 procedure codes associated with these surgeries. The median number of procedures per year per surgeon was 2. Of the orthopedic surgeons who performed knee replacements in FY 2013, some 46 percent performed just 1 procedure, and 10

surgeons performed 50 or more procedures. Those 10 high-volume providers performed about one-fifth of all procedures; another 24 providers performed 24 or more procedures in FY 2013, accounting for another one-third of TKA procedures.

Figure 6. Distribution of total knee arthroplasty (TKA) volume, orthopedic surgeons (FY13)



Source: CNA calculations from MDR data

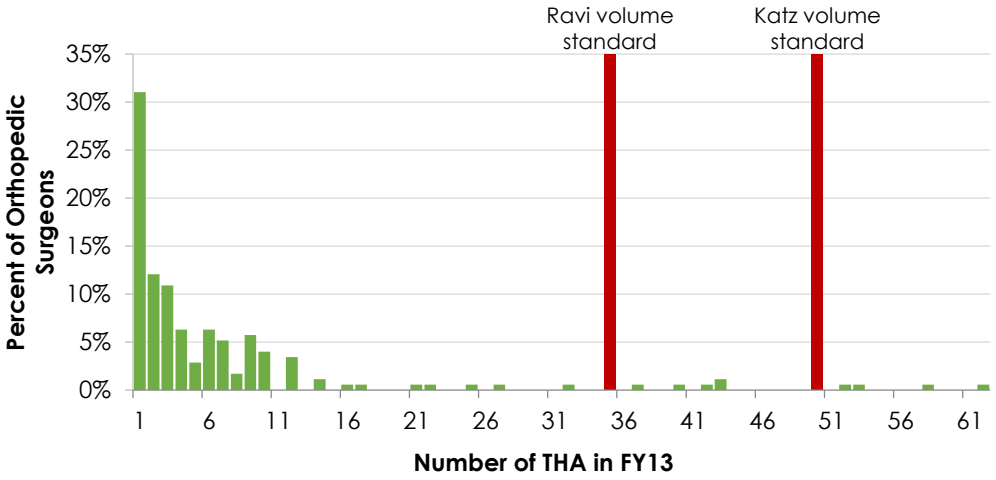
Total hip arthroplasty

Ravi et al. [22] found that patients of surgeons who perform more than 35 primary hip replacements per year are at lower risk for dislocation and early revision. Katz et al. [46] found that patients of surgeons who perform 50 or more procedures per year have lower rates of mortality and of selected complications.

In FY 2013, some 943 total hip arthroplasties (THAs) were performed in across all MHS facilities. A total of 174 orthopedic surgeons (including subspecialists) recorded a total of 1,225 procedure codes associated with these surgeries. Thirty-one (31)

percent of these surgeons recorded just 1 THA-related procedure in FY 2013. The median provider in this group performed 3 procedures per year; nine providers performed 35 or more procedure codes in FY 2013. These nine surgeons performed 29 percent of all THA procedures in FY 2013. A total of four providers recorded 50 or more procedure codes; these providers logged 18 percent of all hip replacement procedures and are associated with nearly 24 percent of all surgeries.

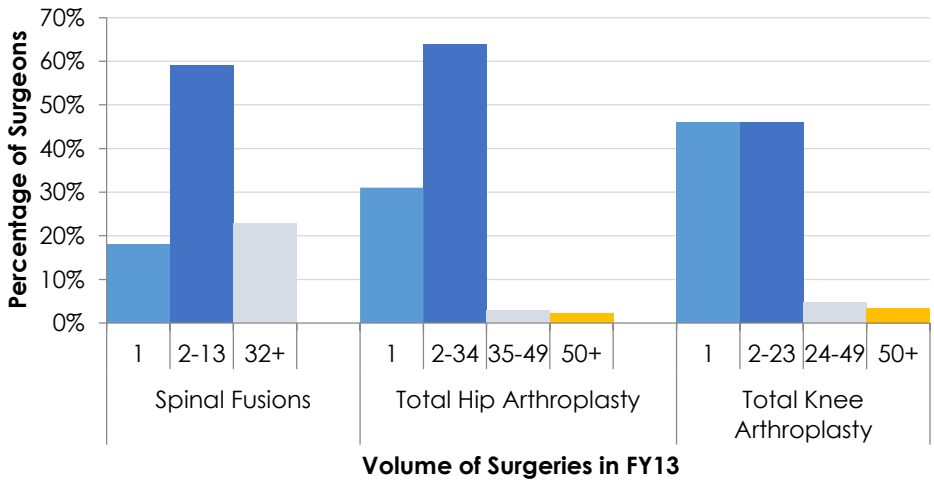
Figure 7. Distribution of total hip arthroplasty volume, orthopedic surgeons (FY13)



