IMPORTANCE The quality of surgical care in the Veterans Health Administration improved markedly in the 1990s after implementation of the Veterans Affairs (VA) National Surgical Quality Improvement Program (now called the VA Surgical Quality Improvement Program). Although there have been many recent evaluations of surgical care in the private sector, to date, a contemporary global evaluation has not been performed within the VA health system.

OBJECTIVE To provide a contemporaneous report of noncardiac postoperative outcomes in the VA health system during the past 15 years.

DESIGN, SETTING, AND PARTICIPANTS A retrospective cohort study was conducted using data from the VA Surgical Quality Improvement Program among veterans who underwent inpatient general, vascular, thoracic, genitourinary, neurosurgical, orthopedic, or spine surgery from October 1, 1999, through September 30, 2014.

MAIN OUTCOMES AND MEASURES Rates of 30-day morbidity, mortality, and failure to rescue (FTR) over time.

RESULTS Among 704 901 patients (mean [SD] age, 63.7 [11.8] years; 676 750 [96%] male) undergoing noncardiac surgical procedures at 143 hospitals, complications occurred in 97 836 patients (13.9%), major complications occurred in 66 816 (9.5%), FTR occurred in 12 648 of the 97 836 patients with complications (12.9%), FTR after major complications occurred in 12 223 of the 66 816 patients with major complications (18.3%), and 18 924 patients (2.7%) died within 30 days of surgery. There were significant decreases from 2000 to 2014 in morbidity (8202 of 59 421 [13.8%] vs 3368 of 32 785 [10.3%]), major complications (5832 of 59 421 [9.8%] vs 2284 of 32 785 [7%]), FTR (1445 of 8202 [17.6%] vs 351 of 3368 [10.4%]), and FTR after major complications (1388 of 5832 [23.8%] vs 343 of 2284 [15%]) (trend test, \(P<.001\) for all). Although there were no clinically meaningful differences in rates of complications and major complications across hospital risk-adjusted mortality quintiles (any complications: lowest quintile, 20 945 of 147 721 [14.2%] vs highest quintile, 18 938 of 135 557 [14%]; major complications: lowest quintile, 14 044 of 147 721 [9.5%] vs highest quintile, 12 881 of 135 557 [9.5%]), FTR rates (any complications: lowest quintile, 2249 of 20 945 [10.7%] vs highest quintile, 2769 of 18 938 [14.6%]; major complications: lowest quintile, 2161 of 14 044 [15.4%] vs highest quintile, 2663 of 12 881 [20.7%]) were significantly higher with increasing quintile (\(P<.001\)). However, across hospital quintiles, there were significant decreases in morbidity (20.6%-29.9% decrease; trend test, \(P<.001\) for all) and FTR (29.2%-50.6% decrease; trend test, \(P<.001\) for all) during the study period. After hierarchical modeling, the odds of postoperative mortality, FTR, and FTR after a major complication were approximately 40% to 50% lower in the most recent study year compared with 15 years ago (\(P<.001\) for all).

