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Variation in Bariatric Surgery Costs and Complication Rates in the Military Health System

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ABSTRACT Introduction: Within the Military Health System (MHS), facilities have struggled to meet minimum recommended volume thresholds for certain procedures. Understanding variations in complication rates and cost can help policymakers tailor policy to target improvement. Our objective was to quantify the variation in bariatric surgery complication rates and costs across a sample of military hospitals. Materials and Methods: We study a retrospective cohort of 38 military surgeons practicing in 21 military treatment facilities from 2007 to 2014 who performed 1,277 bariatric surgeries. Data from the Centralized Credentials and Quality Assurance System, which provides education and training characteristics of physicians, were linked to patient encounter data from the MHS Data Repository. Physicians were included if they performed at least five bariatric surgeries over the study period. Patients were included if they had a diagnosis of obesity (body mass index > 30) and underwent a bariatric weight loss surgery. We calculated and summarized inpatient costs and complication rates across both surgeons and facilities using multivariable mixed-effects linear or logistic models. We used these models to calculate adjusted complication rates and average costs across both providers and hospitals to characterize variation in bariatric outcomes within the MHS. This study was considered exempt by the Uniformed Services University Institutional Review Board. Results: We find evidence of large variations in both complication rates and costs per admission. Overall, we found a 15.5% complication rate across the sample. When comparing averages across facilities, we find large variation in complications (49.4% coefficient of variation [CV]) and procedure costs (25.9% CV). Controlling for patient comorbidities, BMI, and year attenuates much of the variation (12.6% CV complications, 4.4% CV cost), but cannot completely explain differences across facilities. Our model suggests that complications cost 32% more than complication-free surgeries on average suggesting that quality improvement efforts could potentially yield large savings. Conclusions: We find large variations in complication rates even after controlling for patient health. Furthermore, surgical complications are a significant determinant of cost. Policymakers should target efforts to improve surgical quality across facilities and physicians. Surgical quality improvement initiatives could produce savings to the MHS through reduced complications and improved surgical readiness.

INTRODUCTION

With a rise in obesity rates, bariatric surgery has become an increasingly common surgical procedure.[1,2] While mortality rates have decreased over time to 0.1 to 0.2%, serious complication rates remain a challenge.[2] Furthermore, small caseloads and low event rates make reliably differentiating between both low- and high-performing surgeons and facilities difficult.[3] Within the Military Health System (MHS), the prevalence of obesity is around 18.3% among active duty service members and 32.9% among nonactive duty beneficiaries.[4] Bariatric surgery for weight loss has been identified as a low-volume high-risk surgery in media outlets leading to a recent full review by the Defense Health Board.[5] In pursuit of improving clinical outcomes, several military treatment facilities, such as William Beaumont Army Medical Center and Madigan Army Medical Center, have pursued accreditation as a Bariatric Center of Excellence by the American College of Surgeon's Metabolic and Bariatric Surgery Accreditation and Quality Improvement Program.[6] Other programs have allowed uniformed providers to perform surgeries in civilian bariatric centers of excellence to maintain clinical readiness and currency.[7]

The magnitude and determinants of variation in the costs of surgical procedures are not well characterized. Research has shown that the costs of common surgical procedures can vary widely by up to 28-fold even after adjustment for patient observables and surgical complexity.[8] Similarly, complication rates have been shown to vary significantly across facilities by up to a factor of 17 irrespective of surgical volume or accreditation as a surgical Center of Excellence.[9,10] These surgical complications have been shown to be significant drivers of costs to hospitals and healthcare payers.[11,12] A large vein of research has found that surgical volume is closely associated with better outcomes and lower costs for some procedures. While the literature relating volume to quality is quite

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extensive, there are few studies investigating the relationship between surgical cost and quality. Work using Medicare data, which has more standardized prices, has found that surgical complications and quality are important determinants of costs.[13–15] Lower-quality, lower-volume facilities have been shown to receive higher payments for 30-day readmissions and post-discharge ancillary care.[16] This suggests that efforts to target quality improvement may reduce expenditures.

