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The Department of Veterans Affairs' NSQIP

The First National, Validated, Outcome-Based, Risk-Adjusted, and Peer-Controlled Program for the Measurement and Enhancement of the Quality of Surgical Care

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Objective

To provide reliable risk-adjusted morbidity and mortality rates after major surgery to the 123 Veterans Affairs Medical Centers (VAMCs) performing major surgery, and to use risk-adjusted outcomes in the monitoring and improvement of the quality of surgical care to all veterans.

Summary Background Data

Outcome-based comparative measures of the quality of surgical care among surgical services and surgical subspecialties have been elusive.

Methods

This study included prospective assessment of presurgical risk factors, process of care during surgery, and outcomes 30 days after surgery on veterans undergoing major surgery in 123 medical centers; development of multivariable risk-adjustment models; identification of high and low outlier facilities by observed-to-expected outcome ratios; and generation of annual reports of comparative outcomes to all surgical services in the Veterans Health Administration (VHA).

Results

The National VA Surgical Quality Improvement Program (NSQIP) data base includes 417,944 major surgical procedures performed between October 1, 1991, and September 30, 1997. In FY97, 11 VAMCs were low outliers for risk-adjusted observed-to-expected mortality ratios; 13 VAMCs were high outliers for risk-adjusted observed-to-expected mortality ratios. Identification of high and low outliers by unadjusted mortality rates would have ascribed an outlier status incorrectly to 25 of 39 hospitals, an error rate of 64%. Since 1994, the 30-day mortality and morbidity rates for major surgery have fallen 9% and 30%, respectively.

Conclusions

Reliable, valid information on patient presurgical risk factors, process of care during surgery, and 30-day morbidity and mortality rates is available for all major surgical procedures in the 123 VAMCs performing surgery in the VHA. With this information, the VHA has established the first prospective outcome-based program for comparative assessment and enhancement of the quality of surgical care among multiple institutions for several surgical subspecialties. Key features to the success of the NSQIP are the support of the surgeons

who practice in the VHA, consistent clinical definitions and data collection by dedicated nurses, a uniform nationwide informatics system, and the support of VHA administration and managerial staff.

In today's managed health care environment, it is increasingly important to measure and compare the quality of health care delivery among various institutions. Measures of both process and outcome of care have been proposed for the comparative assessment of the quality of health care delivery.[1] Measures of outcome, however, are particularly suitable for the assessment of the quality of surgical care because surgery involves an intervention with an expected outcome—a repair of an abdominal aortic aneurysm is *expected* to prevent a subsequent fatal rupture; a replacement of an osteoarthritic hip is *expected* to enable the patient to walk without pain. The main limitation of the use of outcome in the comparative assessment of the quality of surgical care, however, is the need to use adequate and validated models for risk adjustment. The presurgical severity of illness must be adjusted if outcome is to be used in the comparative assessment of the quality of surgical care.[2–5] Several models for risk adjustment and comparative assessment of outcome have been prospectively developed for cardiac surgery.[6] Until 1994, however, uniform and validated models for noncardiac surgery did not exist.

Prompted by a 1986 congressional mandate, the Veterans Health Administration (VHA) conducted the National VA Surgical Risk Study (NVASRS)[7] between October 1, 1991, and December 31, 1993. The NVASRS was conducted in 44 VA Medical Centers (VAMCs) with the aim of developing and validating risk-adjustment models for the prediction of surgical outcome and the comparative assessment of the quality of surgical care among multiple facilities. A dedicated clinical nurse reviewer in each VAMC prospectively collected presurgical, surgical, and 30-day outcome information on major surgery. On the basis of data from 87,078 major surgical procedures, risk-adjustment models for 30-day mortality and morbidity rates were developed for all noncardiac surgery and for each of the following subspecialties: general surgery, vascular surgery, orthopedic surgery, urology, thoracic (noncardiac) surgery, neurosurgery, plastic surgery, and otolaryngology.[4,5] The ability of these models to detect variations in the quality of surgical care was demonstrated in a validation study.[7] Separate models were developed for risk adjustment of the 30-day mortality rate of cardiac surgery, based on a previously published methodology.[8]

The NVASRS provided the VHA with a validated tool with which the quality of surgery could potentially be monitored, compared, and improved in all 132 of the VAMCs performing surgery. Hence, based on the results of the NVASRS, the National VA Surgical Quality Improvement Program (NSQIP) was established in January 1994; it provided, for the first time, a reporting and managerial structure for the continuous monitoring and enhancement of the quality of surgical care in the VHA.

The purpose of this article is to describe the NSQIP and to report on the results achieved since its inception in January 1994. The underlying hypothesis is that the quality of surgical care can be measured, compared, and enhanced in various institutions by the use of proper, validated, and peer-reviewed models for risk-adjusted reporting of outcome.

METHODS

Organizational Structure

The NSQIP is an ongoing quality-management initiative that applies the methodology developed and validated by the NVASRS to all the VAMCs that perform major surgery. Since the inception of the program in 1994, nine VAMCs have stopped performing major surgery, bringing the number of participating medical centers as of January 1998 to 123. These VAMCs fall administratively into 22 Veterans Integrated Service Networks (VISNs), which are coordinated by the VHA Headquarters in Washington DC. Each VISN is managed by a network director, assisted by a chief medical officer (also referred to as a clinical manager), one of whose primary duties is to ensure the quality of clinical care. The NSQIP, fiscally and administratively, resides within the Office of Patient Care Services in Headquarters but exercises its monitoring and advisory functions through the various chief medical officers in their respective VISNs.

The NSQIP is governed by an executive committee chaired by a VAMC chief of surgery and co-chaired by a health services researcher. The committee includes eight VA chiefs of surgery, the directors of surgery and anesthesia at Headquarters, three health research scientists, an internist, a senior biostatistician, a national nurse coordinator, a network director, and a network chief medical officer. The executive committee oversees the functions of three coordinating centers: the Chairman's Office at the Brockton/West Roxbury VAMC, which assumes the overall coordination of the NSQIP activities; the Cooperative Studies

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Program Coordinating Center at the Hines (Illinois) VAMC, which coordinates the data acquisition and analysis and research related to all surgical specialties except cardiac surgery; and the Center for Continuous Improvement in Cardiac Surgery at the Denver (Colorado) VAMC, which coordinates the data acquisition and analysis and research related to cardiac surgery. Forty-two of the 123 surgical centers in the VHA perform cardiac surgery. The executive committee conducts its business through weekly conference calls and two 3-day meetings annually. The chair and co-chair conduct, on a monthly basis, a 1-day meeting with the staff at the Hines Coordinating Center to plan acquisition, analysis, and reporting of data. Other participants in the NSQIP are invited to these meetings if needed. A separate longstanding cardiac surgery consultants committee reviews and makes recommendations about the VA's cardiac surgery program.

