
Measuring Surgical Quality: Comparison of Postoperative Adverse Events with the American College of Surgeons NSQIP and the Thoracic Morbidity and Mortality Classification System

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BACKGROUND: Monitoring surgical outcomes is critical to quality improvement; however, different data-collection methodologies can provide divergent evaluations of surgical outcomes. We compared postoperative adverse event reporting on the same patients using 2 classification systems: the retrospectively recorded American College of Surgeons (ACS) NSQIP and the prospectively collected Thoracic Morbidity and Mortality (TM&M) system.

STUDY DESIGN: Using the TM&M system, complications and deaths were documented daily by fellows and reviewed weekly by staff for all thoracic surgical cases conducted at our institution (April 1, 2010 to December 31, 2011). The ACS NSQIP recording was performed 30 to 120 days after index surgery by trained surgical clinical reviewers on a systemic sampling of major cases during the same time period. Univariate analyses of the data were performed.

RESULTS: During the study period, 1,788 thoracic procedures were performed (1,091 were designated “major,” as per ACS NSQIP inclusion criteria). The ACS NSQIP evaluated 182 of these procedures, representing 21.1% and 16.7% of patients and procedures, respectively. Mortality rates were 1.4% in TM&M vs 2.2% in ACS NSQIP ($p = 0.42$). Total patients and procedures with complications reported were 24.4% and 31.1% by TM&M vs 20.2% and 39.0% by ACS NSQIP ($p = 0.23$ and 0.03), respectively. Rates of reported cardiac complications were higher in TM&M vs ACS NSQIP (5.8% vs 1.1%; $p = 0.01$), and wound complications were lower (2.5% vs 6.0%; $p = 0.01$).

CONCLUSIONS: Although overall rates were similar, significant differences in collection, definitions, and classification of postoperative adverse events were observed when comparing TM&M and ACS NSQIP. Although both systems offer complementary value, harmonization of definitions and severity classification would enhance quality-improvement programs. (J Am Coll Surg 2014; 218:1024–1031. © 2014 by the American College of Surgeons)

It is increasingly important to measure and evaluate the quality of surgical care, as surgery has become more and more complex. Surgical care is technologically advanced, highly specialized, and involves invasive procedures performed frequently on high-risk and complex patients.¹

Surgical outcomes, particularly postoperative complications, are the most commonly used indicator for surgical quality assessment.² As such, data on postoperative complications are often used as a means of comparing surgical techniques, individual surgeon outcomes, and institutional

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Abbreviations and Acronyms

ACS	= American College of Surgeons
AE	= adverse event
M&M	= morbidity and mortality
SSI	= surgical site infection
TM&M	= Thoracic Morbidity and Mortality
TOH	= The Ottawa Hospital

performance.³ However, different data-collection methodologies can provide divergent evaluations of surgical outcomes.

In 2010, the American College of Surgeons (ACS) NSQIP was implemented at The Ottawa Hospital (TOH) as a means to evaluate surgical quality and facilitate quality-improvement initiatives through rigorously collected risk-adjusted outcomes. The ACS NSQIP traditionally has assessed cases from the fields of general and vascular surgery¹; however, there is now a model that allows inclusion of cases from multiple specialties, including thoracic surgery. The ACS NSQIP methodology provides estimates of both unadjusted and risk-adjusted postoperative morbidity and mortality (M&M) rates, has been demonstrated to considerably improve surgical outcomes,⁴ and is widely considered the gold standard surgical quality-improvement program.

Similarly, Clavien and colleagues were the first to introduce an innovative system to grade postoperative complications by severity proportional to the effort required to treat the complication as a means to facilitate surgical quality improvement.⁵ This system, now known as the Clavien-Dindo classification system, was validated in 2004 in a large cohort of patients who underwent a number of general surgical procedures, and it has been used in several surgical subspecialties,⁶ including thoracic surgery.⁷

The Thoracic Morbidity and Mortality (TM&M) classification system was developed in 2008 by TOH's Division of Thoracic Surgery in accordance to the Clavien-Dindo classification of surgical adverse events (AEs). The TM&M classification system is a prospective system that documents all postoperative AEs and their severity for all thoracic surgical procedures. The TM&M classification system has recently been evaluated for its reproducibility, reliability, and inter-rater agreement.⁸ The TM&M classification system facilitates monitoring, reporting, and evaluation of postoperative AEs.⁷ However, despite its proven feasibility as an effective method for continuous surgical quality assessment, no studies have been done to compare the TM&M classification system with an external gold standard.