For the Department of Defense's MHS, these challenges pose a two-pronged quandary. On one hand, due to the relative youth and health of the military population, the system often lacks the patient caseload to meet recommended minimum volume thresholds at some facilities.[17] On the other, leaders within the MHS must balance the organization's role as a payer against its obligation to maintain the highest readiness and competency standards for its surgeons all while providing the safest care possible to its patients. In other words, policymakers need to understand if the "business case" for improving surgical quality and efficiency translates to the MHS and aligns with other operational goals. As the MHS shifts to a centrally managed structure under the Defense Health Agency, an understanding of surgical variations could help policymakers to consider ways to standardize and improve surgical quality and outcomes. Given these challenges, we sought to evaluate variations in complication rates and the costs of bariatric surgery, considered an important training surgery for deploying medical personnel, in a population of uniformed surgeons practicing in military hospitals across the country.

METHODS

Data Source and Study Population

We analyze data from the Department of Defense's MHS Data Repository (MDR) database. The MDR is a centralized data repository integrating MHS healthcare data worldwide. This system contains robust beneficiary, clinical, and administrative data. We also extract provider training and education characteristics from the Centralized Credential and Quality Assurance System (CCQAS), a web-based, worldwide credentialing, privileging, and risk management system for the Defense Health Agency. CCQAS is a regularly updated database compiling information on uniformed providers including medical education, post-graduate training, and any additional qualifying medical training.

We study a sample of Active Duty physicians who practiced and were stationed within the continental United States for the years 2007 through 2014. We then match bariatric surgeries (identified from International Classification of Diseases, 9th Revision, Clinical Modification [ICD-9-CM] codes) from the MDR to our sample of providers over the same time period. For this analysis, we focus on bariatric procedures, including Roux-en-Y gastric bypass, sleeve gastrectomy, gastric banding, and biliopancreatic diversion with duodenal switch. We exclude surgical revisions from our sample. The ICD-9-CM codes used to identify procedures are included in Supplemental Table 1. Note that over the course of this study, ICD-9 codes were added for select procedures (ie, lap sleeve gastrectomy). For this reason, we do not stratify our analysis by the type of bariatric surgery performed. Practice location is determined by the Defense Medical Information System ID, a facility identifier. We excluded physicians who performed fewer than five surgeries over the 8-year period of observation resulting in a 6% decrease in sample size. Our final patient sample consisted of 1,277 unique TRICARE beneficiaries who received bariatric surgery from 2007 through 2014. Due to data restrictions resulting from deidentification, we have limited patient demographic information.

Outcome Variable—Surgical Complications

We calculate complication rates using previously described ICD-9-CM codes.[1,18] These complications fell into the following general categories: anastomotic leak, splenic injury, hemorrhagic, wound infection, gastrointestinal, pulmonary, cardiac, genitourinary, neurologic, obstruction, postoperative shock, thromboembolic, and unexpected reoperation. We include a full list of the codes used in the Supplemental Table 2. We then create an indicator variable for the presence of any recorded complication. For this analysis, we only consider complications which occurred during the initial inpatient admission.

Outcome Variable—Costs

This outcome variable is composed of a surgical encounter's cost. For this analysis, we use MDR generated patient-level cost accounting figures which best capture the true cost to the MHS of a surgical episode. Patient-level cost accounting allocates patient care, support, and overhead costs to clinical services. These costs are centrally administered and regularly audited for accuracy. Due to the right-skewed distribution of expenditure data, for estimating equations, we take the natural log to reach a more normal distribution appropriate for use with linear models.