Source: CNA calculations from MDR data

To summarize (see Figure 8, below): Most of the surgeons performing spinal fusion, TKA, and THA in the MHS do not meet volume standards identified in the empirical literature. Though we looked at a limited number of procedures, there is no reason to believe that these surgeries are exceptions.

Figure 8. Distribution of spinal fusions, total hip arthroplasty, and total knee arthroplasty, specialty surgeons (FY13)



Source: CNA calculations from MDR data

Intensive care units operate at low volumes

Data from FY 2013 MHS administrative records shows that most MTFs with ICUs are providing services at volumes that are low relative to the standards called out in the peer-reviewed literature.

Total admissions

Glance et al. [50] finds the best outcomes in facilities in the highest quartile of their sample (with volumes above 1,234 admissions per year) and poorest outcomes in facilities in the lowest quartile (with volumes below 631 admissions per year).

Only 7 of 39 MTFs (18 percent) with ICUs in the MHS had a volume of admissions of 1,234 per year or greater during FYs 2011–2013. Sixty (60) percent of MTFs had annual admissions lower than 631 per year. (See Figure 9.)

Sepsis cases

Hospitals with at least 120 admissions yearly for sepsis have the lowest mortality rates, while hospitals with fewer than 40 admissions yearly have the highest rates [27].

Only 5 of 39 MTFs (13 percent) with ICUs met the high-volume standards during FYs 2011–2013. (See Figure 10.)

Pneumonia cases

Patient mortality rates are higher for physicians who treat fewer than 36 cases of pneumonia in the ICU per year than for physicians who treat more than 315 cases [28].

Regardless the number of physicians operating at MTFs, not one MTF ICU admitted 315 pneumonia cases during FYs 2011–2013. (See Figure 11.)

Cardiac care

Facilities with greater than 50 ICU admissions for cardiac-related conditions have better mortality rates than do facilities with less than 20 admissions per year [29].