The objectives of this study were 2-fold. First, we sought to compare outcomes and the relative effectiveness

of postoperative AE reporting on the same patients using the 2 classification systems: the retrospectively recorded ACS NSQIP and the prospectively collected TM&M classification system. Second, we performed a qualitative analysis of the context and processes of data collection for the 2 systems to yield insights into the strengths and weaknesses of each system.

METHODS

This study was approved by TOH Research Ethics Board. Data used in this study originated from thoracic surgical patients operated at TOH between April 2010 to December 2011, spanning one 18-month period. The Ottawa Hospital is a high-volume, single academic thoracic surgery center serving a population of 1.35 million people; thoracic surgical care is consolidated at 1 campus by 6 thoracic surgeons. The annual operative volume for thoracic surgery averages approximately 1,200 patients.

The analytic approach and methods of ACS NSQIP have been described previously.^{1,9,10} Briefly, ACS NSQIP is based on manual and retrospective review of medical records using strict AE definitions. The ACS NSQIP collects preoperative patient demographics, risk factors, procedure, and 30-day complications relating to an index surgical procedure using a systematic and temporal approach for a typical institution.¹ Specifically, the first 40 successive surgical cases meeting the inclusion criteria are collected during an 8-day cycle.¹ This sampling might or might not result in a 20% sample of eligible cases.

In comparison, the TM&M classification system is a prospective database that provides an accurate summary of the absolute rate of complications and quantifies their severity. The TM&M system was developed according to the Clavien-Dindo classification schema⁶ of surgical AEs. Definitions of surgical AEs were modified according to complications in patients after noncardiac thoracic surgery through peer review and questionnaire, and adjusted based on surgeons' experience. The TM&M data collection and reporting is a continuous, collegial, and divisional activity that is composed of daily reporting (by thoracic surgical fellows), weekly review (by staff surgeons), monthly rounds, and quarterly analysis (by the entire Division of Thoracic Surgery).

To improve the value and overall quality of TM&M data reporting, a web-based reporting system has recently been developed. Patients with complications are recorded in real time on a daily basis by thoracic surgical fellows. Postoperative AEs are chosen from a series of standardized definitions (a complete list of definitions is available at: <https://sites.google.com/site/ottawatmtool/classifying-surgical-complications>). Information on surgical volume,

priority of surgery, disease diagnosis, procedure class, and surgical approach/incision is also collected and stored in the TM&M database. The result is a powerful source of information for all thoracic surgical patients that is available for monthly presentation and discussion at M&M rounds, quality assurance and scientific analysis by a multidisciplinary team of surgeons, clinical epidemiologists, and clinical managers. With respect to the current study, all major TM&M surgical cases (ie, the same population being selected for ACS NSQIP review) were selected for the comparison.

Statistical analysis

Univariate analyses of the data were performed using chi-square analysis of contingency tables, with a p value <0.05 considered statistically significant. Reported rates of complications common to both systems were analyzed. A qualitative comparison of the 2 systems was conducted to identify their strengths and weaknesses. Data were analyzed using SAS software (version 9.2, SAS Institute).

RESULTS

Quantitative comparison

During the study period, 1,788 thoracic procedures were performed, 1,091 of which met ACS NSQIP inclusion criteria. The ACS NSQIP evaluated 182 (16.7%) of these procedures and 178 (21.1%) patients.

Table 1 illustrates the types of operative procedures performed during the study period. No significant differences were noted in the sampling of major operative procedures performed, including mediastinoscopy/mediastinotomy, bullectomy/pleurectomy, sublobar resection, bilobectomy, pneumonectomy, esophagectomy, gastrectomy, and laparoscopic surgery of the gastroesophageal junction.

Significant differences in the sampling scheme were noted in the rate of lobectomy procedures captured by ACS NSQIP (26.4% vs 19.2%; $p = 0.0247$), and the rate of other major types of operative procedures captured by ACS NSQIP (16.5% vs 29.7%; $p = 0.002$). Other major surgical procedures included excision/resection of mediastinal tumors, empyema/decortication, and other explorative procedures.