Statistical Analysis

First, we present summary statistics of our physician cohort including demographic and educational characteristics. We then summarize counts of different types of bariatric surgery and average costs stratified by facility. For unadjusted costs presented in summary tables and figures, we deflate costs to 2014 dollars using the Medical Care component of the Consumer Price Index (CPI-U).[19,20]

We use multivariable mixed-effects logistic models to adjust complication rates for patient-level factors. The model includes the number of Elixhauser comorbidities, patient body mass index (BMI) bins, and calendar year as covariates. To account for clustering and small samples, we include random effects at both the facility and individual surgeon levels to shrink our estimates. We then use this model to calculate adjusted complication rates for both surgeons and facilities. To model spending, we use linear mixed-effects models to estimate ln-transformed spending per surgical episode including categorical variables for year, the number of Elixhauser comorbidities, patient BMI bins, and an indicator for the presence of a complication. We do not overtly control for additional covariates such as individual comorbidities, surgical history, or additional demographics due to concerns of model overfitting. Given the smaller cell sizes at the physician and facility levels, the addition of too many covariates would likely lead to overfitting, which can cause misleading model results. This multilevel model also includes random effects at both the facility and physician levels. Note that when summarizing variations in spending at the facility and physician levels in subsequent figures we remove the complication indicator from the model to capture real variation in complications that could be causing differences in spending across hospitals. We apply a Bonferroni correction to adjust confidence intervals for multiple comparisons when plotting costs and complications rates. Analysis was conducted using STATA Version 15.

TABLE I. Bariatric Surgeon Cohort Characteristics

	Count	Percent
Service		
Air Force	9	24
Army	18	47
Navy	11	29
Rank		
O-4	7	19
O-5	13	34
O-6	18	47
Medical degree		
DO	3	8
MD	35	92
Recorded specialty (2017)		
General surgery	36	94
Trauma surgery	1	3
Surgical oncology	1	3
Total	38	100
	Mean	**SD**
Years of post-graduate experience	13.02	3.95
Number of bariatric surgeries per year	12.45	7.84
Physician-years of observation	5.44	1.71

Note. Medical specialty is recorded based upon the last entry at the time of the data pull which occurred in 2017. Surgeons could be in a residency or fellowship during the study period and have further subspecialized in the years during or after our study period.

RESULTS

We analyzed a total of 1,277 bariatric surgeries. Characteristics of the surgeons in our sample are shown in Table I. Overall, surgeons are more likely to be affiliated with the U.S. Army, tend to be more senior officers, possess a MD, and be trained as a general surgeon. Individual surgical volumes vary substantially and are relatively low as compared to civilian medicine with about 12 surgeries per year. There was large heterogeneity in both the procedure type and volume in our sample. Supplemental Figure 1 summarizes counts of the type of bariatric surgery by the 21 military hospitals in our sample. The blue line overlaying the histogram depicts the average unadjusted cost per surgical episode for each facility deflated to 2014 dollars. Laparoscopic Roux-en-Y gastric bypass and laparoscopic sleeve gastrectomy were the most common types of procedures performed in our sample. Open surgeries were uncommon, consistent with trends in clinical practice toward less invasive procedures.[21] Unadjusted, untransformed surgical episode costs exhibited variation in the sample with mean costs of $22,554 and a coefficient of variation across hospitals of 26%. We find that procedure choice, surgical volume, and cost are all heterogeneous across facilities. The most frequently performed type of bariatric surgery varied across hospitals as did overall bariatric volume in the sample. Overall, the complication rate in our sample was 15.5%, in-range with comparable estimates among civilian facilities (12.3–18.7%) when using the same set of ICD-9 codes of complications.[18]

To better account for differences in patient health, we present results from our models of complications and cost in Tables II and III, respectively. In Table II, we present odds ratios for variables included in the model. Multiple comorbidities strongly increase the odds of a surgical complication. We then use this model to calculate adjusted complication rates for each physician and hospital which we present in Figure 1A and B. Along with point estimates, we also present corresponding 95% confidence intervals corrected for multiple comparisons. The horizontal black line represents the overall sample average. We find evidence of significant variation in complication rates even after adjustment when considering both individual surgeons (17% coefficient of variation [CV]) and hospitals (12.6% CV).

