The Society of Thoracic Surgeons Adult Cardiac Surgery Database: 2016 Update on Outcomes and Quality

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The Society of Thoracic Surgeons Adult Cardiac Database is one of the longest-standing, largest, and most highly regarded clinical data registries in health care. It serves as the foundation for all quality measurement and improvement activities of The Society of Thoracic Surgeons. This report summarizes current aggregate national outcomes in adult cardiac surgery and reviews database-related activities in the areas of quality measurement and performance improvement.

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The Society of Thoracic Surgeons (STS) Adult Cardiac Surgery Database (ACSD) was established in 1989 as the first component of what has ultimately become the STS National Database. ACSD was initiated in direct response to the publication of minimally adjusted coronary artery bypass grafting (CABG) mortality data by the federal government in 1986 and the resulting concern by the STS leaders that these results did not reflect differences in the inherent risk of patients [1, 2].

During the ensuing quarter century, the STS has progressively refined the ACSD into what has become the preeminent clinical cardiac surgery data registry in the world, now containing more than 5.7 million patient records. These data are used to support nationally benchmarked performance assessment and feedback, sophisticated risk-adjustment models [3–5], quality improvement initiatives, performance measurement [6, 7], voluntary public reporting [8], research, reimbursement strategies, and government and regulatory collaborations. Much of this work has been detailed in more than 150 peer reviewed publications.

This is the first in a series of annual reports summarizing national aggregate cardiac surgical outcomes and detailing quality measurement and performance improvement activities derived from the ACSD during the past year.

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Brief Overview of the ACSD

Collection of detailed clinical data and feedback of risk-adjusted nationally benchmarked results to participant groups remain the primary functions of the ACSD. A participant is typically a hospital cardiac surgery program, a practice group of cardiothoracic surgeons, or uncommonly, an individual surgeon. Data are submitted to the STS data warehouse and analytical center at Duke Clinical Research Institute during four quarterly harvests each year, and results are disseminated quarterly to each ACSD participant. These results contain participant-specific information regarding risk factors and nationally benchmarked outcomes as well as aggregate national results for comparison and internal quality assurance. Semiannually, participants also receive their performance on National Quality Forum (NQF)–endorsed STS measures and composite quality scores based on a running 12 months (CABG) and 36 months (valve) of data ending in June or December of each year.

More than 1,300 clinical data elements are available for each patient, although many are "child fields" that are not coded unless the relevant "parent" element is coded. Approximately 225 data elements are coded for a typical CABG patient. To maintain clinical relevance with evolving surgical practice, data elements undergo periodic revision to clarify existing variables, harmonize definitions with related national and international databases, add new variables of interest, and remove irrelevant ones. These revisions are performed on a 3-year cycle.

Abbreviations and Acronyms

ACSD = Adult Cardiac Surgery Database
AVR = aortic valve replacement
CABG = coronary artery bypass grafting
CMS = Centers for Medicare and Medicaid Services
FTR = failure to rescue
MV = mitral valve
MVR = mitral valve replacement
MVRR = mitral valve repair or replacement
NQF = National Quality Forum
QMTF = Quality Measurement Task Force
STS = Society of Thoracic Surgeons
TQI = Task Force on Quality Initiatives

Data integrity is critical to the validity of any clinical database, and the STS uses an internal validation process and external audit. Each year, 10% of sites are randomly selected for an independent external audit. Submitted data elements are validated by comparison with the medical record, and hospital surgical logs are reviewed to verify that all cases are included. These audits have shown nearly 100% completeness of case ascertainment and greater than 95% agreement rates with recorded data elements [9]. Completeness of case inclusion at STS sites has also been corroborated by analyses based on successful linkage of ACSD data with claims data from the Centers for Medicare and Medicaid Services (CMS) [10].

As of September 2015, the ACSD included 1,126 participant groups comprising 2,976 surgeons from all 50 states in the United States and from 8 other countries. Of the 5.7 million cumulative worldwide operations included in the ACSD, more than 5.1 million have been performed in the United States. A recently completed analysis of linked CMS and ACSD CABG data showed the center-level and patient-level penetration of the ACSD in 2012 had reached 90% and 94%, respectively. Furthermore, this study linked 98% of CMS CABG hospitalizations at active STS sites to an STS ACSD record, a very high degree of completeness [11]. These findings suggest that nearly all CMS CABG operations performed at STS sites are captured in the ACSD. Given the predominance of Medicare patients in the CABG population, this is an excellent indicator that the STS ACSD captures the vast majority of cardiac cases in the United States.