Total patients and procedures with complications reported were 24.4% and 31.1%, respectively, by TM&M vs 20.2% and 39.0%, respectively, by ACS NSQIP ($p = 0.2299$ and $p = 0.03$) (Table 2). Mortality rate was 1.4% as reported by TM&M vs 2.2% as reported by ACS NSQIP ($p = 0.4214$) (Table 2). Rate of readmission was 1.5% as reported by TM&M vs 1.7% as reported by ACS NSQIP ($p = 0.88$) (Table 2).

Table 3 illustrates the absolute rates of postoperative occurrences as detected by both systems. Rates of cardiac complications were significantly higher as reported by TM&M vs ACS NSQIP (specifically, 5.8% vs 1.1%; $p = 0.0080$); and rates of wound (6.0% vs 2.5%; $p = 0.0088$) and other types of complications (12.6% vs 6.0%; $p = 0.0013$) were significantly higher as reported by ACS NSQIP. Of the 63 cardiac events captured by the TM&M system, 43 were atrial fibrillation, representing a total of 68% of all cardiac events and a total of 3.9% of all adverse events. No significant differences were noted in the rates of reported complications in the remaining groupings of complications.

Table 4 illustrates specific postoperative complications detected by both ACS NSQIP and the TM&M system. Rates of congestive heart failure (2.7% vs 0.1%; $p < 0.0001$), pulmonary embolism (1.6% vs 0.3%; $p = 0.0123$), wound dehiscence (1.6% vs 0.1%; $p = 0.0005$), transfusion (9.3% vs 0.4%; $p < 0.0001$), and sepsis (1.1% vs 0.2%; $p = 0.0410$) were significantly higher as reported by ACS

Table 1. Number and Types of Major Operative Procedures Performed, April 2010 to December 2011

Procedure	TM&M (n = 1091)		ACS NSQIP (n = 182)		p Value
	n	%	n	%	
Mediastinoscopy/mediastinotomy	239	21.9	37	20.3	0.6327
Bullectomy/pleurectomy	38	3.5	10	5.5	0.1872
Sublobar resection	127	11.6	30	16.5	0.0659
Lobectomy	209	19.2	48	26.4	0.0247*
Bilobectomy	6	0.5	3	1.7	0.1016
Pneumonectomy	12	1.1	1	0.5	0.4941
Esophagectomy	31	2.8	5	2.7	0.9434
Gastrectomy	29	2.7	4	2.2	0.7175
Laparoscopic surgery of the gastroesophageal junction	85	7.8	14	7.7	0.9633
Other	324	29.7	30	16.5	0.0002*

*Significant.

ACS, American College of Surgeons; TM&M, Thoracic Morbidity and Mortality system.

Table 2. Postoperative Morbidity, Mortality, and Readmission Rates

	TM&M		ACS NSQIP		p Value
	n	%	n	%	
Patients	843	100	178	21.1	NA
Operative procedures	1,091	100	182	16.7	NA
Patients with complications	206	24.4	36	20.2	0.2299
Complications	339	31.1	71	39.0	0.0339*
30-Day mortality	12	1.4	4	2.2	0.4214
30-Day readmission	13	1.5	3	1.7	0.8888

*Significant.

ACS, American College of Surgeons; NA, not applicable; TM&M, Thoracic Morbidity and Mortality system.

NSQIP. A trend toward significance was observed in rates of surgical site infections (SSIs) between the 2 systems, with higher reported rates of SSIs captured by ACS NSQIP (3.8% vs 2.2%; $p = 0.1822$). No significant differences in reporting rates were detected among the remaining complications.

Qualitative comparison

Table 5 illustrates the similarities and differences in definitions of postoperative AEs between the 2 systems for the 7 types of events with statistically significant differences in reported rates, including atrial fibrillation, congestive heart failure, pulmonary embolism, wound dehiscence, SSIs, transfusion, and sepsis.

Table 6 provides a qualitative comparison of the TM&M classification system and ACS NSQIP. Significant differences in data collection and reporting of postoperative AEs were observed when comparing an in-hospital prospectively collected methodology on all patients vs a retrospective methodology to measure AEs in systematically selected patients.