Next, we consider our model of spending. We use natural log-transformed costs as an outcome to better account for the right-skewed distribution of our data.[22] This transformation means that regression coefficients must be exponentiated in order to be easily interpreted. The last column in Table III presents exponentiated coefficients representing the percent change in untransformed dollars of a one unit change in the independent variable. Our model shows that comorbidities and complications explain a large share of the differences in spending. For instance, surgical episode costs are 30% higher for patients with six Elixhauser comorbidities relative to those without a single comorbidity. Similarly, complications result in 32% higher episode costs on average when controlling for other variables. The variance components of the random effects estimate the amount of the overall variance in costs attributable to facilities and individual physicians

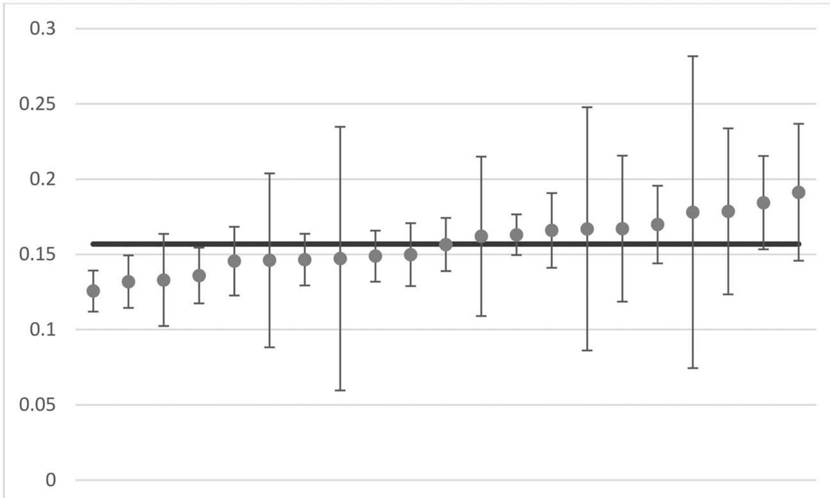
TABLE II. Mixed-Effects Logistic Model of Surgical Complication

	Odds Ratio	Standard Error	*P* value
BMI 30–39	Reference		
BMI > 40	1.037	0.189	0.840
Elixhauser comorbidity count			
0	13.099	8.314	<0.001
1	Reference		
2	1.022	0.240	0.925
3	1.756	0.404	0.015
4	1.023	0.323	0.941
5	2.995	1.213	0.007
6	5.623	4.403	0.027
Calendar year			
2007	Reference		
2008	0.432	0.183	0.047
2009	0.748	0.277	0.433
2010	0.662	0.244	0.262
2011	0.754	0.265	0.421
2012	0.342	0.137	0.006
2013	0.651	0.235	0.234
2014	0.429	0.162	0.025
Constant	0.123	0.029	0.001
	Variance	**SE**	
Random-effects levels			
Facility	8.94E-36	4.00E-19	
Physician	0.159	0.089	