I. National Outcomes in Adult Cardiac Surgery

This report encompasses aggregate outcomes for all operations performed from January 1 to December 31, 2014, and presented in the 2015 Harvest 1 report. The outcomes are based on the data elements specified in the current version (2.81) of the data collection instrument.

CABG remains the single most commonly performed major procedure, followed by isolated aortic valve replacement (AVR), combined aortic valve and CABG, mitral valve operations, operations for aortic aneurysm, and combined aortic and mitral valve replacement (MVR)

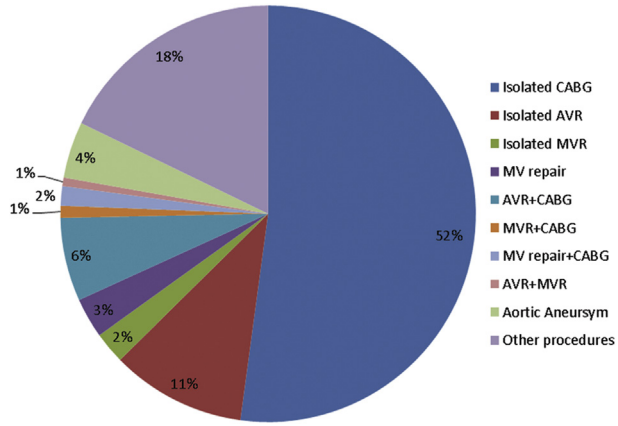

Fig 1. Relative distribution of cardiac operations by procedure type for calendar year 2014. "Other procedures" includes cardiac procedures not classified in the pie chart (ie, tricuspid valve operations, ventricular assist devices, arrhythmia operations, transplants, etc). (AVR = aortic valve replacement; CABG = coronary artery bypass grafting; MV = mitral valve; MVR = mitral valve replacement.)

(Fig 1). Approximately 18% of procedures performed nationally are not included in one of the above categories. These include procedures, such as tricuspid valve repair/replacement, arrhythmia correction surgery, implantation of ventricular assist device, and septal defect repair, among others, that were performed in isolation or in combination with other procedures.

Table 1 details the change in procedure volume during the past decade. The number of isolated CABG operations has decreased by 6%, reflecting the effect of improving medical management and coronary artery stenting. The number of isolated surgical aortic valve replacements demonstrated a dramatic 95% increase during the past decade, from 14,945 to 29,158 operations, probably due to the aging of our population and the "halo effect" of transcatheter aortic valve technology. Similar increases are seen for the other major procedures, with the exception of combined mitral valve repair and CABG, which showed a 7% decline during the same interval. Surgical interventions on the mitral valve have shown a continuing national trend in favor of repair over replacement. From 2011 to 2014, approximately 70% of primary mitral valve procedures involved valve reconstruction across all pathologies [12].

Selected aggregate national outcomes for the more commonly performed operations in calendar year 2014 are presented in Table 2. Among the procedures listed, operative mortality ranges from a low of 1.2% for mitral valve repair to a high of 9.9% for MVR and CABG. MVR+CABG also has the highest incidence of major morbidity, most notably, a 31% incidence of prolonged ventilation beyond 24 hours.

New-onset postoperative atrial fibrillation is the most common complication after cardiac surgery and has detrimental effects on postoperative clinical outcomes, resource utilization, and hospital costs [15]. Despite numerous proposed prophylactic management strategies,

Table 1. Change in Procedure Volume During the Past Decade

Variable	2005	2014	2005 to 2014 (% Change)
Overall procedure count	250,819	277,913	11
Major procedures			
Isolated CABG	155,012	144,940	–6
Isolated AVR	14,945	29,158	95
Isolated MVR	4,289	6,857	60
MV repair	4,671	8,658	85
AVR + CABG	13,763	18,016	31
MVR + CABG	2,496	2,582	3
MV repair + CABG	4,518	4205	–7
AVR + MVR	1,032	1,851	79
Procedures not classified above	50,093	61,726	23
Incidence of select other procedures			
Tricuspid valve	5,271	9,684	84
Ventricular assist device	1,010	4,467	342
Atrial septal defect repair	2,826	5,786	101
Atrial fibrillation correction surgery	12,912	18,999	47
Aortic aneurysm surgery	8,437	12,188	44
Cardiac transplant	858	1,586	85

AVR = aortic valve replacement; CABG = coronary artery bypass grafting; MV = mitral valve; MVR = mitral valve replacement.

a widely accepted effective protocol remains elusive. In 2014 new-onset atrial fibrillation occurred in 23% of CABG patients and varied between approximately 28% and 44% for patients undergoing one of the listed valve procedures (Table 2).