Table 3. Rates of Total Postoperative Occurrences Detected by Both Systems

Postoperative occurrences by system	TM&M (n = 1,091)		ACS NSQIP (n = 182)		p Value
	n	%	n	%	
Cardiac*	63	5.8	2	1.1	0.0080†
Central nervous system	22	2.0	2	1.1	0.3994
Respiratory	134	12.3	24	13.2	0.7319
Urinary	27	2.5	9	4.9	0.0627
Wound	27	2.5	11	6.0	0.0088†
Other	66	6.0	23	12.6	0.0013†
Total	339	31.1	71	39.0	0.0339†

*Of the 63 cardiac events captured by the thoracic morbidity and mortality system, 43 were atrial fibrillation, representing a total of 68% of all cardiac events and a total of 3.9% of all adverse events.

†Significant.

ACS, American College of Surgeons; TM&M, Thoracic Morbidity and Mortality system.

Table 4. Rates of Specific Postoperative Occurrences Recorded by Both the Thoracic Morbidity and Mortality System and the American College of Surgeons National Surgical Quality Improvement Program

System and postoperative occurrence	TM&M (n = 1,091)		ACS NSQIP (n = 182)		p Value
	n	%	n	%	
Cardiac					
Congestive heart failure	1	0.1	5	2.7	<0.0001*
Deep venous thrombosis	1	0.1	1	0.5	0.1489
Ischemia (MI)	9	0.8	2	1.1	0.7116
Central nervous system					
Cerebrovascular accident/stroke	4	0.4	1	0.5	0.7151
Respiratory					
Pneumonia	26	2.4	8	4.4	0.1190
Pulmonary embolism	3	0.3	3	1.6	0.0123*
Urinary					
Renal insufficiency	8	0.7	1	0.5	0.7841
Urinary tract infection	15	1.4	6	3.3	0.0595
Wound					
Wound dehiscence	1	0.1	3	1.6	0.0005*
Wound (surgical site) infection	24	2.2	7	3.8	0.1822
Other					
Transfusion intraoperative/postoperative	4	0.4	17	9.3	<0.0001*
Sepsis	2	0.2	2	1.1	0.0410*

*Significant.

ACS, American College of Surgeons; TM&M, Thoracic Morbidity and Mortality system.

DISCUSSION

The reporting and evaluation of surgical outcomes is imperative to improving surgical quality.¹¹ Postoperative complications are important surgical outcomes that impact the health of the patient as well as increase hospital costs and length of stay.¹² The ACS NSQIP is considered the gold standard surgical quality-improvement program and has been demonstrated to considerably improve surgical M&M.⁴ We performed a comparative analysis on the relative effectiveness of postoperative AE reporting using the ACS NSQIP thoracic surgical patient database and the TM&M classification system from a single institution, TOH, in one 18-month period.

Both ACS NSQIP and TM&M are robust and designed for their own individual purposes. The ACS NSQIP identifies predefined postoperative AEs based on documented data in the clinical medical record and patient-reported events during the follow-up period by trained and audited surgical clinical reviewers. The ACS NSQIP is a validated methodology and is useful for comparing risk-adjusted

Table 5. Selected Postoperative Occurrences as Defined by the Thoracic Morbidity and Mortality Classification System and the American College of Surgeons National Surgical Quality Improvement Program

System and postoperative occurrence	TM&M*	ACS NSQIP†
Cardiac, congestive heart failure	Cardiac output is insufficient to meet the body's normal requirements for oxygen and nutrients, and pulmonary edema develops	Congestive heart failure is the inability of the heart to pump a sufficient quantity of blood to meet the metabolic needs of the body or can do so only at increased ventricular filling pressure; or if indication on chest x-ray of pulmonary edema
Respiratory, pulmonary embolism	Occlusion of one or more pulmonary arteries by thrombi that originate elsewhere	Lodging of a blood clot in a pulmonary artery with subsequent obstruction of blood supply to the lung parenchyma
Wound		
Wound dehiscence	Previously closed wound reopening	Postoperative incision dehiscence (superficial or dehiscence to fascia; fascia remains intact)
Surgical site infection	Purulent wound discharge and/or local host response	Deep incisional surgical site infection, organ space surgical site infection, superficial incisional surgical site infection
Other		
Transfusion intraoperative/postoperative	Postoperative hemorrhage or hematoma	Bleeding transfusions ≥ 4 U
Sepsis	Confirmed or suspected infection in the presence of the systemic inflammatory response syndrome	Sepsis (2 clinical signs and symptoms of systemic response to infection) or septic shock (associated with organ and/or circulatory dysfunction)

*Thoracic morbidity and mortality complications are subclassified according to the severity and effort required to treat the complication. Specifically, grades I and II complications require no therapy, or pharmacologic intervention only. Grades III and IV require surgical intervention or life support. Grade V complications result in patient death.