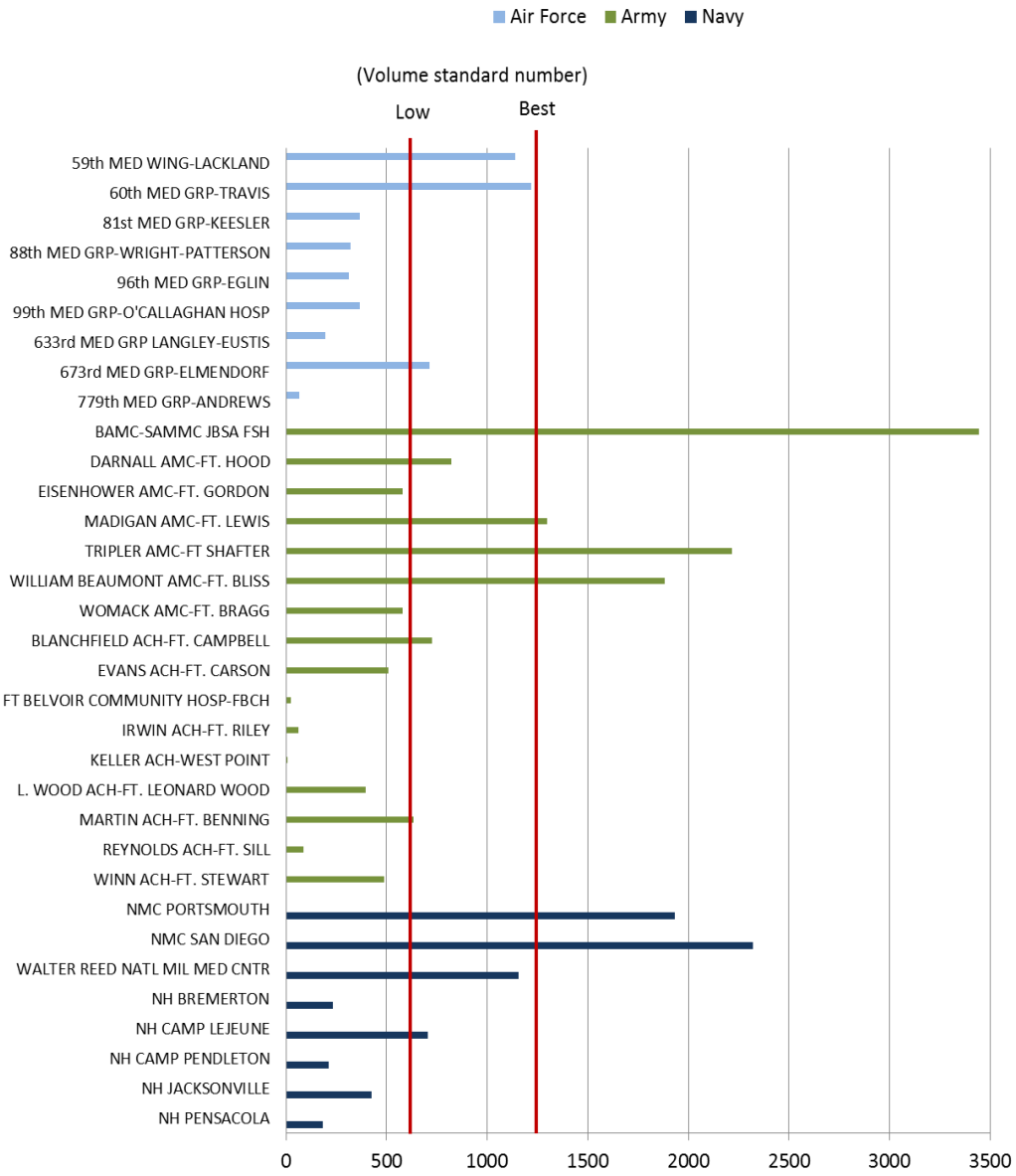
More than three-quarters of MTFs admitted 50 or more cardiac care cases during FYs 2011–2013. (See Figure 12.)

Mechanical ventilation

Mortality rates are higher in facilities that admit fewer than 99 cases of patients requiring mechanical ventilation than in facilities with 282 or more cases in the ICU per year [30].