Exposure to allogeneic blood is sometimes associated with adverse outcomes, including infection, transfusion-associated lung injury, complex immunologic effects, transfusion reactions, graft versus host disease, and other complications. A recent study has demonstrated that patients receiving only small quantities of packed red blood cells have an increased risk for pneumonia after CABG [16]. Recognition of these risks has led many cardiac surgical programs to adopt strategies to reduce transfusion. In 2012 the STS Task Force on Quality Initiatives (TQI) devoted its first quality improvement web-based seminar (webinar) to the topic of blood conservation. Table 3 presents the percentage of patients receiving at least 1 unit of blood product during the intraoperative or postoperative period, or both, after each of the seven major cardiac surgical procedures. The results for 2014 are compared with those from 5 years earlier. Although transfusion rates dropped between 10% and 15% during that time, a substantial number of patients still are exposed to a blood product. The lowest rates occur in CABG and mitral valve repair patients (44.5% and 34.4%, respectively) and the highest rates (84.4%) in patients undergoing MVR+CABG.

II. Quality Measurement

The STS Quality Measurement Task Force (QMTF) is the locus for all STS initiatives related to the development of risk models and performance measures. These activities involve a close collaboration between clinical cardiothoracic surgeons, many of whom have developed

Table 2. Selected Outcomes of the More Commonly Performed Cardiac Surgical Procedures in Calendar Year 2014

Outcomes	CABG (n = 144,940)	AVR (n = 29,158)	AVR + CABG (n = 18,016)	MVR (n = 6,857)	MVR + CABG (n = 2,582)	MV Repair (n = 8.658)	MV Repair + CABG (n = 4,205)
Mortality, %							
In-hospital	1.7	1.9	3.2	4.2	9.2	1.0	4.3
Operative[a]	2.1	2.4	3.9	4.9	9.9	1.2	5.1
Major morbidity, %							
Reoperation[b]	2.3	3.9	4.7	5.8	7.5	2.7	5.4
DSWI/mediastinitis	0.3	0.2	0.2	0.1	0.4	0.1	0.3
Permanent stroke	1.3	1.1	2.3	2.0	3.8	0.9	2.5
Prolonged ventilation >24 h	8.2	7.9	13.4	18.5	30.8	5.0	21.8
Renal failure	2.0	2.0	3.8	4.3	7.9	1.1	5.4
New-onset atrial fibrillation, %	23.4	31.1	38.7	33.1	43.8	27.9	40.2
Readmission ≤30 days of discharge, %	9.7	10.2	11.7	14.4	15.7	8.3	13.2
Post-op length of stay, d							
Mean	6.8	7.3	8.6	10.1	11.7	6.5	9.9
Median	6.0	6.0	7.0	7.0	9.0	5.0	8.0

[a] Operative mortality is defined in the three Society of Thoracic Surgeons databases as (1) all deaths, regardless of cause, occurring during the hospitalization in which the operation was performed, even if after 30 days (including patients transferred to other acute care facilities); and (2) all deaths, regardless of cause, occurring after discharge from the hospital, but before the end of the 30th postoperative day [13, 14]. [b] National Quality Forum definition of reoperation.

AVR = aortic valve replacement; CABG = coronary artery bypass grafting; DSWI = deep sternal wound infection; MV = mitral valve; MVR = mitral valve replacement.

Table 3. Blood Product Utilization for the Seven Major Procedures: 2009 vs 2014

Procedure	Calendar Year	
	2009 Patients (%)[a]	2014 Patients (%)[a]
CABG	59.1	44.5
AVR	67.1	50.0
AVR + CABG	82.6	67.7
MVR	80.9	69.8
MVR + CABG	90.5	84.4
MV repair	49.5	34.4
MV repair + CABG	83.5	71.5

[a] Patients receiving any blood product during the intraoperative or postoperative period, or both.