Data Collection

A total of 88 permanent full-time-equivalent positions have been assigned for trained surgical clinical nurse reviewers (SCNRs) at the 123 VAMCs participating in the program. The SCNRs, working closely with the chief of surgery at each VAMC, ensure the accurate collection and timely transmission of the data. An operations manual that details data-collection processes and study definitions ensures uniformity in data collection and transmission. Based on the geographic location of each VAMC, the SCNRs are organized into 10 teams, each team comprising 11 to 13 nurse reviewers. An assigned team leader for each team maintains the communication between the SCNRs in the field and the national nurse coordinator in the chairman's office. Regular conference calls to address data collection and transmission issues are held between the coordinating centers and the team leaders and between all the SCNRs and the chair and co-chair of the NSQIP. The VA Information Service Center at Birmingham, Alabama, develops computer software and coordinates the installation at the participating centers to aid in the data-collection process.

Depending on the type of data collection and surgical volume, the VAMCs are divided into three "peer" groups:

- Development Group: Comprises the 44 VAMCs that participated in the NVASRS. It serves as the test group for new model development and limited research initiatives.
- Managerial Group I: Comprises the 55 VAMCs with high and medium surgical volumes but no cardiac surgery.
- Managerial Group II: Comprises the 33 VAMCs with low surgical volume.

Two types of data are collected:

- Workload data (volume): Total number of surgical procedures performed at each medical center, categorized by surgical specialty and classified into "major *versus* minor" and "inpatient *versus* outpatient." Major surgery is defined as procedures performed under general, spinal, and epidural anesthesia, and all carotid endarterectomies and inguinal herniorrhaphies, regardless of anesthesia type. An operation is defined as outpatient if the length of stay in the hospital does not exceed 23 hours.
- Risk-adjustment data: The patient variables collected for the purpose of risk adjustment of outcome in the Development and Managerial I groups of medical centers have been listed in previous publications.[4,5,7] They include 45 presurgical, 17 surgical, and 33 outcome variables.

Electronic Infrastructure and Data Transmission

Workload data, including Common Procedural Terminology 4 (CPT-4) codes, are entered by the providers into the surgery module within VISTA, the VA's decentralized hospital computer system; identical software is used in all 123 participating VAMCs. These data are automatically transmitted to the coordinating center at Hines at the time when the risk-adjustment data are transmitted by the SCNR. Risk-adjustment data are entered by the SCNR into a special risk-assessment software module, which is integrated into the surgery module. Thirty days after each surgical procedure, the computer generates a follow-up letter that is sent to the patient requesting follow-up information. Forty-five days after each surgical procedure, the SCNR completes the entry of the patient's data into the risk-assessment module and, with the concurrence of the chief of surgery, transmits the data to the coordinating center at Hines (for noncardiac surgery) or to the coordinating center in Denver (for cardiac surgery). Laboratory data are automatically transmitted from each medical center's laboratory module in VISTA to the respective coordinating center; the SCNR does not have to collect or transmit these data. The electronic data collection and transmission infrastructure is supported by a full-time programmer within the VHA's software services who is in frequent communication with the three coordinating centers and the SCNRs in the field.

When the data are received at the data coordinating centers, they are put through a data-editing program to check for missing or out-of-range values and inconsistencies between data fields. Error-free data are put into the NSQIP master file. Records with potential errors are put into a suspend file until these are rectified by the SCNR at the participating VAMC. Query reports are sent to the participating VAMCs quarterly for correction of the potential errors. Suspended records are then corrected, if necessary, and passed again through the data-editing program. An audit trail of all data corrections is also kept. In addition, all deaths are verified against the VHA Beneficiary Identification and Records Locator System (BIRLS) death records.

Monthly, an inventory of cases received at the data coordinating centers is sent to the SCNRs so they can check on the completeness of the electronic data transmission.

On an annual basis, each VAMC is asked to complete a detailed questionnaire describing structure and processes of care on each surgical service. These data are entered into a cumulative data base that is used to assess the quality of care at specific VAMCs.

Data Analysis

Reporting of NSQIP data is timed to coincide with the federal fiscal year (October 1 to September 30). By the end of December each year, the data from the patients entered into the NSQIP data base before the end of the previous fiscal year are received at the Hines coordinating center, edited, and cleaned. At this time, the final analysis for the completed fiscal year begins.

Logistic regression analysis[9] is used to develop the predictive models for surgical death and complications. In the logistic regression model, surgical death and complications are the dependent variables, and the presurgical risk factors are the independent variables. Surgical mortality is defined as the death of a patient within 30 days after the index surgical procedure, in or out of the hospital. Surgical morbidity is defined as the presence of one or more of 20 predefined complications[7] in the same time period. The intercept term and beta coefficients attached to the independent variables in the model are estimated using maximum likelihood methods. The logistic procedure in SAS version 6.12[10] is used to perform the calculations. A "step-up" stepwise procedure is used. The most important patient risk factor is entered into the model in the first step. In the second step, the next most important factor is entered, given that the first factor is already in the model. This process is repeated until all important predictor variables are in the model at the $\alpha = 0.05$ level of significance.

Once the model has been developed, it can be used to calculate a predicted probability of death or complications for each patient on the basis of that patient's presurgical risk factors. These probabilities can then be summed within each subspecialty and for all surgical procedures combined within each hospital to obtain an expected number of deaths or patients with complications. For each VAMC, O/E ratios (observed number of deaths or patients with complications divided by the expected number of deaths or patients with complications) are calculated for all surgical procedures combined and for each of nine major subspecialties (general surgery, orthopedics, urology, peripheral vascular surgery, neurosurgery, otolaryngology, noncardiac thoracic surgery, cardiac surgery, and plastic surgery). An O/E ratio statistically significantly greater than 1 is an indication that the hospital is experiencing more deaths or complications than would be expected on the basis of its patient characteristics. An O/E ratio statistically significantly less than 1 indicates that the hospital is having better results than expected on the basis of its patient characteristics. Ninety percent confidence intervals (CIs) are calculated for death O/E ratios and 99% CIs for complications O/E ratios based on the binomial distribution.[11] A CI interval encompassing 1 indicates that the numbers of observed and expected deaths or patients with complications are approximately equal. CIs of more than 1 indicate high outlier status; CIs of less than 1 indicate a low outlier status. Previous work using split-sample and bootstrapping methods have shown the models to have good calibration and discrimination.[4,5]

O/E ratios are presented for death and complications for each VAMC for all surgical procedures combined and for each of the nine major subspecialties. The only exceptions are for deaths in the subspecialties of urology, plastic surgery, and otolaryngology, where the number of deaths is too low to develop reliable O/E ratios. Also, O/E ratios are not reported in the low-volume hospitals in subspecialties where the number of cases is less than 50 annually.

O/E ratios are also reported over time for all surgical procedures and each subspecialty within each VAMC. For the 44 centers that have participated in the NSQIP from its inception, O/E ratios are reported for four periods: phase 1 (27 months, October 1, 1991, to December 31, 1993), phase 2 (20 months, January 1, 1994, to August 31, 1995), FY96, and FY97. For the other 79 centers, O/E ratios are reported for the last three periods. For the 23 VAMCs with very low surgical volumes, the last three periods have also been combined to present more reliable O/E ratios over a longer period of time.