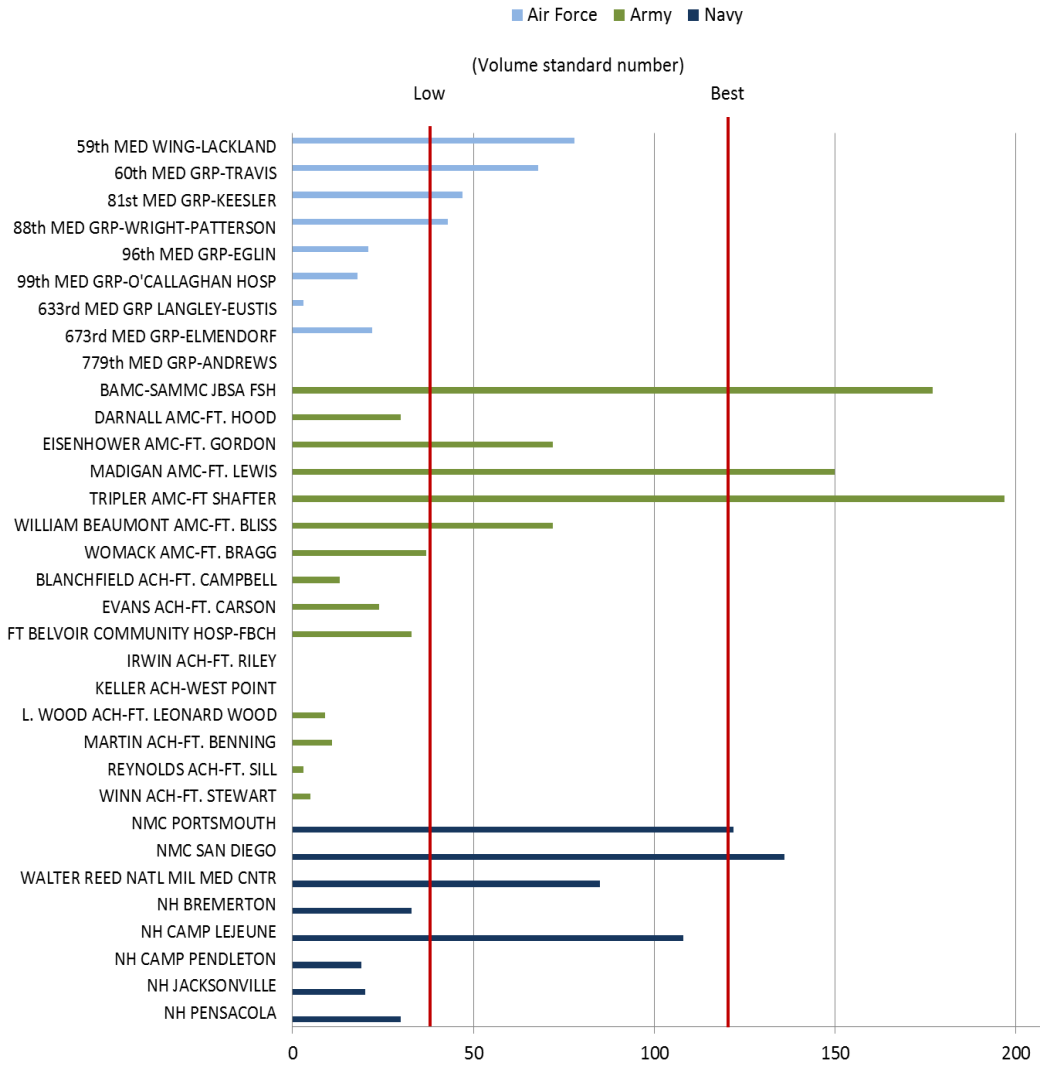
Only one MTF admitted more than 282 cases in the ICU requiring mechanical ventilation during FYs 2011–2013. (See Figure 13.)

Figure 9. Average total ICU admissions per year, by MTF (FY11–FY13)