CONCLUSIONS AND RELEVANCE For the past 15 years, morbidity, mortality, and FTR have improved within the VA health system. Other integrated health systems providing a high volume of surgical care for their enrollees may benefit by critically evaluating the system-level approaches of the VA health system to surgical quality improvement.
The Veterans Affairs (VA) health system is the largest integrated health system in the United States, providing care for approximately 9 million veterans. Despite recent adverse attention in the lay press, the VA health system has been and continues to be a progressive, forward-thinking healthcare system and a source of high quality care for its patients. For example, the VA health system has consistently made the use of health information technology a national priority, with an electronic medical record system in place long before such approaches were brought to the attention of the broader health care community through the Health Information Technology for Economic and Clinical Health Act as part of the 2009 American Recovery and Reinvestment Act. The quality of care within the VA health system has consistently been demonstrated to meet, and in many cases surpass, that provided in the private sector. In fiscal year 2015, nearly 400,000 patients underwent an operation within the VA health system, of which 102,556 (25.8%) were inpatient cases. As far back as the 1980s, the VA health system has been investing in the development of processes to monitor and improve the quality of cardiac and non-cardiac surgical care provided in its institutions. A hallmark of these efforts is the current VA Surgical Quality Improvement Program (VASQIP). Established in 1991, its precursor (the National Surgical Quality Improvement Program [NSQIP]) became a national benchmark in terms of surgical quality improvement (QI) efforts. Renamed VASQIP after merging the Continuous Improvement in Cardiac Surgery Program and NSQIP, during the past 2 decades, this nonvoluntary program has continuously collected standardized, rigorously obtained, clinically rich data from all VA institutions in which major surgery is performed and then has conveyed back risk-adjusted data on postoperative morbidity and mortality. This approach not only allows each individual institution to compare itself with other VA facilities but it also offers a more global view of system-wide performance. The program and its success were so profound that it was used as a template for a private sector version of this QI program championed by the American College of Surgeons (ACS-NSQIP).

Significant improvements in the quality of surgical care within the VA health system were noted in the first decade after implementation of VASQIP, with a 27% and 45% decrease in mortality and morbidity, respectively. Recent data suggest significant improvement in surgical care in the private sector associated with participation in the ACS-NSQIP. However, there have not been similar, contemporaneous evaluations of inpatient, noncardiac surgical care within the VA health system. As such, the goals of this study are to describe any changes in postoperative morbidity and mortality that have occurred over time and to understand whether any such changes have occurred system-wide or only at specific VA hospitals.

Methods

Data

Data from VASQIP were used to conduct a retrospective, national cohort study of patients undergoing inpatient, noncardiac surgery from October 1, 1999, through September 30, 2014. Prior descriptions of VASQIP, data collection practices and protocols, the type of data collected, and the quality and reliability of the data have been previously published. This study was approved by the Baylor College of Medicine institutional review board, the Michael E. DeBakey Veterans Affairs Medical Center Research and Development committee, and the Surgical Quality Data Use Group in the Veterans Affairs National Surgery Office. As VASQIP is an existing data source, patient consent was waived.

Patients

The VASQIP data set included 850,754 patients who underwent inpatient, noncardiac surgery. Patients younger than 18 years and those 90 years or older were excluded. A small proportion (751 [0.09%]) of patients was missing data for important study variables and/or model covariates and were excluded. For patients who underwent more than 1 operation within a 30-day interval, only the first procedure in that period was used for analysis. After these exclusions, there were 795,286 inpatient surgical procedures. Finally, our analysis was restricted to patients who underwent general, thoracic, vascular, genitourinary, neurosurgical, orthopedic, or spine operations (704,901 [88.6%] of the 795,286 inpatient surgical procedures in the VASQIP cohort). The analysis was restricted to these specialties because they accounted for 97,836 of 106,895 (91.5%) complications and 18,924 of 20,351 (93%) 30-day mortality events during the study period. The overall VASQIP cohort (inclusive of all specialties) was also analyzed in a sensitivity analysis with similar rates and trends noted.

Variables

The VASQIP data set provides demographic patient data as well as information on clinically relevant preoperative clinical conditions. An established Current Procedural Terminology matrix was used to identify the surgical specialty for each operation. Morbidity and mortality within 30 days of each index operation are provided. The abstractors of the VASQIP data set collect information on the following specific types of complications: myocardial infarction, cardiac arrest, cerebrovascular event, coma, failure to wean from mechanical ventilation within 48 hours, reintubation, pneumonia, renal insufficiency, renal failure, urinary tract infection, superficial surgical site infection, deep wound infection, fascial dehiscence, pulmonary embolism, deep vein thrombosis, wound infection, fascial dehiscence, or pulmonary embolism.

Key Points

Question Have 30-day postoperative surgical outcomes changed in the Veterans Affairs health system over time?