Feedback to Providers and Managers

Feedback is provided primarily through an annual evaluation by peers of the results at each medical center, and by the generation of an annual report distributed to the chief of surgery, the SCNR, the director, and the chief of staff of each VAMC, and the chief medical officer of each VISN. The annual report for each facility is designed to allow the providers to compare their volume, patient risk profiles, and risk-adjusted outcomes to the national average and to the averages in their peer group of hospitals. Each hospital is identified by a specific code known only to the providers and managers at that hospital and the chief medical officer of the VISN.

At the end of each fiscal year, the coordinating centers at Hines and Denver prepare tables of the observed and expected outcomes and the O/E ratios at each medical center. These tables are then reviewed by a panel consisting of members of the NSQIP executive committee and three or four additional chiefs of surgery from VAMCs. Panel members are blinded to the identity of the medical centers during the review. Recommendations regarding specific hospitals (in all surgery and the subspecialties) are made in accordance with preset guidelines and forwarded to the above persons along with the annual report.

Hospitals with consistently low outlier status are com-

Table 1. ACCRUAL OF NSQIP MAJOR OPERATIONS OVER TIME

	Number of VAMCs	Major Assessed Operations	Major Assessed Operations/Year/VAMC Mean
Phase 1 (10/1/91–12/31/93)	44*	103,013	1040
Phase 2 (1/1/94–8/31/95)	132†	120,135	586
FY 96 (10/1/95–9/30/96)	125	95,620	765
FY 97 (10/1/96–9/30/97)	123	99,176	806

VAMC = Veterans Affairs Medical Centers; NSQIP = National VA Surgical Quality Improvement Program.
* Phase 1 includes 44 academically affiliated VAMCs that performed cardiac surgery as of 10/1/91.
† Beginning 1/1/94 the NSQIP includes all VAMCs performing major surgery.

mended and encouraged to share with the NSQIP (which subsequently disseminates this information to the rest of the medical centers) the processes and structures that these hospitals consider to have contributed to their good performance. Various levels of concern are raised about high outlier hospitals, and suggestions are forwarded regarding internal and external reviews to verify and improve outcomes of surgery at these hospitals.

The NSQIP has developed a set of guidelines to help the providers in the field conduct structured internal reviews to identify problems in the quality of their surgical care. Through an ongoing dialogue with the chief medical officers of the 22 VISNs, the NSQIP provides management with advice regarding reviews of problematic surgical services and expertise in conducting external reviews and site visits.

Additional feedback for cardiac surgery is provided by a semiannual report that includes more information; it is generated by the coordinating center in Denver. The cardiac surgery consultants committee also reviews the various hospitals' reports before they are distributed and makes specific recommendations regarding high and low outliers to the Office of Patient Care Services at Headquarters and to the chief medical officers in the VISNs.

Access to the Data Base for the Purpose of Research

The NSQIP data base accrues risk factors and outcome information on approximately 100,000 major surgical procedures annually. Surgeons and researchers in the VHA can gain access to the data base for research by submitting research proposals to the executive committee. Peer reviewers are assigned to these proposals and provide input to the executive committee. Proposals approved by the executive committee are assigned a study biostatistician from the NSQIP who coordinates the data analysis with the principal investigator. All publications and presentations that use NSQIP data need to be reviewed and approved by the chair, co-chair, senior biostatistician, and executive committee of the NSQIP.

RESULTS

Data Accrual

In phase 1 of the NSQIP, 103,013 cases were assessed (mean 1040 cases/year/VAMC) at the 44 VAMCs then participating in the program (Table 1). In phase 2, the program was expanded to include all 132 VAMCs performing surgery. In this phase, 120,135 cases were assessed (mean 586 cases/year/VAMC). The number of assessed cases/year/VAMC declined between phases 1 and 2 because in phase 2 smaller VAMCs were added to the program. In FY96, 95,620 cases were accrued (mean 765 cases/year/VAMC); in FY97, 99,176 cases were accrued (mean 806 cases/year/VAMC). Thus, the total number of major surgical procedures accrued into the program up to September 30, 1997, was 417,944.

Percentage of Total Procedures Assessed

In FY97, accurate data on the assessed major surgical cases in the NSQIP in relation to the total surgical volume in the VA have been available. In FY97, a total of 343,808 surgical operations were performed in the VA and entered into the surgical module (Surgery 3.0) at each hospital. Of these, 157,226 (45.7%) were classified as major procedures, 159,107 (46.3%) were classified as minor procedures, and 27,475 (8%) were unclassified. Of the 157,226 major procedures, 48,960 (31.1%) were ineligible for assessment and 108,266 (68.9%) were eligible for assessment. Reasons for ineligibility included:

- The SCNR was on annual leave and had no backup to enter cases (14.4%).
- Cases at the high-volume hospitals exceeded the limit of 36 cases per 8-day cycle, the number of cases thought to be reasonable for one SCNR to review (11.5%).
- Excluded CPT codes of procedures with known low morbidity and mortality rates, or transurethral resections of the prostate (TURPs), transurethral resections of the bladder tumor (TURBTs), and herniorrhaphies exceeding the limit of five per week (74.1%).

Table 2. ACCRUAL OF NSQIP MAJOR OPERATIONS OVER TIME BY SUBSPECIALTY

	Phase 1* (10/1/91–12/31/93)		Phase 2† (1/1/94–8/31/95)		FY 96 (10/1/95–9/30/96)		FY 97 (10/1/96–9/30/97)		All Phases (10/1/91–9/30/97)	
Subspecialty	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
General	19,136	18.6	28,220	23.5	26,967	28.2	29,650	29.9	103,973	24.9
Orthopedics	18,882	18.3	23,700	19.7	16,529	17.3	18,172	18.3	77,283	18.5
Cardiac surgery	15,935	15.5	12,894	10.7	7903	8.3	7811	7.9	44,543	10.7
Urology	14,374	14.0	16,776	14.0	14,252	14.9	13,566	13.7	58,968	14.1
Vascular	10,929	10.6	13,585	11.3	9950	10.4	10,275	10.4	44,739	10.7
Neurosurgery	8226	8.0	7759	6.5	5078	5.3	5403	5.4	26,466	6.3
Otolaryngology	5182	5.0	5896	4.9	6347	6.6	5573	5.6	22,998	5.5
Noncardiac thoracic	5080	4.9	5008	4.2	3419	3.6	3545	3.6	17,052	4.1
Plastic	3300	3.2	3191	2.6	1985	2.1	2080	2.1	10,556	2.5
Other noncardiac‡	1969	1.9	3106	2.6	3190	3.3	3101	3.1	11,366	2.7
Total	103,013	100.0	120,135	100.0	95,620	100.0	99,176	100.0	417,944	100.0

NSQIP = National VA Surgical Quality Improvement Program; VAMC = Veterans Affairs Medical Centers.
* Phase 1 includes 44 academically affiliated VAMCs that performed cardiac surgery as of 10/1/91.
† Beginning 1/1/94 the NSQIP includes all VAMCs performing major surgery.
‡ Ophthalmology, gynecology, dental surgery, and podiatry.