AVR = aortic valve replacement; CABG = coronary artery bypass grafting; MV = mitral valve; MVR = mitral valve replacement.

special expertise in quality measurement, and a team of statisticians from the Duke Clinical Research Institute who also have interest and experience in this specialized area. The following topics have been the major foci of the QMTF during 2015:

1. Composite Performance Measures for Mitral Valve Repair and Replacement, With or Without CABG

The STS QMTF has expanded its portfolio of composite performance measures with two new additions: isolated mitral valve repair or replacement (MVRR) [12] and MVRR+CABG [17]. Similar to the AVR and AVR+CABG measures [18, 19], and in the absence of widely accepted or NQF-endorsed process measures for mitral valve procedures, these composites consist of two outcomes domains—risk-adjusted mortality and morbidity. As in prior STS composite measures, morbidity consists of the occurrence of any of the following five major complications: reoperation, stroke, renal failure, sternal infection, or prolonged ventilation. Because contemporary mitral operations are frequently performed with surgical ablation for atrial fibrillation, closure of a patent foramen ovale/atrial septal defect, or concomitant tricuspid valve repair, the MVRR model was designed using modified versions of our existing risk models that now included these adjunctive procedures. After exclusions, 61,201 patients from 867 participating sites were available upon which to base the development of the MVRR measure [12].

To provide composite scores to as many sites as possible while maintaining acceptable model reliability, the MVRR measure includes 3 years of data from programs with at least 25 cases and uses 95% Bayesian credible intervals to assess performance categories. In the development cohort, 2.6% (23 of 867) of programs were assigned a rating of 1 star (lower-than-expected performance), 91.7% (795 of 867) were awarded 2 stars (as-expected performance), and 5.7% (49 of 867) were awarded 3 stars (higher-than-expected performance). A companion MVRR+CABG model was constructed using similar variables, inclusion/exclusion criteria, and volume eligibility thresholds. After exclusions, 24,740 MVRR+CABG patients at 703 participating sites were identified. These data were used to classify 2% of programs (14 of 703) as 1-star, 95% as 2-star, and 3% as 3-star programs [17]. For both measures, mortality and morbidity progressively declined as star ratings increased.

2. Stroke Mitigation

One of the most devastating complications of CABG is permanent stroke. The prevalence of this complication has not diminished appreciably over the years, and it is arguably the greatest short-term disadvantage of CABG compared with percutaneous coronary intervention. Long-term stroke rates do not differ substantially between the two approaches to revascularization [20].

To address this serious CABG complication, the STS established a Stroke Task Force with the goal of identifying potentially modifiable intraoperative processes that might contribute to perioperative stroke. Working in collaboration with the QMTF, the Stroke Task Force analyzed ACSD version 2.73 data from July 2011 to June 2014. That period included 439,044 CABG procedures performed by 1,096 participants. After exclusions, such as off-pump procedures and missing or out-of-range key variables, 263,255 patients formed the study population.

Preliminary results suggest that longer cardiopulmonary bypass times, postoperative blood product use, substantial decrease in intraoperative hematocrit levels compared with preoperative levels, very low intraoperative hematocrit, and female gender were associated with increased stroke risk. Preliminary analyses did not show a protective effect of ultrasonographic assessment of the ascending aorta. There is a complex association between gender, preoperative hematocrit level, lowest intraoperative hematocrit, and intraoperative transfusion that appears to affect stroke risk, but definitive recommendations are premature. Continuing research into these risk factors may allow more proactive and effective stroke mitigation in the CABG population.

3. Surgeon-Level Metrics

The STS has historically estimated outcomes results only at the hospital or program level, given the team nature of cardiac surgery and the relatively small sample sizes for individual surgeons. However, there is intense interest in surgeon-level metrics by the public, and there is evidence that both surgeon and hospital have an effect on outcomes. Finally, with the release of physician-specific data by CMS, outside entities have obtained these data and are generating their own report cards based on claims data. In most instances, the methodologies used by these entities are not published in the peer reviewed literature, and their accuracy is questionable. Previous analyses suggest that their results often differ from those derived from clinical data (eg, the STS Database) and using methodologies that have been rigorously peer reviewed.

Accordingly, the STS QMTF has devoted several years to the development of a responsible and highly credible surgeon-level metric that addresses many of the concerns previously expressed, including adequacy of sample size and end points and excessive focus on one procedure (CABG) and one metric (risk-adjusted mortality) [21]. The goal of the QMTF was to develop a performance measure that would capture most of the major cardiac procedures performed by a typical surgeon. It also would assess not just risk-adjusted mortality but also the risk-adjusted occurrence of any of the five major complications included in our hospital-level metrics (stroke, reoperation, deep sternal wound infection, prolonged ventilation, and renal failure).