Findings In this cohort study of 704,901 patients in the Veterans Affairs Surgical Quality Improvement Program data set, absolute rates and the likelihood of complications, mortality, and failure to rescue have significantly decreased for the past 15 years. These decreases were observed system-wide at all Veterans Affairs hospitals, not just those with the best performance.

Meaning Perioperative outcomes in the Veterans Affairs health system have consistently improved for the past 15 years.
thrombosis, bleeding requiring a transfusion of 4 or more units of packed red blood cells, sepsis, and vascular graft failure. We used a previously established classification scheme to categorize complications as major complications (excluding urinary tract infection, renal insufficiency, deep vein thrombosis, and superficial surgical site infection). 13

Statistical Analysis
Patients were the unit of analysis, but outcomes were ascertained and results presented at the hospital level. The main outcomes of interest were hospital-level 30-day morbidity (overall and major complications), mortality, and failure to rescue (FTR) (defined as mortality after 1 or more postoperative complications). To delineate whether any observed trends were system-wide or explained by institution-level variation in outcomes, hospitals were stratified into quintiles of risk-adjusted mortality (1, lowest mortality; 5, highest mortality). 13 As previously described, observed hospital mortality rates were calculated. Expected mortality was then ascertained through the use of logistic regression adjusted for patient age, sex, American Society of Anesthesiology classification, emergency procedure, congestive heart failure within 30 days of surgery, history of severe chronic obstructive pulmonary disease, history of neurologic event, the presence of diabetes requiring oral medications or insulin, dialysis within 2 weeks of surgery, preoperative functional status, and preoperative weight loss of more than 10% of body weight within 6 months of surgery, as well as specialty and complexity of the operation. Robust standard errors were applied, as was an adjustment for within-hospital clustering. This risk adjustment model had a C statistic of 0.85. Final risk-adjusted mortality was then calculated using a ratio of observed to expected mortality multiplied by the overall mortality in the analytic data set (2.7%).

A Cochran-Armitage test for trend was applied to evaluate changes in rates over time. Multivariable hierarchical regression, including a random effect for the treating hospital, was used to estimate the odds of each outcome over time with study year evaluated as the main variable of interest. For the model evaluating 30-day mortality, in addition to the covariates noted in the risk-adjustment model, hospital quintile and the number of complications were also included. To evaluate the odds of FTR over time, 2 separate models were used. The first evaluated patients with 1 or more complications of any type. The second was restricted to patients with 1 or more major complications. Sensitivity analyses were performed including all VASQIP procedures (regardless of specialty), individually on the 3 most common procedural specialties (general, orthopedic, and vascular), and restricting to elective cases. All analyses were performed using Stata SE, version 14.1 (Stata Corp). Statistical comparisons were 2-sided and P < .05 was considered significant.

Results
A total of 704,901 patients treated at 143 VA hospitals were included. The Table summarizes demographic and clinical characteristics for the overall cohort. Rates of complications and major complications were 13.9% (n = 97,836) and 9.5% (continued)
The noted time is in reference to the preoperative period (eg, 30 days leading up to surgery).