Of the 108,266 major surgical procedures eligible for assessment, 105,722 (97.7%) were assessed. Only 5 of the 123 VAMCs assessed less than 80% of the eligible cases and did not receive O/E ratios (at 1 of the 5 VAMCs, the surgical service was closed). Of the 105,722 assessed cases, 99,176 (93.8%) were included in the analysis file. Most of the cases excluded from analysis were the result of multiple index operations on the same patient within a 30-day period.

Procedures by Surgical Subspecialty

Table 2 presents the assessed cases in the NSQIP by surgical subspecialty and phase. General surgery, orthopedics, urology, and vascular surgery are the most prevalent surgical subspecialties in the VA, each representing 10% to 30% of all major procedures. Cardiac surgery represented a large percentage of all major surgical procedures assessed in phase 1 (15.5%) because this phase included only the 44 VAMCs that perform both cardiac and noncardiac surgery. In the later phases, the percentage of all assessed major surgical procedures that were cardiac decreased to less than 10%. There has been a steady rise in the percentage of cases from general surgery, the dominant surgical subspecialty in the smaller VAMCs that entered the NSQIP beginning in phase 2.

Table 3 presents the accrual over time of the most frequent individual procedures in each subspecialty. Some of the individual procedures represent 20% or more of the NSQIP cases in their respective subspecialties (disc surgery in neurosurgery; lobectomy in thoracic surgery; TURP in urology). Assessments of TURPs have been limited to less than six per VAMC per week because of their high volume in the VHA.

Patient Characteristics

Patient presurgical characteristics and risk factors have remained remarkably constant over time, including mean age, racial and gender distributions, functional status, American Society of Anesthesiology (ASA) classification, many dichotomous risk factors, and presurgical laboratory results (Table 4). There has been a slight decrease in emergent cases (9.8% in phase 1 *vs.* 7.9% in FY97; $p < 0.001$), disseminated cancer (3.6% in phase 1 *vs.* 1.9% in FY97; $p < 0.001$), and weight loss of more than 10% in the 6 months before surgery (4.7% in phase 1 *vs.* 3.9% in FY97; $p < 0.0.001$). The mean surgical complexity score (a measure on a low [1] to high [5] scale of the complexity of the procedure above and beyond the risk factors that the typical patient brings to the procedure) has declined from 3.04 ± 0.85 in phase 1 to 2.70 ± 0.85 in FY97 ($p < 0.001$).

Outcomes

The mortality and morbidity outcomes over the phases of the NSQIP are reported in Table 5. Both mortality and morbidity rates have declined over time. This trend is not related to the expansion of the program from the original 44 VAMCs to the current 123 VAMCs; these trends are also observed in the subgroup of the original 44 centers.

Stability of Risk Models

The risk models for death and complications have remained stable over time. Table 6 presents the order of entry into the logistic regression of the risk variables for the mortality model for the four phases of the NSQIP. With the exception of functional status, which entered the phase 1 model at the 24th step, the 12 variables listed in Table 6 entered the models in all four phases relatively early. In particular, serum albumin, ASA class, disseminated cancer, emergency operation, age, blood urea nitrogen level of more

Table 3. MOST FREQUENT OPERATIONS BY EACH SUBSPECIALTY OVER TIME

		Phase 1*		Phase 2†		FY 96		FY 97		All Phases	
Subspecialty	Operation	n	% of Specialty	n	% of Specialty	n	% of Specialty	n	% of Specialty	n	% of Specialty
General	Cholecystectomy‡	3278	17.1	5018	17.8	3069	11.4	3354	11.3	14,719	14.2
	Colectomy	3144	16.4	4199	14.9	2627	9.7	2788	9.4	12,758	12.3
Neurosurgery	Disc surgery	1999	24.3	2223	28.6	1603	31.6	1659	30.7	7484	28.3
	Craniotomy	429	5.2	526	6.8	268	5.3	290	5.4	1513	5.7
Orthopedics	Knee replacement	2852	15.1	3633	15.3	2564	15.5	3006	16.5	12,055	15.6
	Hip replacement	1752	9.3	2138	9.0	1305	7.9	1451	8.0	6646	8.3
Otolaryngology	Laryngectomy	541	10.4	487	8.3	295	4.6	250	4.5	1573	6.8
	Tracheostomy	496	9.6	560	9.5	414	6.5	520	9.3	1990	8.6
Noncardiac thoracic	Lobectomy	1127	22.2	1063	21.2	666	19.5	681	19.2	3537	20.7
	Pneumonectomy	245	4.8	176	3.5	96	2.8	82	2.3	599	3.5
Urology	TURP	5686	39.6	6138	36.6	3384	23.7	3380	24.9	18,588	31.5
	Radical prostatectomy	1574	10.9	1709	10.2	1130	7.9	1316	9.7	5729	9.7
Vascular	AAA	1107	10.1	1256	9.2	794	8.0	764	7.4	3921	8.7
	Amputations	1094	10.0	1107	8.2	754	7.6	772	7.5	3727	8.3
Plastic	M-C flap transfers	148	4.5	138	4.3	105	5.3	111	5.3	502	4.7
Cardiac	CABG	12,857	79.6	10,440	80.6	6486	81.8	6265	80.1	36,048	80.4
	Valve replacement§	2491	15.4	1927	14.9	1149	14.5	1233	15.8	6800	15.2

TURP = Transurethral resection of the prostate; AAA = Repair of non-ruptured abdominal aortic aneurysm; Amputations = above and below knee; M-C = Musculocutaneous.

* Phase 1 includes 44 academically affiliated VAMCs that performed cardiac surgery as of 10/1/91.

† Beginning 1/1/94 the NSQIP includes all VAMCs performing major surgery.

‡ Includes laparoscopic and open cholecystectomy.

§ With and without CABG (coronary artery bypass graft).

than 40 mg/dl, and do-not-resuscitate status were important predictors of 30-day mortality in all four phases.

Table 7 presents similar results for morbidity. Serum albumin, ASA class, complexity score, emergency procedure, functional status, history of chronic obstructive pulmonary disease, age, hematocrit of 38% or less, and white cell count of more than 11,000 were important predictors of morbidity in all four phases.

Review of Outlier Status

The NSQIP executive committee meets annually to review the O/E ratios of the VAMCs over time. Table 8 presents a typical VAMC's table of mortality O/E ratios over time as reviewed by the committee. The table gives for each subspeciality and phase the number of assessed cases (volume), the observed number of deaths, the observed death rate, the expected number of deaths, the expected death rate, the O/E ratio, and outlier status.