This performance measure was developed from 621,489 isolated CABG, isolated AVR, AVR+CABG, MVRR, or MVRR+CABG procedures performed by 2,286 surgeons between July 1, 2011, and June 30, 2014. Existing STS risk model variables were used to risk adjust, but a number of modifications were made to the mitral models to accommodate changes in contemporary practice, such as the inclusion of tricuspid repair patients, all atrial septal defect and patent foramen ovale closures, and any surgical ablation procedures (both epicardial and endocardial). Results were based on 3 years of data. Each surgeon's composite score combines his or her aggregate risk-adjusted mortality and major morbidity (each weighted inversely by their standard deviations) for the five procedures and reflects the proportion of cases of each type that each surgeon performed. Estimated in a fully Bayesian framework, computation of this complex model required more than a week of continuous processing on a dedicated server. After various Bayesian credible intervals were tested to determine outliers, 98% intervals were chosen that correspond to 99% Bayesian probabilities that a surgeon is truly a high or low outlier.

Risk-adjusted mortality and morbidity rates, as well as overall composite scores, all varied substantially across surgeons. There were 207 (9.1%) 1-star (lower-performance) surgeons, 1,701 (74.4%) 2-star (as-expected performance) surgeons, and 378 (16.5%) 3-star (higher-performance) surgeons. With an eligibility threshold of 100 cases over 3 years, measure reliability was 0.81. This is one of the highest reliabilities of any STS measure and reflects the use of data from multiple procedures and outcomes, collected over 3 years, thus providing a large number of end points. In summary, the STS has developed a highly reliable surgeon-level performance metric based on multiple procedures and outcomes. Surgeons will begin receiving their own results in 2016, which will provide an opportunity for them to identify any potential concerns and to become more familiar with their use.

4. Failure to Rescue

Assessment of operative quality requires attention both to survival and postoperative complications. In many instances, overall survival may relate to the effective response of hospitals to the development of a serious complication. Complications are more common in patients with more serious comorbidities or those whose presentation is more acute. Complication rates do vary across institutions, often related to the acuity of their patients; however, much greater variation is observed in mortality rates after complications occur, or so-called failure to rescue (FTR) [22–25]. This interhospital variation in outcomes after the development of a complication reflects the breadth, depth, and expertise of relevant clinical and support services. Patients experiencing similar complications in one institution may be more likely to survive than in another.

FTR is thus an indicator of the prompt recognition and effective treatment of postoperative complications. Factors leading to lower FTR rates (higher survival after complications) include early detection (eg, early recognition of sepsis) and more effective management such as rapid response teams or experienced interventional cardiologists to deal with acute myocardial infarctions.

FTR measures for CABG and other procedures are now being developed using the STS National Database. Because stroke, prolonged ventilation, reoperation, and renal failure are included in the STS CABG composite measure, these complications were chosen for STS FTR studies of CABG. The STS 2010 to 2013 CABG population of 604,154 eligible patients was used to develop a statistical model to predict FTR for each of the complications and for a composite of all four complications. These models are based on the specific array of patient complications and preoperative risk factors from the STS CABG models.

These analyses showed that FTR rates varied much more than complication rates across terciles of overall mortality. Furthermore, when centers were grouped by terciles of complication rates, lower rates were associated with higher FTR. The explanation for this somewhat paradoxical finding can only be speculated at this point. Perhaps some centers have fewer complications because they care for less severely ill patients; however, when serious complications do occur, these institutions do not have the necessary infrastructure to provide optimal care. For example, preliminary analyses suggest that high-volume programs tend to have the lowest FTR rates. Further studies are ongoing to better understand the complex determinants of FTR. Additional results will be reported at the 2016 STS Annual Meeting.

Several more risk-adjusted FTR measures will be developed in the upcoming year, each based on a single procedure. With the extensive data in the STS National Database, it should be possible to more clearly define the role of FTR and possibly to provide STS members with a valuable new quality metric. The confounding effect of age will need to be further investigated, because patient and family preferences may affect the aggressiveness of resuscitation efforts after serious complications. The analyses used for FTR research may also be useful for patient and family counseling as they demonstrate the average likelihood of survival for

patients with specific combinations of postoperative complications.

5. Risk Model Revisions

One of the most important functions of the STS QMTF is the periodic revision of our risk models for major procedures. The last set of risk models in adult cardiac surgery, based on STS Database versions 2.35, 2.41, and 2.52.1, was published in 2009 as a series of 3 articles [3–5]. Despite evidence from regional studies indicating that some new variables from Database version 2.73 might be important additions to the new STS risk models, many centers did not routinely collect these new variables, and they could therefore not be considered for inclusion. Missing data exceeding 5% generally disqualified a variable for inclusion in the risk model. Notably, although it triples the risk of surgery at any baseline level, frailty (as measured by the 5-meter walk test) was frequently not assessed by participants and could not be included in the new models.