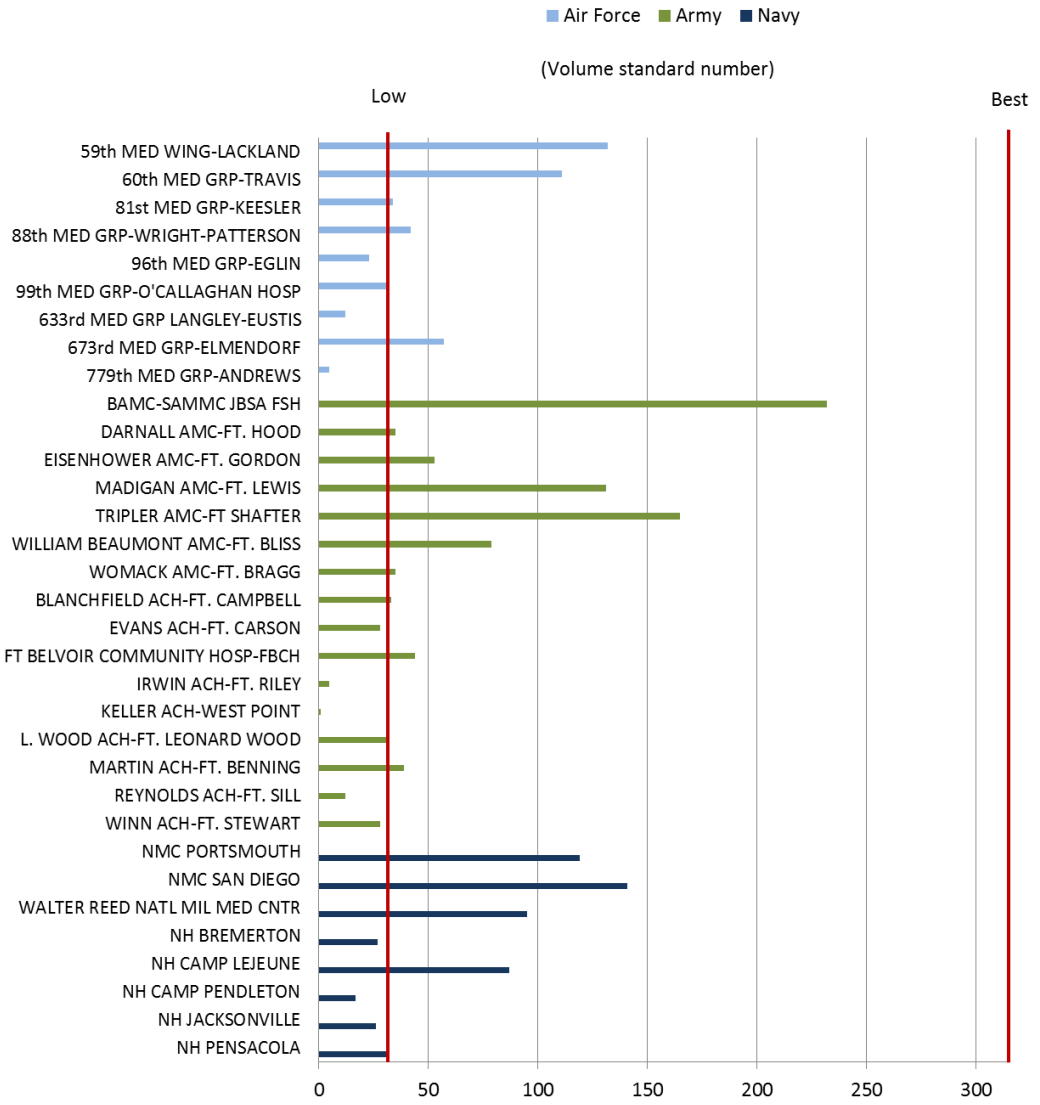
Source: CNA calculation from MDR data

Figure 10. Average ICU sepsis cases per year, by MTF (FY11-FY13)