Across quintiles of hospital risk-adjusted mortality, there were no clinically meaningful differences in rates of complications (quintile 1, 20 945 of 147 721 [14.2%]; quintile 2, 19 051 of 143 555 [13.3%]; quintile 3, 18 170 of 133 021 [13.7%]; quintile 4, 20 732 of 145 047 [14.3%]; quintile 5, 18 938 of 135 557 [14%]) and major complications (quintile 1, 14 044 of 147 721 [9.5%]; quintile 2, 13 040 of 143 555 [9.1%]; quintile 3, 12 461 of 133 021 [9.4%]; quintile 4, 14 390 of 145 047 [9.9%]; quintile 5, 12 881 of 135 557 [9.5%]). By comparison, FTR after any complication (quintile 1, 2 229 of 20 945 [10.7%]; quintile 2, 2 295 of 19 051 [12.1%]; quintile 3, 2 430 of 18 170 [13.4%]; quintile 4, 2 905 of 20 732 [14%]; quintile 5, 2 769 of 18 938 [14.6%]; trend test, $P < .001$) and FTR after a major complication (quintile 1, 1 216 of 14 044 [15.4%]; quintile 2, 2 223 of 13 040 [17%]; quintile 3, 2 369 of 12 461 [19%]; quintile 4, 2 817 of 14 390 [19.6%]; quintile 5, 2 663 of 12 881 [20.7%]; trend test, $P < .001$) increased significantly with worsening performance quintile. However, in all performance quintiles, there were significant (trend test, $P < .001$ for all) decreases over time in rates of complications (20.6%-29.9%), major complications (23.3%-33%), FTR (29.2%-50.6%), and FTR after major complication (28.1%-47.5%) (Figure 2).

The odds of postoperative mortality in the VA health system decreased significantly over time (Figure 3). Relative to 15 years ago, in the most recent study year, the odds of mortality were 47% lower (odds ratio, 0.53; 95% CI, 0.46-0.60), with a significant trend favoring improved performance ($P < .001$). The odds of mortality associated with FTR also decreased over time and to a similar magnitude. For FTR after any complication, the odds were 41% lower in the most recent study year (odds ratio, 0.59; 95% CI, 0.50-0.69). For FTR after a major complication, the odds were 39% lower (odds ratio, 0.61; 95% CI, 0.52-0.72). In both cases, there was a significant trend for improved performance ($P < .001$). All findings were robust in sensitivity analyses.

### Discussion

Improving quality, value, and safety in health care are national priorities. More than 2 decades ago, the VA health system pioneered the original version of VASQIP (at that time called VA NSQIP). After implementation of this program, significant improvements in perioperative outcomes were noted across the VA health system. Following a similar model, the ACS developed a private sector version that was recently recognized as an important component of national surgical QI efforts. However, it is often forgotten that the original version of this program was pioneered by the VA health system. Although ACS-NSQIP data have recently been used to describe postoperative outcomes in the private sector, similar contemporary evaluations from VASQIP for the VA health system are lacking. In this context, the purpose of this analysis was to provide a global and contemporaneous perspective on the outcomes of surgical care within the VA health system. We found that, during the past 15 years, there have been decreases of 25.4%, 54.1%, and 40.9% in morbidity, mortality, and FTR, respectively, with an approximately 40% to 50% decrease in the odds of postoperative adverse events during that time. More important, these improvements have occurred system-wide and not only at the VA hospitals with the best performance.

The VA health system is a unique entity in the US health care landscape. It is the nation’s largest integrated health system, has the longest standing electronic medical record, and has well-established national QI initiatives for both medical and surgical specialties. Amid controversy regarding patient wait times and major changes in leadership, as well as new and evolving fiscal challenges, some suggest that the future of the VA health system might be in doubt and that health care for our nation’s veterans could be more efficiently and/or effectively administered in the
private sector. However, this is not the first time that questions about the relevance of the VA health system in today’s health care landscape have been raised. In the 1990s, the VA health system faced significant criticism for providing poor-quality care, which led to a reengineering of the health system to address these concerns. These changes were associated with notable improvements and, in the period following, the quality of care was found to surpass that provided to Medicare fee-for-service beneficiaries. Veterans have a higher burden of clinical and sociodemographic characteristics associated with poorer outcomes. In a health care environment that has become increasingly reliant on quality measures and comparative benchmarking, preventive services, primary care, mental health care, oncology, and surgical specialties in the VA health system have been comparable with or performed better than and been less variable relative to those in the private sector. Regarding veterans’ satisfaction with the care they receive, in a recent patient survey, VA inpatient and outpatient services fared favorably relative to those in the private sector.