The updated risk model will be constructed using STS ACSD version 2.73; however, any data element selected for inclusion in the new model must correspond (directly or through mapping) to an equivalent data element in version 2.81, because those are the data to which the model will be applied. Whenever possible, categoric variables will be parameterized in the most efficient manner, which sometimes involves collapsing adjacent categories. Finally, for some risk factors, such as chronic lung disease, the STS QMTF is working with outside experts to be certain that our risk model classification is consistent with national best practice. As of late 2015, work continues on these models, and publication is expected in 2016.

6. STS Voluntary Public Reporting—Analysis of the First 4 Years

In response to the publication of inadequately risk-adjusted CABG mortality rates by the federal government in 1986, the STS developed a comprehensive cardiothoracic clinical data registry, which has now evolved into the STS National Database. These granular clinical data have been used to develop risk models for many cardiothoracic surgical procedures [3–5], and these have been iteratively refined during the succeeding quarter century. It is possible to use these models to account for the inherent preoperative risk of patients and not penalize providers who care for the most acutely and severely ill patients.

The STS approach to discriminating performance has also evolved. For many years, the STS and most states with "report cards" evaluated cardiac surgery quality based primarily on one procedure (CABG) and one outcome (risk-adjusted mortality). With declining numbers of CABG patients and falling mortality rates, it was recognized that this was insufficient as a quality metric, often lacking sufficient sample size and end points to reliably discriminate performance.

Furthermore, death is the most obvious but not the only important outcome that characterizes the quality of cardiothoracic procedures. The QMTF began work in 2007 on a multidimensional composite performance measure for CABG [6, 7] that included mortality, the occurrence of any of five major complications (deep sternal wound infection, stroke, renal failure, prolonged ventilation >24 hours, or reoperation), performance of at least one internal mammary artery graft, and use of all 4 NQF-endorsed perioperative medications (preoperative β-blockade, discharge aspirin, antilipid agents, and β-blockade in patients without contraindications).

Subsequent composite measures, based only on morbidity and mortality domains, were developed for isolated AVR [18] and AVR+CABG [19], and similar measures for MVRR and MVRR+CABG procedures are currently being finalized. Each individual composite measure provides much more comprehensive information about the quality of the procedure, and these composite measures also effectively increase sample size, thereby allowing performance to be more reliably discriminated. Composite scores are estimated using Bayesian hierarchical approaches and are presented as numeric scores as well as star ratings to assist consumer interpretation. One star represents lower-than-expected performance, 2 stars represent average or expected performance, and 3 stars represent higher-than-expected performance.

Composite scores initially were provided in a confidential manner only to hospital and cardiac surgical groups. However, the STS leadership increasingly views transparency and accountability as a professional responsibility, especially because the STS had developed some of the most sophisticated, multidimensional performance measures in all of health care. The STS partnered with Consumer Reports in 2010 to publish its performance ratings on their website for those programs wishing to voluntarily participate [26], and a similar opportunity subsequently was made available on the STS website.

In late 2014, the STS completed 4 full years of voluntary public reporting, and these results were presented at the 2015 meeting of the American Surgical Association [8]. Between 2010 and 2014, there were nine harvest and reporting periods, with approximately 1,000 STS participant sites per period, yielding 8,929 unique observations. Overall STS public reporting participation varied from 22.2% for the first harvest to 46.3% (currently 44%). Reporting sites had significantly higher volumes for every reporting period ($p < 0.0001$ to 0.0007), although not all high-volume programs chose to report. Overall, 916 sites (10.3%) were classified low performing (1 -star), 6,801 (76.2%) were as expected (2 stars), and 1,212 (13.6%) were high performing (3 stars). Risk-adjusted, patient-level mortality rates for isolated CABG were consistently lower in public reporting vs nonreporting sites ($p < 0.001$ to 0.0077), and reporting centers had higher composite performance scores and star ratings (23.2% high performing and 4.5% low performing vs 7.6% high performing and 13.8% low performing for nonreporting sites). High-performing programs had higher mean CABG volumes (n = 241) than average- (n = 139) or low-performing (n = 153)

sites. STS public reporting sites also had higher mean annualized CABG volumes than nonreporting sites (169 vs 145, $p < 0.0001$).