The NSQIP executive committee held its most recent meeting in January 1998. Decisions were made on the basis of O/E mortality ratios. O/E morbidity ratios without outlier status, along with O/E mortality ratios, were reported to the individual VAMCs and VISNs for their own local quality-improvement activities. Of the 123 VAMCs that perform surgery in the VA system, 4 VAMCs were not issued O/E ratios because they had assessed fewer than 80% of eligible major procedures. Six VAMCs were sent letters of commendation for having low O/E mortality ratios for all surgical procedures combined for at least two of the four reporting periods, including the most recent period (FY97). Eleven VAMCs were given high outlier status #1 (watch list: high O/E mortality ratio for all procedures and possibly some subspecialties for FY97 only). Two VAMCs were given high outlier status #2 (moderate concern: high O/E mortality ratios for all procedures and possibly some subspecialties for two of the three or four reporting periods, including FY97). Two VAMCs were given high outlier status #3 (serious concern: high O/E mortality ratios for all procedures and possibly some subspecialties for three of the four reporting periods, including FY97).

Figure 1 compares the FY97 ranking of outlier hospitals by 30-day mortality rate before and after risk adjustment. Compared with the outlier status determined after risk adjustment, an outlier status before risk adjustment would have been erroneously ascribed to 15 hospitals, and 10 outlier hospitals would have been missed. Hence, the identification of high and low outliers by unadjusted mortality rates would have ascribed an outlier status incorrectly to 25 of 39 hospitals, an error rate of 64%.

Table 4. PREOPERATIVE PATIENT CHARACTERISTICS FOR NSQIP MAJOR NONCARDIAC OPERATIONS OVER TIME (INCLUDES THE PATIENT RISK FACTORS THAT ARE MOST PREDICTIVE OF 30-DAY MORTALITY AND/OR MORBIDITY)

	Phase 1* (10/1/91–12/31/93) (%)	Phase 2† (1/1/94–8/31/95) (%)	FY 96 (10/1/95–9/30/96) (%)	FY 97 (10/1/96–9/30/97) (%)
Demographics				
Mean age (Years) ± SD	60.1 ± 13.5	60.3 ± 13.8	60.4 ± 13.8	60.6 ± 13.8
Race				
White	72.8	73.9	68.7	73.1
Black	15.9	16.1	14.8	15.8
Other	11.3	10.0	16.5	11.1
Gender				
Male	96.7	95.5	95.9	95.6
Female	3.3	4.5	4.1	4.4
General condition				
Functional status				
Independent	84.9	85.1	87.0	87.2
Partially dependent	11.4	11.2	9.9	10.2
Totally dependent	3.7	3.7	3.1	2.6
ASA Class				
1	5.1	5.1	5.2	4.8
2	36.2	35.3	35.2	34.5
3	50.0	51.3	51.1	51.6
4	8.3	8.0	8.2	8.8
5	0.4	0.3	0.3	0.3
Dichotomous risk factors				
Ventilator dependent	1.1	1.0	1.2	1.3
DNR	1.4	1.8	1.5	1.3
Emergency operation	9.8	8.9	7.9	7.9
Disseminated cancer	3.6	2.7	2.1	1.9
Weight loss > 10% in 6 months	4.7	4.8	4.1	3.9
Laboratory tests				
Mean serum albumin (g/dl) ± SD	3.80 ± 0.65	3.79 ± 0.65	3.78 ± 0.66	3.74 ± 0.71
Platelet count < 150,000/mm^3	5.3	6.0	7.2	8.7
BUN > 40 mg/dl	3.3	3.4	3.7	3.7
Hematocrit ≤ 38%	31.0	30.7	28.7	29.0
WBC > 11,000/mm^3	16.7	16.9	15.3	14.8
Mean operative complexity				
Score ± SD (range 1–5)	3.04 ± 0.85	2.99 ± 0.85	2.68 ± 0.86	2.70 ± 0.85

* Phase I includes 44 academically affiliated VAMCs that performed cardiac surgery as of 10/1/91.
† Beginning 1/1/94 the NSQIP includes all VAMCs performing major surgery.

Research Using the Data Base

An important byproduct of the NSQIP database is the opportunity to conduct meaningful surgical and health services research. At the time of this writing, published and ongoing studies using the data base include five studies related to NSQIP as a quality-management tool (*e.g.*, validation[12] and best practice[13] studies), four studies related to specific surgical procedures (*e.g.*, cholecystectomy[14] and colectomy), four studies related to special patient populations (*e.g.*, gender differences and patients with do-not-resuscitate status before major surgery), six studies related

Table 5. 30-DAY MORTALITY AND MORBIDITY RATES OVER TIME (NONCARDIAC SURGERY)

	Phase 1 (10/1/91–12/31/93)	Phase 2 (1/1/94–8/31/95)	FY 96 (10/1/95–9/30/96)	FY 97 (10/1/96–9/30/97)
30-day mortality (%)	3.1	3.0	2.7	2.8
30-day morbidity (% of patients with 1 or more complications)	17.4	14.8	10.9	10.3

Table 6. ORDER OF ENTRY OF MOST PREDICTIVE PREOPERATIVE RISK FACTORS IN MORTALITY MODELS FOR NONCARDIAC SURGERY

	Order of Entry into Logistic Regression Model for All Operations				
Risk Factor	Phase 1	Phase 2	FY 96	FY 97	Average Rank
Serum albumin (G/dl)	1	1	1	1	1
ASA class	2	2	2	2	2
Disseminated cancer	4	3	3	3	3.3
Emergency operation	3	4	5	5	4.3
Age	5	5	4	6	5
BUN > 40 mg/dl	6	7	6	9	7
DNR	7	10	8	4	7.3
Operation complexity score	12	9	10	13	11
SGOT > 40 IU/ml	11	8	9	17	11.3
Weight Loss > 10% in 6 months	9	13	14	10	11.5
Functional status	24	6	11	8	12.3
WBC > 11,000/mm^3	16	14	15	11	14

ASA = American Society of Anesthesiology; BUN = blood urea nitrogen; DNR = do not resuscitate; SGOT = serum glutamic; WBC = white blood cell count.

to specific outcomes (*e.g.*, predictors of postsurgical pneumonia and postsurgical length of stay), and one study related to a specific risk factor (presurgical serum albumin as a predictor of surgical outcomes).

Cost of the NSQIP

The total direct cost of the NSQIP is approximately $4 million dollars annually. The salaries of the SCNRs, who spend on the average 75% of their time on the NSQIP and 25% on other quality-management issues, make up 85% of the expenditures. The cost would be approximately $12 for each surgical procedure performed in the VA and approximately $38 for each major procedure assessed by the program.