†These definitions do not provide the detailed specifications of each event that are applied within ACS NSQIP.

ACS, American College of Surgeons; TM&M, Thoracic Morbidity and Mortality system.

perioperative surgical outcomes across participating institutions and represents a systems-based approach to surgical quality improvement.¹ Retrospective reviews of patients' medical records have been the foundation of research into errors and AEs,¹³ and studies have shown that medical record review is more detailed, robust, and informative than are administrative claims, and has greater validity than voluntary reporting.¹⁴ However, the method is retrospective and can be limited by poor documentation in clinical records.¹⁵ For this purpose, the ACS NSQIP has implemented training and audit procedures for its hospital participants that are highly effective in collecting robust data. An analysis of inter-rater reliability of variables in the ACS NSQIP found that the reliability of the data

was high from the inception and has improved over time (3.2% disagreement in 2005 vs 1.6% disagreement in 2008).^{16,17} In addition, disagreement levels for individual variables have continually improved, with 26 individual variables demonstrating $>5\%$ disagreement in 2005, to only 2 such variables in 2008.¹⁷

The TM&M classification system is an in-hospital prospectively collected monitoring system. Our staff and residents are trained to proactively monitor patients for postoperative AEs. Postoperative AEs are chosen from a series of standardized definitions and complications are recorded in real time on a daily basis by thoracic surgical residents using a web-based AE reporting system. Weekly review by staff surgeons allows for affirmation of

Table 6. Qualitative Comparison of the Thoracic Morbidity and Mortality Classification System and the American College of Surgeons National Surgical Quality Improvement Program with Respect to Key Quality Indicators

Quality indicator	TM&M	ACS NSQIP
Data collection	Prospective, in-hospital	Retrospective, 30 d
Data reporting	Continuous	6-month lag period
Patient population	All thoracic surgical patients	20% sample
Burden of complications	Incidence and severity	Incidence only
Application and relevance	Divisional monitoring	Institutional benchmarking

ACS, American College of Surgeons; TM&M, Thoracic Morbidity and Mortality system.

complications. Ongoing feedback in the process of quality reporting plays an essential role in maintaining the accuracy and completeness of data. The TM&M classification system allows users to analyze outcomes in the full census of thoracic surgical patients and data can be subdivided by priority of surgery, disease diagnosis, procedure class, and surgical approach/incision. The system can be used to evaluate severity and burden of postoperative AEs, and represents a continuous and divisional approach to surgical quality assessment. Prospective clinical surveillance has been cited as the most precise and accurate method of reporting AEs and is ideally suited for assessing the effectiveness of specific interventions to decrease explicitly defined AEs. However, prospective clinical surveillance is limited by practical and methodological issues, including the requirement for an observer who clearly understands clinical processes to ensure reliability.^{18,19} A previous study done by our group has demonstrated that the TM&M classification systems offers high inter-rater reliability: 87% of kappa statistics were >0.81 , a range that is interpreted as “almost perfect agreement;” and the remaining 13% ranged between 0.61 and 0.8, interpreted as “substantial agreement.”⁸

Our results show that overall rates of reported M&M were similar between ACS NSQIP and the TM&M classification system. However, significant differences were observed in the raw incidence of specific postoperative AEs. The differences in incidence reflect different definitions within each system, the difference between prospective and retrospective data collection, and the differing time horizons of the 2 programs.

First, altered definitions might seem trivial, but impact the data and yield differing results. For example, rates of wound dehiscence were significantly higher as reported by ACS NSQIP. Wound dehiscence as defined by ACS NSQIP refers to postoperative incision dehiscence in which the fascia remains intact; TM&M defines it as a previously closed wound reopening; the term *dehiscence* is reserved for fascial dehiscence. Rate of intraoperative/postoperative transfusion was significantly higher as reported by ACS NSQIP, again reflecting the differential definitions. The precise definition of postoperative bleeding remains controversial in the surgical community. The ACS NSQIP defines postoperative bleeding as requiring a transfusion of ≥ 4 U, which might be due to a variety of causes (eg, gastrointestinal bleed), or occur over several days.