Many factors likely influenced the system-wide improvements in postoperative outcomes observed in our data. The trends observed in the VA health system generally mirror those reported in the private sector. A potential explanation is the existence of underlying, unmeasured factors associated with global improvements in surgical management across all health care settings (private and federal); more simply put, perioperative and postoperative care has improved over time and measured outcomes reflect these secular trends. Alternatively, the continuity of VASQIP as a QI program within the VA health system could also explain these findings. Two recent studies have brought into question the value associated with hospital participation in ACS-NSQIP. However, an issue not addressed in these analyses is the fact that nonparticipating hospitals could have been enrolled in any of several existing regional, state, or internal QI initiatives intended to provide similar data and services. It may be that programs such as VASQIP and ACS-NSQIP have helped to raise the collective awareness of the surgical community regarding the importance of such surgical QI efforts. Although data measurement alone may not be enough to drive QI, there may be an element of the Hawthorne effect at play—recognition that measurement is occurring may be imperative enough to encourage a critical evaluation of an institution’s own outcomes. In our current health care environment, which emphasizes transparency and public availability of data for health care consumers, stakeholders are likely more acutely and increasingly aware of the quality of care delivered at their institution. Thus, although programs such as VASQIP may not be the sole reason that outcomes have improved across all surgical settings, they continue to provide a necessary and important source of performance-based data to help guide health care professionals’ QI efforts.

In addition to VASQIP, VA hospitals also participate in several other national quality initiatives, such as the Surgical Care Improvement Project. Although rates of adherence to Surgical Care Improvement Project measures within the VA health system have improved over time, there has not been a concurrent decrease in rates of surgical site infections. Similar findings also have been noted in the private sector and with respect to other QI initiatives. Data such as these have compelled some critics of process-level measures to question their value as potential quality metrics. Although the effect of an individual quality initiative may not be readily apparent when examined in isolation, to our knowledge, there are presently no data describing what happens when a hospital simultaneously adheres to all process-level QI measures in aggregate. Given that a variety of processes are likely to affect a single outcome, in the context of improved or improving institutional adherence to individual quality measures, our findings may suggest that the changes in morbidity, mortality, and FTR over time noted in VASQIP (and reported in the private sector from studies using ACS-NSQIP data) could be representative of a final common pathway. Put differently, while hospitals have increased adherence across all quality measures over time, this change may not necessarily manifest as an improvement in an individual outcome (ie, decreased surgical site infection associated with improved adherence to Surgical Care Improvement Project measures). Instead, because a single outcome is likely to be affected by a multitude of perioperative processes, the aggregate effect of a hospital performing well on all quality measures concurrently may actually be reflected as an improvement in a more composite measure of overall institutional performance. Future work delineating the association between hospital performance on multiple process-level
metrics (rather than individual metrics in isolation) and clinically relevant perioperative outcomes may be of value.

There are important limitations to consider when interpreting our results. VA Surgical Quality Improvement Program is a mandatory surgical QI program for all VA hospitals; therefore, we did not have a contemporaneous group of control hospitals to allow for an evaluation of underlying, unmeasured factors not associated with VASQIP that might have also explained the observed system-wide improvements. Furthermore, because of the observational nature of this study, it is not possible to directly attribute the observed improvements in postoperative outcomes to VASQIP. The trends over time observed in our data are consistent with trends in outcomes in the private sector. However, because this was not a comparative study, we could not quantify

Significant decreases in all 30-day outcomes were seen across all Veterans Affairs hospitals during the study period (trend test, *P* < .001).
After multivariable adjustment, hierarchical modeling demonstrated statistically significant ($P < .001$) decreases in the odds of mortality, failure to rescue, and failure to rescue after major complications in the Veterans Affairs health system during the study period. The blue line indicates an odds ratio of 1.00; error bars, 95% CI.