One concern about public reporting is that it might result in risk aversion, or unwillingness of surgeons to accept high-risk patients for surgery. To address this concern, the STS data were used to examine trends in risk-factor prevalence over time, beginning in 2004, 10 years before the onset of STS voluntary public reporting, and ending in late 2014, 4 years after public reporting began. Overall, expected mortality rates and the prevalence of individual important risk factors, such as shock, advanced age, and emergency status, were all stable over that time, and the prevalence of chronic lung disease and dialysis-dependent renal failure steadily increased. Only the prevalence of reoperation decreased, and this finding may reflect improvements in medical therapy and interventional cardiology, making reoperation less often necessary.

7. NQF Process and STS Measures

The NQF is a multistakeholder, membership-based organization that aims to improve health care quality through better measurement. NQF endorsement is the gold standard for health care quality, and NQF-endorsed measures are recognized by the national health care community as "best in class," evidence-based, and rigorously validated. NQF uses a structured, systematic consensus development process to evaluate and endorse performance measures. This process evaluates measures using four major criteria: importance to measure and report, scientific acceptability of measure properties, feasibility, and usability and use. Endorsed measures are reevaluated every 3 years (ie, measure maintenance) to ensure they continue to meet NQF requirements.

The STS is committed to the development and use of the highest-quality performance measures. To affirm this commitment, all STS measures are published in their entirety in the peer reviewed literature and are submitted to the NQF for endorsement. In 2004, 21 adult cardiac surgery measures received NQF endorsement. Since then, the STS has expanded its performance measures portfolio, which now includes not only adult cardiac composite measures but also similar measures for general thoracic and congenital heart surgery.

The STS recently participated in the second phase of the NQF Surgery Project, during which 13 STS maintenance measures and one new measure were reviewed and endorsed. The Society now has 34 NQF-endorsed measures encompassing all three of its component databases, the largest number of any health care professional society [27].

The STS QMTF is responsible for the development and ongoing maintenance of the STS risk models and performance measures, and it collaborates with STS staff and Duke Clinical Research Institute statisticians to prepare detailed measure submission forms for NQF review. This process includes updating measure specifications, providing measure-specific data to demonstrate performance gaps, and conducting adequate reliability and validity testing to further support each measure. Working with QMTF, the Task Force on Quality Initiatives (TQI) contributes information on clinical practice guidelines and other evidence to demonstrate that each measure focus is evidence-based. The TQI has also developed special expertise in preparing and submitting measures to NQF for endorsement. Results for NQF-endorsed STS individual and composite measures are provided to STS National Database participants in their database harvest reports, and composite measures are used in the voluntary STS public reporting initiative.

III. Quality Initiatives

Activities of the STS TQI have focused primarily on the development and maintenance of NQF-endorsed measures (in collaboration with QMTF), development of quality webinars, promotion of surgeon-led regional quality collaboratives, and providing surgeon support for Data Manager Regional Groups.

STS Quality Webinars

Commencing with the first webinar in February 2012, all presentations are available for viewing on the STS Webinar Series page of the STS website (http://www.sts.org/education-meetings/sts-webinar-series) The first webinar was devoted to the topic of blood conservation and included live presentations by a multidisciplinary panel of recognized experts, followed by a question and answer session. Topics included a review of transfusion risks, a summary of the STS blood conservation guidelines, techniques to minimize transfusion, and the potential clinical and financial benefits associated with blood management protocols. The live webinar was attended by 636 individuals.

The second quality webinar, presented in April 2013, focused on glycemic control. Topics discussed included the underlying biochemistry and physiology of glucose metabolism, how to identify those patients who would benefit most from aggressive glycemic control, target glucose level and duration of control, and finally, the associated risks and benefits of tighter glucose control. This live webinar was attended by 121 individuals.

The third quality webinar, in March 2014, discussed approaches to mediastinal staging of lung cancer. Topics covered included the American College of Chest Physician guidelines for lung cancer staging and the indications for and pros/cons of the various invasive and noninvasive staging options. These include computed tomography and positron emission tomography scanning, endobronchial, and endoesophageal ultrasound, and cervical mediastinoscopy. This live webinar, with its intended target audience being participants in the somewhat smaller General Thoracic Surgery Database, was attended by 95 individuals.

The fourth and most recent installment of the STS quality webinars, in December 2014, focused on prolonged ventilation in adult cardiac surgery. An expert

panel detailed the association of prolonged ventilation with increased pulmonary and other complications as well as hospital costs. Two institutional approaches to a program of early extubation and the associated clinical benefits were presented. The webinar was viewed by 268 individuals. Unlike the first three webinars, this webinar was prerecorded and followed by a live phone-based question and answer period.