TABLE III. Multivariable Linear Mixed Model of Surgical Episode Costs

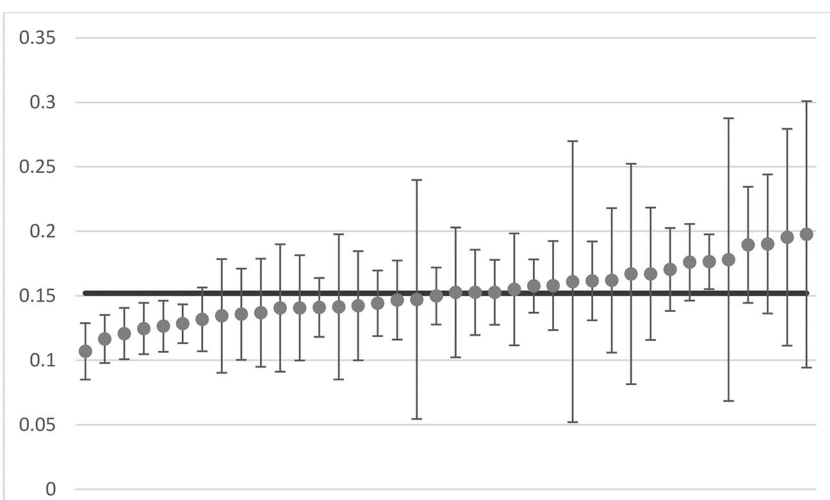
	Coefficient	SE	*P* value	Proportional Change (%)
BMI 30–39	Reference			
BMI > 40	0.024	0.015	0.121	2.4
Elixhauser comorbidity count				
0	−0.135	0.071	0.056	−12.6
1	Reference			
2	−0.019	0.018	0.313	−1.8
3	−0.002	0.020	0.927	0.2
4	0.072	0.025	0.004	7.5
5	0.044	0.042	0.294	4.5
6	0.260	0.088	0.003	29.7
Complication indicator	0.277	0.019	<0.001	31.9
Calendar year				
2007	Reference			
2008	−0.033	0.037	0.360	−3.2
2009	−0.094	0.035	0.008	−9.0
2010	−0.069	0.035	0.050	−6.7
2011	−0.078	0.034	0.022	−7.5
2012	0.062	0.034	0.071	6.4
2013	0.091	0.034	0.008	9.5
2014	0.085	0.034	0.012	8.9
Constant	9.654	0.089	<0.001	
	Variance	**SE**		
Random-effects levels				
Facility	0.038	0.013		
Physician	0.002	0.002		
Residual	0.059	0.002		

A. Average Adjusted Complication Rates by Facility



Note: An observation represents a facility's average adjusted complication rate with accompanying 95% confidence intervals. Complication rates are adjusted for calendar year, Elixhauser comorbidities, and patient BMI bins. The horizontal black line represents the sample average complication rate. The coefficient of variation is 12.6%

B. Average Adjusted Complication Rates by Surgeon



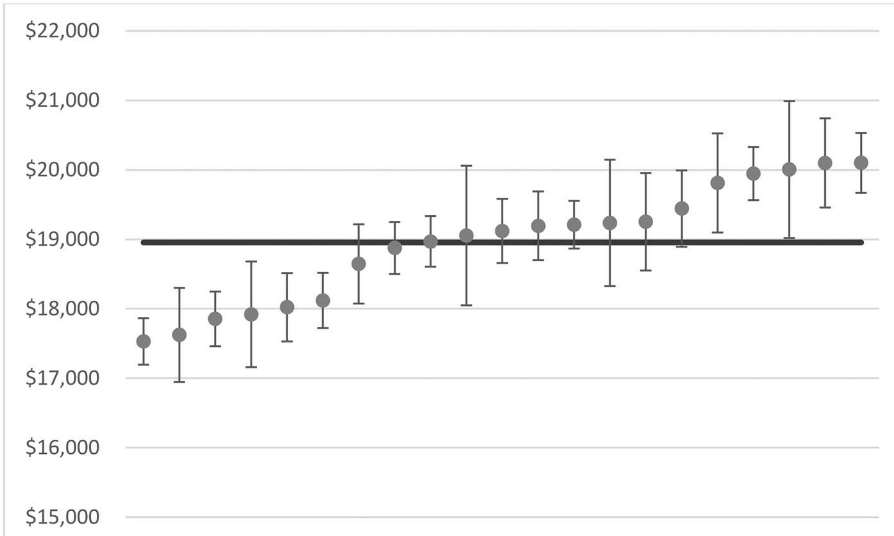
Note: An observation represents a surgeon's average adjusted complication rate with accompanying 95% confidence intervals. Complication rates are adjusted for calendar year, Elixhauser comorbidities, and patient BMI bins. The horizontal black line represents the sample average complication rate. The coefficient of variation is 17.0%

FIGURE 1. Complication rates and costs by facility and surgeon. (A) Average adjusted complication rates by facility. (B) Average adjusted complication rates by surgeon. (C) Average adjusted cost by facility. (D) Average adjusted cost by surgeon. *Continue*

nested within facilities. Differences between hospitals explain 38% of the total variance while differences between surgeons explain 2%. While the total variance is relatively small, hospital-level effects explain a greater share of the variance than physicians.