DISCUSSION

The NSQIP was created and implemented to extend the methods, analysis, and reporting developed in the NVASRS[4,5,7] to all VAMCs performing major surgery in the VHA. Since its implementation in 1994, the NSQIP has been endorsed by clinicians and managers in the VHA as one of the principal means of assessing the quality of surgical care for veterans. Prospectively collected presurgical patient risk factors, key surgical process information, 30-day mortality and morbidity data, and length of stay are collected on 95,000 to 100,000 major surgical procedures annually in 123 VAMCs. For the 44 VAMCs that participated in the NVASRS, the volume of major surgery, risk-adjusted 30-day morbidity and mortality rates, and O/E

Table 7. ORDER OF ENTRY OF MOST PREDICTIVE PREOPERATIVE RISK FACTORS IN MORBIDITY MODELS FOR NONCARDIAC SURGERY

	Order of Entry into Logistic Regression Model for All Operations				
Risk Factor	Phase 1	Phase 2	FY 96	FY 97	Average Rank
Serum albumin (G/dl)	1	1	1	2	1.3
ASA class	2	3	2	1	2
Operation complexity score	3	2	3	3	2.8
Emergency operation	4	4	4	4	4
Functional status	5	5	5	5	5
History of COPD	8	10	6	6	7.5
Age	10	6	7	10	8.3
Hematocrit ≤ 38%	9	13	9	7	9.5
WBC > 11,000/mm^3	11	7	13	9	10
Weight loss > 10% in 6 months	29	8	8	8	13.3
Ventilator dependent	6	11	11	38	16.5
BUN > 40 mg/dl	12	9	31	29	20.3

ASA = American Society of Anesthesiology; COPD = chronic obstructive pulmonary disease; WBC = white blood cell count; BUN = blood urea nitrogen.

Table 8. EXAMPLE OF REPORT FOR VAMC #12: RISK-ADJUSTED MORTALITY (O/E RATIOS) OVER TIME

Subspecialty	Phase 1 (10/1/91–12/31/93) Vol	Mortality Rate n (%) O	E	O/E ratio	Phase 2 (1/1/94–8/31/95) Vol	Mortality Rate n (%) O	E	O/E ratio	FY 96 (10/1/95–9/30/96) Vol	Mortality Rate n (%) O	E	O/E ratio	FY 97 (10/1/96–9/30/97) Vol	Mortality Rate n (%) O	E	O/E ratio
General surgery	433	28 (6.5)	27 (6.2)	1.04	151	8 (5.3)	10 (6.5)	0.81	260	10 (3.8)	12 (4.7)	0.82	288	8 (2.8)	13 (4.6)	0.6
Vascular surgery	136	5 (3.7)	6 (4.7)	0.78	87	1 (1.1)	3 (2.9)	0.39	152	2 (1.3)	5 (3.2)	0.4	132	2 (1.5)	6 (4.7)	0.32
Noncardiac thoracic surgery	84	3 (3.6)	5 (6.0)	0.59	57	1 (1.8)	3 (6.1)	0.28	56	3 (5.4)	3 (5.7)	0.94	36	2 (5.6)	NA	NA
Orthopedic surgery	285	4 (1.4)	4 (1.4)	1.02	198	1 (0.5)	3 (1.7)	0.3	138	4 (2.9)	2 (1.6)	1.75	178	4 (2.2)	3 (1.8)	1.26
Neurosurgery	7	0 (0)	NA	NA	2	0 (0)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Urology	246	2 (0.8)	2 (1.0)	0.85	139	0 (0)	1 (0.5)	0	186	1 (0.5)	1 (0.8)	0.7	138	0 (0)	2 (1.8)	0.0
Otolaryngology	NA	NA	NA	NA	NA	NA	NA	NA	6	0 (0)	NA	NA	63	1 (1.6)	1 (1.3)	1.21
Plastic surgery	79	2 (2.5)	NA	NA	28	0 (0)	NA	NA	38	0 (0)	NA	NA	34	0 (0)	0 (0)	NA
Total of above	1270	44 (3.5)	49 (3.8)	0.9	662	11 (1.7)	20 (3.0)	0.56#	836	20 (2.4)	23 (2.8)	0.86	869	17 (2.0)	27 (3.1)	0.63#
Cardiac (Denver)	613	32 (5.2)	39 (6.4)	0.81	545	20 (3.7)	30 (5.4)	0.67#	375	16 (4.3)	18 (4.8)	0.89	427	8 (1.9)	22 (5.2)	0.36#
Table total	1883	76 (4.0)	88 (4.7)	0.86	1207	31 (2.6)	49 (4.1)	0.63#	1211	36 (3.0)	41 (3.4)	0.87	1296	25 (1.9)	49 (3.8)	0.51#

Vol = assessed volume; O = Observed; E = Expected.
Note: Outlier status (* = high and # = low) based on 90% C.I.
No O/E ratios for assessed volume < 50 cases.

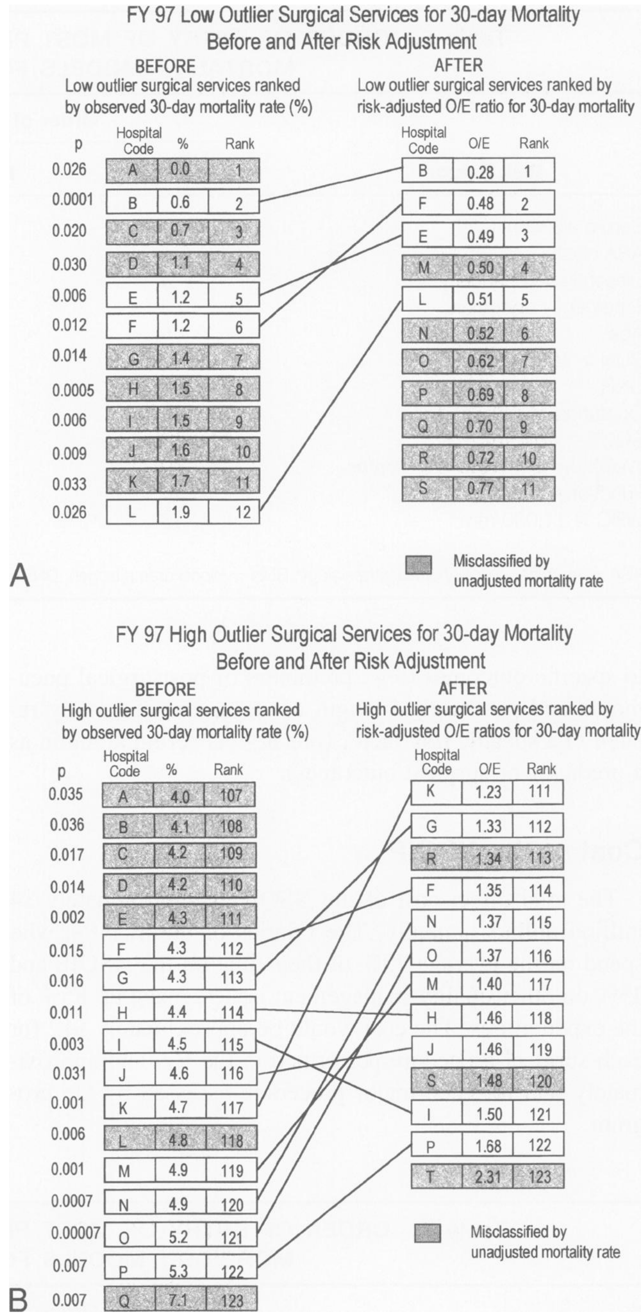

Figure 1. Low (panel A) and high (panel B) outlier hospitals in 30-day mortality rates for all surgical procedures performed during FY97. Within each panel, the hospitals' rankings by adjusted and unadjusted mortality rates are compared. Hospitals appearing in both rankings are connected with a line. In the columns showing the risk-adjusted mortality rates, the O/E ratios shown are those that are significantly different from one at the 90% confidence limits. In the columns showing the unadjusted mortality rates, a probability value is calculated that refers to the test comparing each hospital's observed mortality rate to the observed mortality rate of all hospitals combined ($p < 0.05$).

ratios are available for a 6-year period; for the remaining VAMCs that joined the NSQIP in January 1994, this information is available for a 3.75-year period. Annual comparative reports are available approximately 5 months after the

close of each fiscal year and are disseminated to the clinical and administrative leadership of each VAMC and VISN.