The next webinar, presently planned for early 2016, will focus on the increasingly important issue of 30-day readmissions after cardiac surgery. Scheduled topics will include the clinical and financial significance of readmission, analysis of the STS readmission risk model, and preoperative, postoperative, and postdischarge strategies to decrease the incidence of readmissions.

Surgeon-Led Regional Quality Collaboratives

Members of the TQI presented a moderated panel discussion titled, "The STS Adult Cardiac Surgery Database and the Genesis, Evolution, and Sustainability of Local and Regional Quality Collaboratives," as a component of the "Evidence and Quality Reshaping Practice" session at the 2015 STS Annual Meeting in San Diego. The panel was moderated by Dr Richard Prager, who gave a brief introduction to the concept of regional collaborative groups and shared his experience as the executive director of the Michigan Society of Thoracic and Cardiovascular Surgeons Quality Collaborative. Dr William Nugent shared thoughts and reflections on his pioneering work with the Northern New England Cardiovascular Disease Study Group. TQI members Drs Alan Speir and Baron Hamman discussed their efforts with the Virginia Cardiac Surgery Quality Initiative and the Texas Quality Initiative, respectively. The panel discussion focused on the differences in overall approach, particularly with regard to the structure and funding of the different collaborative models, and most importantly, on the improvement in outcomes realized by each group.

Data Manager Regional Groups

STS National Database data managers, whose responsibilities include the abstraction and submission of participant data, are essential to the integrity and long-term viability of the STS National Database. For more than 20 years, data manager regional groups have offered a collaborative networking environment for peer-to-peer support and guidance related to data abstraction. There are now 19 such regional groups that span 41 states, each meeting regularly by conference call or in person, with the goal of increasing the consistency and accuracy of STS data abstraction. Active surgeon participation is a vital component to the success of these regional groups. Collaboration between surgeons and data managers, through joint quality improvement meetings and other educational opportunities for local managers, improves overall data integrity. In addition, surgeons can serve as superb regional advocates for the STS National Database and its value to patients, hospitals, and administrators.

Surgeon involvement in Database Manager Regional Groups, however, has been inconsistent. Currently, only the states of Virginia, Michigan, Texas/Oklahoma, and Maryland, and the Delaware Valley Regional Group (consisting of programs in Pennsylvania, Delaware, and New Jersey) convene regular collaborative meetings attended by surgeons and data managers. Only limited informal and ad hoc surgeon support exists in some regions, and little or no surgeon involvement with data manager groups is available in many states.

Although geographic, individual or institutional obstacles may impede optimal interaction between surgeon and data manager, the STS believes that surgeon support for the data manager group is critical. Earlier this year the TQI, in concert with the Data Manager Regional Group leadership, contacted 1,400 STS member surgeons in those regions with limited support requesting their active participation. Within several weeks, more than 50 responses were received. To date, at least 10 regional groups encompassing 21 states with no prior surgeon support have begun a process of engagement leading to collaborative meetings. TQI will continue to work with the Data Managers Regional Groups on this important initiative.

Upcoming Activities

The ACSD will conduct its next periodic specification revision in 2016. Anticipated improvements include a major expansion of aortic surgery data elements to reflect current practice and emerging technologies, further harmonization with other national and international data registries, and the addition of new data elements that may improve risk stratification. A major focus of the QMTF will involve the development of updated risk models incorporating the new data elements from version 2.73. Appropriateness algorithms based on version 2.81 data elements are in development and will allow verification of the appropriateness of CABG and valve procedures. Efforts are underway to expand the range of outcomes analyzed, with future emphasis on long-term outcomes and costs, which, combined with risk adjusted clinical outcomes, will begin to address the important end point of value. The ACSD continues to explore the potential to automatically extract certain data elements directly from electronic health records, while requiring the same high accuracy and integrity of current data entry approaches. Finally, the TQI is exploring the possibility of offering a broad range of quality improvement opportunities to programs that might desire them.

Summary

The field of cardiothoracic surgery has a long and proud tradition of scientific investigation, innovation, and critical self-examination. More than a quarter century ago, the STS was one of the first specialty organizations to recognize the importance of a prospectively maintained clinical data registry to advance the quality of care we provide to our patients. The ACSD is the cornerstone of the Society's activities in outcomes research, performance measurement, quality improvement, public reporting,

and informing policy stakeholders regarding adult cardiac surgery. The ACSD will continue to evolve, and future efforts will remain focused on leveraging the knowledge gained to provide increasing value to our patients and to society.

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