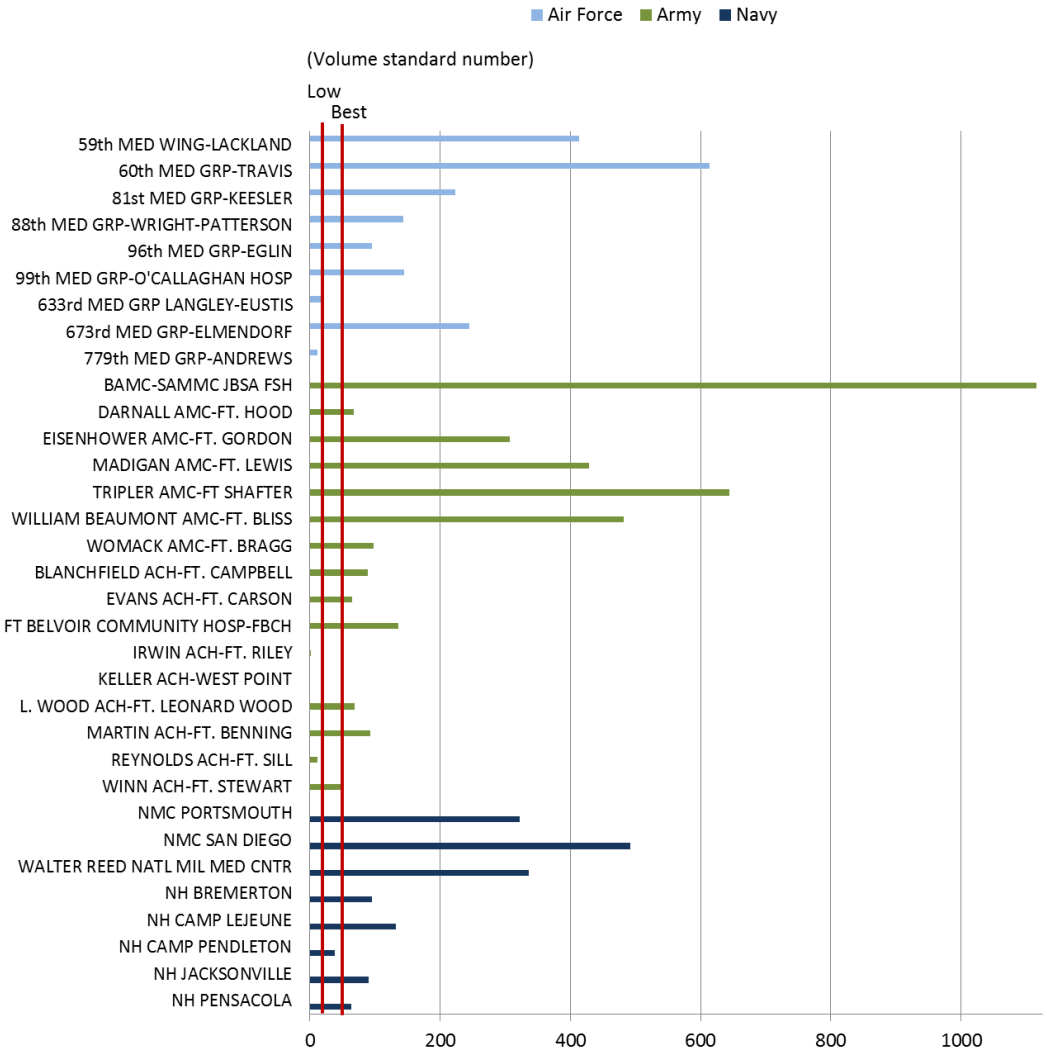
Source: CNA calculations from MDR data

Figure 11. Average ICU pneumonia cases per year, by MTF (FY11-FY13)