One of the initial concerns of the surgeons in the VHA was that comparison of surgical outcomes based on adverse event rates, unadjusted for patient risk factors before surgery, would bias comparative results against the VAMCs that performed surgery on sicker patients. For 30-day mortality rates, analysis of the NSQIP results suggests that these fears are justified: classification of high and low outliers in terms of 30-day mortality by unadjusted mortality could result in a 64% error rate (see Fig. 1).

Since the inception of the NVASRS and the NSQIP, the volume of major surgery performed in the VHA has remained approximately the same, whereas the average complexity of major surgery has declined. The average risk factor profiles of the veterans undergoing major surgery have remained remarkably similar. Since 1991, the 30-day mortality rate after major surgery has decreased from 3.1% to 2.8%, a 9.6% decline. Given verification against the VHA BIRLS file, the NSQIP is confident that the observed decline is valid. We can only speculate on the causes of the decline in postsurgical mortality. Since 1991, anesthetic and surgical techniques have improved, resulting in lower surgical risk for many patients. Concurrent with these changes, the VHA has implemented a rigorous program of surgical attending oversight of the process of care by resident operators, particularly in surgical suites. Eighty-five percent to 95% of all major surgery in the VHA has a surgical resident identified as the primary operator in the NSQIP data base. Finally, the systematic collection and reporting of surgical deaths and complications by the NSQIP may have resulted in a drop in the surgical mortality rate through changes in surgical process of care and, perhaps, the Hawthorne effect.

An even more dramatic decline in the incidence of postsurgical morbidity has been observed. Between January 1994 and September 1997, the number of patients undergoing major surgery in the NSQIP who had 1 or more of 20 predefined postsurgical complications has decreased from 14.8% to 10.3%, a 30% decline. Such a dramatic decline in incidence has raised the question of whether VAMCs may be systematically underreporting postsurgical complications. During the NVASRS, a study of interobserver variability in the outcomes after surgery verified the accuracy of the outcomes information in that study,[4,7] but limited resources have prevented the NSQIP from conducting similar interrater reliability studies in the 123 VAMCs in the NSQIP. Several VAMCs have conducted studies that reabstract the variables in the NSQIP and have not found systematic bias toward underreporting. The presence of a nurse reviewer assigned to each surgical service has provided an independent observer to identify and classify postsurgical adverse occurrences and provides a healthy balance to the tendency of some providers to underreport complications on their patients. Over the course of the NSQIP, the median postsurgical length of stay has declined from 7 to 3 days, so it has become more challenging for the surgical nurse reviewers to follow every patient for 30 days after major surgery. It is also possible that the reduced length of stay has contributed to a reduction in postsurgical complications from iatrogenic causes.

What has contributed to the success of the NSQIP? First, the VHA has a uniform clinical and administrative data base and software program, the decentralized hospital computer program currently known as VISTA.[15] This has permitted the NSQIP to gain access to a consistent surgical scheduling module and operating room log in every VAMC to identify all procedures performed throughout the country and to create and use a dedicated risk-assessment and outcome module into which all the surgical nurse reviewers enter the same data everywhere. Uniform software updates and changes to the definitions and help screens in the software ensure uniform data collection. After completion of data collection that also abstracts information from other parts of VISTA (*e.g.*, the laboratory and administrative components) automatically, the appropriate data fields are automatically electronically transferred to the data coordinating center for further cleaning and analysis.

Second, the presence of a trained clinical nurse with experience in clinical practice, data collection, and quality assurance has ensured a high level of clinical credibility, reliability, and validity of the data collected for analysis in the NSQIP. The nurse reviewers are highly motivated to maintain the integrity of the NSQIP data base as well as their collaborative relationships with the chiefs of surgery and surgical, anesthesia, and nursing staffs of each surgical service. Many of the nurse reviewers have become vital members of the surgical service and are active in the surgical service and hospital quality-improvement activities. Ongoing training and educational activities for the nurse reviewers through frequent conference calls, e-mail communication, telephone contact, and occasional meetings for educational purposes continue to support the reliability and accuracy of the NSQIP data base and provide a vital feedback mechanism between the surgical services and the coordinating centers. Previous experience in the cardiac surgery component of the NSQIP before the introduction of the clinical nurse reviewers demonstrated that the reliability of the data and the accrual of cases were compromised by relying solely on the clinical providers for case identification and data entry.[16]

Finally, the NSQIP has enjoyed the support of the senior surgeons and administrative managers in the VHA. The original impetus for the creation of the NVASRS came from senior surgeons who recognized that their proactive involvement in developing prospective data-collection systems and state-of-the-art risk-adjustment methods that led to reliable, accurate, and clinically credible reports of risk-adjusted outcomes was a good investment in establishing the quality of surgical care in the VHA. In addition, the executive committee of the NSQIP is a peer group of chiefs of surgery with consultation and assistance from senior clinical managers and methodologists, who work together to

assess the quality of surgical care in the VHA. Surgeons have continued to be active leaders in modifying and improving the NSQIP to meet the new demands for measurement of quality and accountability for outcomes in the "new VA."[17] During the initial years of the NVASRS and the NSQIP, senior administrative managers in the VA central office (clinical services, quality management, and health services research and development) collaborated to provide support for the program. Since the restructuring of VHA into the VISNs in 1995–96, the NSQIP has also enjoyed the support of the network directors and chief medical officers in each of the 22 networks.

What are the limitations of the NSQIP? First, the NSQIP risk models and outcomes may not be generalizable to populations that are not similar to veterans—a predominantly older, medically and socioeconomically disadvantaged population of men who served in the military.

Second, to reduce the data-collection burden for the nurse reviewers, procedure- and subspecialty-specific patient risk factors are not collected for noncardiac surgery. Of note is that the predictive validity of the models has been excellent even in the absence of these specific risk factors. Third, the outcomes measured in the NSQIP are currently restricted to the adverse occurrences of postsurgical death and complications, and length of stay. Other important dimensions of postsurgical changes in health status—improvement in functional status and health-related quality of life—are vitally important. For some surgical subspecialties (*e.g.*, urology and orthopedics), the ability to demonstrate that surgical intervention resulted in a positive impact on veterans' health status is critical. The NSQIP is currently exploring patient-centered technologies that will permit the measurement of generic (*e.g.*, SF-36 or SF-12)[18] and procedure-specific health status questionnaires that can be readily self-administered in the presurgical and postsurgical periods and transmitted electronically to the NSQIP data base for analysis of changes in patient health status after surgical intervention.