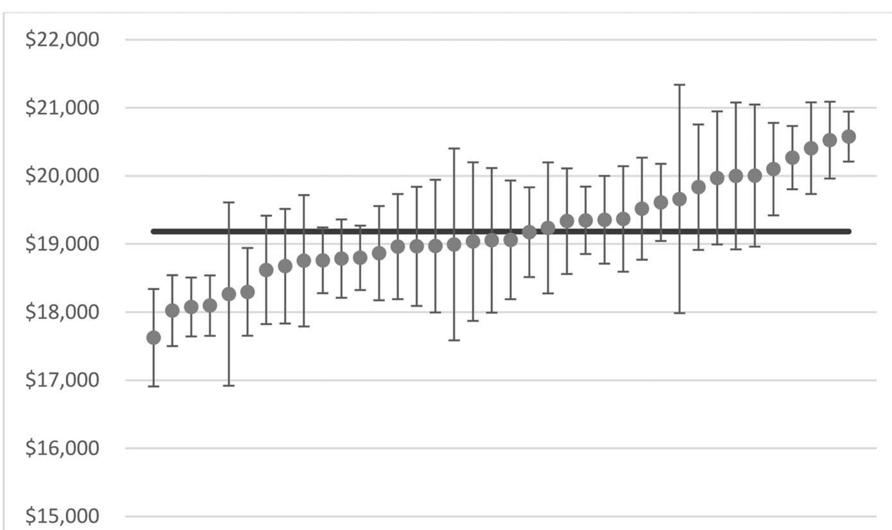
Figure 1C and D presents physician- and facility-average adjusted costs and corresponding 95% confidence intervals. Note that when calculating these adjusted costs, we do not control for complications to capture any heterogeneity in complication rates which may be driving spending

C. Average Adjusted Cost by Facility



Note: An observation is a facility's average surgical cost with accompanying 95% confidence intervals. Costs are adjusted for calendar year, Elixhauser comorbidities, and patient BMI bins. The horizontal black line represents the sample average adjusted cost. The coefficient of variation is 4.4%.

D. Average Adjusted Cost by Surgeon



Note: An observation is a physician's average surgical cost with accompanying 95% confidence intervals. Costs are adjusted for calendar year, Elixhauser comorbidities, and patient BMI bins. The horizontal black line represents the sample average adjusted cost. The coefficient of variation is 3.8%.

FIGURE 1. Continued

differences. Adjusted costs are estimated with categorical variables for patient BMI bins, the count of Elixhauser comorbidities, and calendar year with random effects at the hospital and surgeon levels. The horizontal black line represents the sample average adjusted cost. Ninety-five percent confidence intervals are again adjusted for multiple comparison testing using a Bonferroni correction. We find that several facilities consistently provide more efficient than average care, while other hospitals appear more expensive. This pattern also holds when comparing across physicians.

DISCUSSION

In this study, we aimed to estimate variations in the costs and complication rates of bariatric procedures within the MHS. Upon controlling for patient health through comorbidities and BMI, we find that variations persist with respect to both costs and complication rates. The differences across both hospitals and surgeons suggest that there is room for sustained quality improvement. Furthermore, efforts to standardize and improve surgical quality could not only lead to better patient outcomes and improved surgical readiness but could also decrease costs to the MHS.

This study had several strengths that give credence to our findings. The MHS Data Repository is a robust data source particularly for encounters, which occur in Department of Defense (DoD)-operated facilities. These encounters have a distinct advantage to claims in that we can observe the true cost to the DoD by using patient-level cost accounting. Our modeling approach, which uses random effects at both the hospital and surgeon levels, helps accounts for clustering and small sample sizes that may lead to imprecise estimates. Random effects allow us to shrink our estimates for reliability and consistency.