Figure 3. Association Between Study Year and System-Wide Outcomes

A. Mortality

B. Failure to rescue

C. Failure to rescue after major complications

how and to what extent improvements in the VA health system differed from those in the private sector. VA Surgical Quality Improvement Program provides limited data regarding the surgeon and the institution where the operation is performed. Data are collected for a systematic sample of (not all) surgical cases performed within the VA health system. We were therefore unable to evaluate changes in surgical volume over time or how such changes influenced our findings. Accordingly, we had to categorize hospitals using quintiles of risk-adjusted mortality rather than hospital or surgeon volume, which is a commonly used surrogate measure for quality. Similarly, because VASQIP does not collect data on all surgical cases, we were not able evaluate trends in the use of minimally invasive approaches (ie, laparoscopy, robotic-assisted surgery, or endovascular therapy) that might have been occurring in tandem with the observed improvements in perioperative outcomes. Although VASQIP provides information on an extensive list of specific perioperative complications, this list is not exhaustive and does not provide procedure-specific complications. In addition, the data do not provide details on the severity of a given complication or subsequent management.
Finally, although VA-SQIP provides information on the presence of important preoperative patient conditions (ie, diabetes, heart failure, or dyspnea), it does not offer details about specific testing performed as part of the preoperative workup that might better characterize the role improved patient selection could have played in explaining the observed trends.

Conclusions

Despite numerous challenges, our data suggest the VA health system has made notable and continuous gains in the quality of surgical care provided to its beneficiaries. Given the number of veterans currently receiving surgical care at VA hospitals, we believe the VA health system continues to be an important source of health care in the United States and provides an invaluable service with an often-overlooked societal benefit—one that may be difficult to recapitulate if veterans’ health care was shifted to the private sector alone. As accountable care organizations become a more integral part of the US health care landscape, private sector integrated health systems that provide a high volume of surgical care might benefit from critically appraising surgical QI approaches adopted in the VA health system and applying them to the care of their patients.

ARTICLE INFORMATION

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Complications After Inpatient Noncardiac Surgery in the VA Health System

Invited Commentary

Codman, Hawthorne, and End Results of a Watched System

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Ever since Ernest A. Codman first advocated measuring outcomes of patients through End Results Cards,1 the goal of surgical quality has been to study the results of operative intervention and improve those results through systematic analysis. The article by Massarweh et al clearly documents that the Veterans Administration (VA) Surgical Quality Improvement Program and, with a nod to Codman, the American College of Surgeons National Surgical Quality Improvement Program have systemically advanced the quality of care for millions of surgical patients both in and outside of the VA.

The unique aspect of this article that deserves particular focus is the trends in failure to rescue (FTR). Failure to rescue is defined as in-hospital death after a complication and is considered to be an important indicator of hospital quality. While postoperative mortality is affected by numerous patient characteristics, FTR is thought to be influenced by structural characteristics and safety culture in hospitals through timely recognition and treatment of severe complications. Failure to rescue as a measure is rapidly gaining acceptance as a key metric for assessing surgical quality, with the 2015 adoption by the Agency for Healthcare Research and Quality as a patient safety indicator.3 The authors show how mortality and FTR rates after complications have significantly declined in all hospitals and differed by hospital performance as stratified by quintiles, with a reduced risk of mortality and FTR of 40% to 50% (odds ratio, 0.53; 95% CI, 0.46-0.60 and odds ratio, 0.59; 95% CI, 0.50-0.69; respectively).

The unanswered question the Massarweh et al article2 poses is what ultimately has driven the marked improvements seen over time. The multifactorial nature of surgical care precludes an easy answer, and some have questioned whether participation in a registry is the driving initiative for quality improvement.4,5 Regardless of the mechanism, one cannot discount the Hawthorne effect6 at the VA, with a congressional mandate to measure surgical quality and the scrutiny of public opinion through the fourth estate. The Massarweh et al article2 serves notice that the quality and safety of surgical care in the VA system are on par with if not better than other large integrated health care systems. The important message from these studies is that surgery as a community, especially within the VA, continuously monitors outcomes and continues the work of improving the end result.

ARTICLE INFORMATION

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