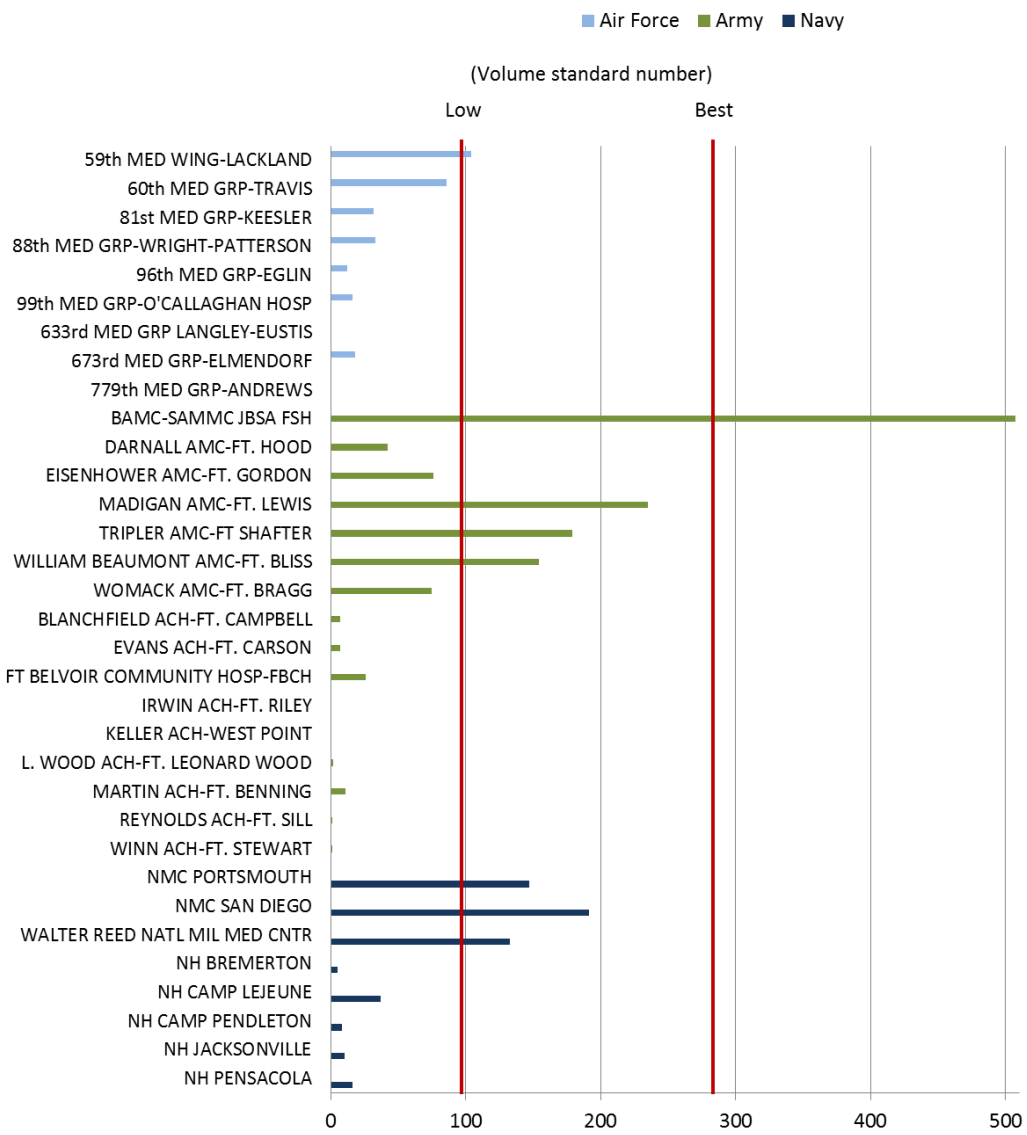
Source: CNA calculations from MDR data

Figure 12. Average ICU cardiac care admissions per year, by MTF (FY11-FY13)



Source: CNA calculations from MDR data

Figure 13. Average mechanical ventilation ICU cases per year, by MTF (FY11-FY13)



Source: CNA calculations from MDR data

Low-volume programs are clustered geographically

Over the last several years, many MTFs have closed down low-volume lines of major surgery. Still, we frequently see relatively low volume military facilities in close proximity to each other. Our findings are summarized in Table 8.

We recognize that some of the lowest-volume facilities listed in this table may possibly be coding errors. Even so, we see cases where the MHS could rationalize and operate one facility that meets the evidence-based volume targets, rather than multiple facilities at low volume.

In the National Capital Area, for example, two major hospitals operate less than 30 miles from each other. Ft. Belvoir and Walter Reed National Military Medical Center operate competing programs in hip and knee replacement and in spine surgery. Unifying the hip and knee programs and directing their patients to one facility would eliminate one very low volume program. Unifying the spine programs would eliminate a low-volume facility and allow the combined program to meet the higher Aetna volume target for its Institute of Quality.