The MDR contains robust beneficiary data; however, owing to data restrictions and deidentification, we could only account for clinical factors recorded in the MDR and could not model patient demographics such as age, race, or sex. Additionally, we were limited to investigating complications, which occur during the initial inpatient admission and cannot examine other quality measures such as readmissions or 30-day complications. Lastly, our study may not be directly generalizable to other settings. Though the MHS faces many similar challenges as the civilian healthcare sector, research has shown that patterns of variation are vastly different between private and public payers.[23]

The MHS has come under considerable pressure in recent years to meet minimum thresholds for surgical volume. Our study suggests that despite the relatively low volume observed in this sample our overall bariatric complication rate (15.5%) is comparable to rates among civilian centers when using the same set of ICD-9 codes for complications (12.3–18.7%).[18] These results support work by Dimick and colleagues who suggest that bariatric procedure volume is not strongly predictive of quality or outcomes.[24] Future study should examine the relationship between bariatric volume and outcomes in the MHS. Currently, surgical volume varies considerably with case load concentrated at large medical centers including Brooke Army Medical Center, William Beaumont Army Medical Center, and Darnall Army Medical Center.[25] Recent reform efforts have instead focused on the accreditation of military medical centers as Centers of Excellence. The civilian literature on this topic finds that at best accreditation brings modest decreases to morbidity and mortality and at worst has no effect.[9,24] However, even among accredited bariatric surgery centers, wide variation still exists in rates of postoperative complications across locations and operative volumes.[9] This suggests that it is important to further understand the higher performing centers and consider alternative means of improving outcomes through a regional approach or selective referrals. Furthermore, accreditation may have spillover benefits to other departments which can also benefit from data-driven clinical improvement and streamlined processes.

In light of the landmark reorganization of the MHS under the Defense Health Agency, policymakers have a unique window of opportunity to shape the future of military medicine. In this context, policymakers should prioritize efforts to reduce surgical complications and improve quality through sustained and standardized quality initiatives. It is also important to remember the MHS's perspective as a payer. Annual budgets are not created using risk-adjusted dollars, and costly complications can contribute to rising healthcare costs. Policymakers can, however, align their obligations to provide cost-effective, high-quality care with the need for competent surgeons capable of deploying to the battlefield. Future research should focus on evaluating a unified strategy for the MHS, which best combines the "business case" for quality improvement with other operational goals such as surgical readiness and a healthy beneficiary population.

CONCLUSION

In summary, as the MHS seeks to promote cost-efficiency, surgical competency, and high-quality care, policymakers and clinicians alike must grasp the dynamics of high-risk, low-volume procedures such as bariatric surgery. To efficiently improve quality and reduce costs, policymakers must understand the magnitude and determinants of variations. This study suggests that standardized improvements to surgical quality would benefit all parties through safer care at lower cost.

SUPPLEMENTARY MATERIAL

Supplementary material can be found at Cerebral *Cortex* online.

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REFERENCES

1. Santry HP, Gillen DL, Lauderdale DS: Trends in bariatric surgical procedures. JAMA 2005; 294(15): 1909–17.
2. Khan S, Rock K, Baskara A, Qu W, Nazzal M, Ortiz J: Trends in bariatric surgery from 2008 to 2012. American Journal of Surgery. 2016; 211(6): 1041–6.
3. Krell RW, Finks JF, English WJ, Dimick JB: Profiling hospitals on bariatric surgery quality: Which outcomes are most reliable? Journal of the American College of Surgeons 2014; 219(4): 725, e723–34.