Finally, because the VHA historically has not maintained detailed billing and utilization data, the NSQIP is also pursuing accurate microcost-accounting systems that will provide reliable cost information about surgery and permit studies of cost-effectiveness and benchmarking of low-cost, high-quality surgical process of care in the VHA.

The NSQIP has met with some criticism and skepticism by some clinicians and administrative managers in the VHA. Initially, a few chiefs of surgery and their staffs were resistant to participating in the NVASRS and the NSQIP. They expressed fear that accurate and reliable reporting of volume and outcomes of surgery might result in punitive action by administrative managers and result in sanction or closure of surgical programs that they considered to be at the heart of training and educational programs for surgeons, anesthesiologists, and nurses. Although several small VAMC surgical programs have been closed or merged with other larger surgical programs over the 7 years since the inception of the NVASRS, these decisions were made in the context of larger changes within the VHA to regionalize many tertiary services within the VISNs. No surgical programs have been closed or merged solely on the basis of NSQIP results, and some surgeons have expressed relief to have reliable and accurate information available to contribute to these strategic decisions. Many surgeons were skeptical that surgical programs with higher-than-expected risk-adjusted outcomes would have lower quality of care than programs with lower-than-expected risk-adjusted outcomes. A carefully conducted site visit study of the high and low outliers provided evidence that surgical programs with lower-than-expected outcomes did have better processes and structures of surgical care.[12,13] Subsequent publications will describe the results of a parallel study of quality of care using chart review by peer surgeons.

Both surgeons and administrative managers have expressed some concern that a peer-reviewed program such as the NSQIP that relies on the voluntary participation of surgeons and surgical services is inherently biased against complete reporting of adverse outcomes. These critics believe that health care providers cannot be trusted to self-report their own adverse events and that the NSQIP is vulnerable to "gaming," in the form of either overreporting of risk factors or underreporting of adverse outcomes. The independent role of the surgical nurse reviewer on the surgical service has helped to obviate some of these concerns. Analysis of the NSQIP data base over time has not demonstrated an overall rise in the risk-factor profiles of patients undergoing major surgery. Presented with the alternative of being assessed using administrative data bases in the VHA or elsewhere (*e.g.*, Medicare), most surgeons in the VHA have welcomed the NSQIP as both fair and accurate.

Finally, some administrative managers in VHA have questioned the cost-effectiveness of the program, arguing that administrative data base analysis would provide similar information at a much lower cost and would provide opportunities for benchmarking against other administrative data. The NSQIP has conducted studies comparing the VHA administrative data base with the NSQIP data base and found significant discrepancies between the two data sources. Detailed results of these analyses will be reported in subsequent communications. Twelve dollars for each surgical procedure in the VHA or $38 per major procedure for which all risk, process, and outcome information is collected seems like a small cost per procedure for accurate, reliable volume and outcome information.[19] The NSQIP has continually worked to reduce the data collection burden on each VAMC. The need, however, for the surgical nurse reviewer to follow each case during a 30-day postsurgical period, most of which occurs outside the acute care hospital, continues to argue for the presence of well-trained nurse clinicians whose primary responsibilities are to identify cases, validate patient risk factors, and assess patient outcome.

Since the beginning of the NVASRS and the NSQIP, the program has provided volume and outcome information to VAMC surgical services that facilitates and prompts self-assessment and internal reviews by the surgeons, anesthesiologists, and nurses on those services. Since the release of NSQIP reports to network directors and chief medical officers in spring 1997, the surgical community has been fearful that the information in the NSQIP will be used against those surgical services with higher-than-expected outcomes in a punitive manner by administrative managers without sophisticated knowledge of surgical practice. The executive committee of the NSQIP has worked hard to educate all the participants in the NSQIP that the intent of the program is for overall quality improvement in surgical practice in the VHA, not for punishing "bad apples."[20] Although the executive committee is concerned with the small number of VAMCs that have consistently had higher-than-expected adverse outcomes over a 3-year or more period, they are equally interested in learning from those programs with better-than-expected outcomes what key processes and structures of care constitute "best practices" and how they might be disseminated to all the surgical services in the VHA to improve the overall quality of care to veterans undergoing surgery. In addition, the NSQIP is interested in collaborating with the affiliated non-VAMC surgical services to implement similar programs and compare surgical outcomes between VHA and other nonfederal hospitals.

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APPENDIX

Program Participants

Chairperson's Office: Shukri F. Khuri, MD (Chairperson); Jennifer Daley, MD (Co-Chairperson); Maureen Forbes, MS, RN, MPH (Health Services Researcher); Ellen M. Ciambriello (Program Assistant); Lynn-Marie Herlihy, BA (Program Assistant); Candace Savage (National Administrative Coordinator); Jeannette Spencer, RN, MS, CS (National Clinical Coordinator). **Hines Center for Cooperative Studies in Health Services:** John Demakis, MD, and William Henderson, PhD (Codirectors); James Gibbs, PhD (Health Services Researcher); Kwan Hur, MS (Biostatistician); Bharat Thakkar (Statistical Programmer); Robbin Denwood, RN MSN, MBA (Data Coordinator); Sharon Urbanski (Statistical Assistant). **Traveling Nurse Coordinators:** Nancy Deegan, MSN, RN, San Antonio, TX; Jeannette Spencer, RN, MS, CS, Brockton/West Roxbury, MA; Debra Wilcox, MSN, RN, Denver, CO. VA Central Office: Galen Barbour, MD (AsCMD for Quality Management); Scott Beck, ME, CPQA (Special Assistant to AsCMD for Quality Management); Daniel Deykin, MD (Chief, Cooperative Studies Program, and Director, Health Services R&D); Gerald McDonald, MD (Deputy Chief of Surgery). Executive Committee: Shukri F. Khuri, MD (Chairperson), Brockton/West Roxbury, MA; Jennifer Daley, MD (Co-Chairperson), Brockton/West Roxbury, MA; J. Bradley Aust, MD, San Antonio, TX; Scott Beck, ME, CPQA, Washington DC; John Demakis, MD, Hines, IL; Peter J. Fabri, MD, Tampa, FL; James Gibbs, PhD, Hines, IL; Frederick Grover, MD, Denver, CO; Karl Hammermeister, MD, Denver, CO; William Henderson, PhD, Hines, IL; George L. Irvin III, MD, Miami, FL; Gerald McDonald, MD, Washington DC; Edward Passaro, Jr., MD, West Los Angeles, CA; Frank Scamman, MD, Director, National Anesthesia Service, Iowa City, IA; Jeannette Spencer, MS, RN, Brockton/West Roxbury, MA; John Stremple, MD, Pittsburgh, PA. **Expert Advisory Committee:** Barbara McNeil, MD, PhD (Chairperson), Boston, MA; J. Bradley Aust, MD, San Antonio, TX; Paul Ebert, MD, Chicago, IL; Frank Harrell, PhD, Durham, NC; Lisa Iezzoni,

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Discussion

DR. FRANCIS D. MOORE, SR. (Boston, Massachusetts): This study makes many contributions. But one of the most important ones has