Table 8. Volume of selected surgeries, by site (FY13)

Surgery	Location	MTF	Procedures (#)
Knee replacement	National Capital Area eMSM	Walter Reed Natl Mil Med Cntr	53
		Ft Belvoir Community Hosp	26
		Kimbrough Amb Car Cntr-Ft Meade	4
	Puget Sound eMSM	Madigan AMC-Ft. Lewis	133
		NH Bremerton	33
	San Antonio eMSM	BAMC-SAMMC JBSA FSH	224
		59th Med Wing-Lackland	1
	San Diego eMSM	NMC San Diego	188
		NH Camp Pendleton	1
	Tidewater eMSM	NMC Portsmouth	191
		633rd Med Grp Langley-Eustis	21
Hip replacement	National Capital Area eMSM	Walter Reed Natl Mil Med Cntr	50
		Ft Belvoir Community Hosp	11
	Puget Sound eMSM	Madigan AMC-Ft. Lewis	80
		NH Bremerton	18
	San Diego eMSM	NMC San Diego	124
		NH Camp Pendleton	1
	Tidewater eMSM	NMC Portsmouth	129
		633rd Med Grp Langley-Eustis	12
Spine surgery	National Capital Area eMSM	Walter Reed Natl Mil Med Cntr	155
		Ft Belvoir Community Hosp	72

Key: eMSM= Enhanced Multi-Service Markets. NH-Naval Hospital. NMC=Naval Medical Center. AMC=Army Medical Center.

Source: CNA calculations from MDR data

In the Puget Sound area are two facilities about 40 miles apart that are operating competing orthopedic programs. Sending all joint replacement patients at Naval Hospital Bremerton to Madigan AMC would put Madigan very nearly at the volume target for hip replacements.

In San Diego, sending patients the 50 miles from Naval Hospital Camp Pendleton to Naval Medical Center San Diego would transfer hip replacement patients from a low-volume program to a program that meets the hip replacement volume target, and it would eliminate a low-volume knee program.

Summary and Conclusions

Patients who have their treatments in high-volume settings generally have better outcomes. For many complex procedures and treatments, there are reputable, broadly accepted studies that link better outcomes to higher volumes.

The quality-volume literature has been embraced by civilian institutions. Civilians use volume statistics for marketing and facility and provider assessment. Civilian medical care has organized itself to send most patients to receive their care in high-volume settings.

Most MTFs are performing their complex surgeries at low volumes. Most patients in the MHS receive their surgeries in settings that the literature associates with poorer quality outcomes. Few MHS physicians meet the volume targets from the literature. With a few exceptions, most facilities miss volume targets for ICU care.

We appreciate that MHS direct care facilities have not been managed with the quality-volume targets in mind. Many changes are necessary if MHS facilities are to have a reasonable prospect of significant increases in procedure volume. Implementing these changes would not be easy or quick. Still, low volume presents several problems for MHS.

First, the direct impact on quality is significant. If the empirical relationships that exist everywhere in civilian medicine also exist in the MHS, then holding all else constant, MHS beneficiaries treated in direct care settings have greater chance of poor outcomes, including mortality, complication, longer length of stay, and higher re-operation rates.

Second, MHS physicians do not have the benefits associated with high volume: Holding all else constant, because they perform few procedures, providers have higher complication rates, higher re-operation rates, higher readmission rates, and higher mortality rates and they are slower in the operating room.

Third, there are ripple effects across the program. For example, low volume also has implications for graduate medical education (GME). Low volume of surgical patients has an adverse impact on GME for surgical specialties. Residents in a Family Practice GME program are required to serve a rotation in an intensive care unit; low volume of complicated cases through these ICUs cannot be helpful for GME. Critical skills across the enterprise have fewer training opportunities.

The alternative vision is one of an MHS designed around quality-volume principles. The vision includes centers of excellence based on process standardization and evidence based practices, resourced to allow providers to achieve high levels of proficiency honed by frequent practice. TRICARE covers nearly 10 million beneficiaries. There is an opportunity to capture the patient workload necessary to achieve this vision of high volume targets for prividers and facilities.

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