4. Eilerman PA, Herzog CM, Luce BK, et al: A comparison of obesity prevalence: military health system and United States populations, 2009-2012. Mil Med. 2014; 179(5): 462–70.
5. Defense Health Board: Low-Volume High-Risk Surgical Procedures, 2019. Available at https://health.mil/Reference-Center/Presentations/2019/05/20/Decision-Brief-Low-Volume-High-Risk-Surgical-Procedures-Second-Report.
6. Ovel S. Bariatric program earns international accreditation, 2018. Available at https://www.army.mil/article/206212/bariatric_program_earns_international_accreditation.
7. Campbell S. Agreement expands beneficiaries' access to bariatric surgery, 2009. Available at https://www.af.mil/News/Article-Display/Article/121427/agreement-expands-beneficiaries-access-to-bariatric-surgery/.
8. Wakeam E, Molina G, Shah N, et al: Variation in the cost of 5 common operations in the United States. Surgery. 2017; 162(3): 592–604.
9. Ibrahim AM, Ghaferi AA, Thumma JR, Dimick JB: Variation in outcomes at bariatric surgery Centers of excellence. JAMA Surgery. 2017; 152(7): 629–36.
10. Dimick JB, Nicholas LH, Ryan AM, Thumma JR, Birkmeyer JD: Bariatric surgery complications before vs. after implementation of a National Policy Restricting Coverage to Centers of excellence. JAMA 2013; 309(8): 792–9.
11. Healy MA, Mullard AJ, Campbell DA Jr, Hospital DJB: Payer costs associated with surgical complications. JAMA Surg. 2016; 151(9): 823–30.
12. Pradarelli JC, Healy MA, Osborne NH, Ghaferi AA, Dimick JB, Nathan H: Variation in Medicare expenditures for treating perioperative complications: the cost of rescue. JAMA Surg. 2016; 151(12): e163340.
13. Birkmeyer JD, Gust C, Dimick JB, Birkmeyer NJ, Skinner JS: Hospital quality and the cost of inpatient surgery in the United States. Ann Surg. 2012; 255(1): 1–5.
14. Scally CP, Thumma JR, Birkmeyer JD, Dimick JB: Impact of surgical quality improvement on payments in Medicare patients. Ann Surg. 2015; 262(2): 249–52.
15. Osborne NH, Nicholas LH, Ryan AM, Thumma JR, Dimick JB: Association of hospital participation in a quality reporting program with surgical outcomes and expenditures for Medicare beneficiaries. JAMA. 2015; 313(5): 496–504.
16. Regenbogen SE, Gust C, Birkmeyer JD: Hospital surgical volume and cost of inpatient surgery in the elderly. Journal of the American College of Surgeons. 2012; 215(6): 758–65.
17. Brevig H, Colosimo C, Jaditz T, et al The Quality-Volume Relationship: Comparing Civilian and MHS Practice. CNA Analysis and Solutions: Arlington, VA; 2014.
18. Banka G, Woodard G, Hernandez-Boussard T, Morton JM: Laparoscopic vs open gastric bypass surgery: differences in patient demographics, safety, and outcomes. Arch Surg (Chicago, Ill: 1960) 2012; 147(6): 550–6.
19. Abe D, GS D, Adjusting Health HZS: Expenditures for inflation: a review of measures for Health services research in the United States. Health Services Research 2018; 53(1): 175–96.
20. Bureau of Labor Statistics: Databases, Tables & Calculators by Subject [Online]. 2018. Available at https://data.bls.gov/pdq/SurveyOutputServlet; accessed June 20, 2018.
21. Kizy S, Jahansouz C, Downey MC, Hevelone N, Ikramuddin S, Leslie D: National Trends in bariatric surgery 2012–2015: demographics, procedure selection, readmissions, and cost. Obesity Surgery 2017; 27(11): 2933–9.
22. Mihaylova B, Briggs A, O'Hagan A, Thompson SG: Review of statistical methods for analysing healthcare resources and costs. Health Economics. 2011; 20(8): 897–916.
23. Cooper Z, Craig S, Gaynor M, Van Reenen J: The price ain't right? Hospital prices and Health spending on the privately insured. NBER Working Paper. 2015.
24. Dimick JB, Osborne NH, Nicholas L, Birkmeyer JD: Identifying high-quality bariatric surgery centers: hospital volume or risk-adjusted outcomes? Journal of the American College of Surgeons. 2009; 209(6): 702–6.
25. J-5 Decision Support Division: Low Volume High Risk Procedures. Defense Health Agency: Falls Church, VA; 2017.