Despite its many positives, our data also highlighted several important limitations to the ACS NSQIP. One important drawback is that ACS NSQIP is not yet comprehensive, some thoracic surgical-specific definitions simply do not appear within ACS NSQIP, such as atrial fibrillation. Our results showed that atrial fibrillation presents a considerable postoperative burden in our patient

population. Of the 63 cardiac events captured by the TM&M system, 43 were atrial fibrillation, representing a total of 68% of all cardiac events and a total of 3.9% of all adverse events.

Postoperative atrial fibrillation has remained one of the most frequent complications that occur after noncardiac thoracic surgery. Although it is difficult to determine the true incidence of postoperative atrial fibrillation due to various methodologies used to identify its occurrence, reported rates have varied between 4% and 37%.²⁰⁻²² The occurrence of postoperative atrial fibrillation is associated with significant morbidity, such as increased risk of stroke, atrial thrombosis and systemic embolization, postoperative mortality, and substantial increases in hospital length of stay and costs.^{20,23} We would suggest that additional procedure-specific standards of reporting within ACS NSQIP would aid quality-improvement programs to alleviate the burden of this costly complication.

Second, the data collected for M&M for ACS NSQIP extend to 30 days, and TM&M captures inpatients during their hospital stay, reflecting the differing time horizons of the 2 programs. Complications that become evident after patients leave the hospital can be particularly difficult to track and are not recorded by the TM&M system, and this might have resulted in under-reporting of specific complications.

Third, one advantage of a retrospective approach, such as the ACS NSQIP, is its ability to capture events post discharge. For example, a trend toward significance was observed in differing rates of SSIs between the 2 systems, with higher reported rates of SSIs captured by ACS NSQIP, reflecting the longer follow-up periods. Surgical site infections can be acquired after hospital discharge (eg, in follow-up clinic visits, with visits to the general practitioner, or emergency room visits) and recorded in ACS NSQIP, but will not be picked up by TM&M. Weigelt and colleagues have demonstrated a 53% increase in infection rates reported by complete 30-day inpatient and outpatient reporting.²⁴

Fourth, the impact of serial or cascading complications were addressed differently by the 2 systems. The ACS NSQIP assesses and records all postoperative AEs in a patient, even if they are serial. As suggested by Clavien and colleagues, our goal is to record only the most severe complication pertaining to the affected system when those complications of a lower grade are a step in the process leading to the more serious outcomes.^{7,25} For example, aspiration leading to respiratory failure is recorded as a single grade IVa; and ACS NSQIP will record aspiration and respiratory failure as 2 separate complications. However, no significant differences were noted in the rates of the total number of patients with complications between the 2 systems.

There is complementary value to the institutionally focused ACS NSQIP compared with the divisionally focused

TM&M. Importantly, ACS NSQIP uses state-of-the-art validated risk-adjustment methodology to address the confounding effect of case mix on the frequency and nature of surgical complications,²⁶⁻²⁸ which provides useful information for benchmarking and comparisons across institutions.^{29,30} However, it is less applicable as a continuous quality-improvement measure for an individual thoracic surgical program, as understanding and improving the delivery of a particular operation might require measures tailored to that operation.² As ACS NSQIP assesses a systematic sample of cases, the sample size is not large enough for subgroup analyses, such as results from specific procedures or individual surgeon performance. Similarly, semi-annual reports allow institution-specific comparisons that form the basis for development of institution-specific quality-improvement action plans; however, at the expense of timely identification of problems within a single surgical service. Ultimately, prompt identification and recognition of problem would mean a more rapid response to rectify them.³¹

Conversely, the TM&M classification system does not yet have a model for risk adjustment of outcomes. Yet, the absence of adjustment for illness should not limit the use of TM&M data for quality assessment because we are not attempting to measure differences between individual hospitals, but rather are monitoring outcomes within one surgical service. A recent study by Salatia and colleagues³² has demonstrated the usefulness of the TM&M classification system in auditing the quality of care within a single surgical unit. The authors concluded that the TM&M classification system revealed a decline in quality of care within their unit otherwise undetected by applying traditional outcomes measures, and that the system can be used as an additional graded outcomes end point to refine internal audit of performance.³² Taken together, risk-adjusted performance feedback enabled by ACS NSQIP, coupled with a continuous and prospective data-collection methodology such as the TM&M system, is fundamental for monitoring surgical outcomes and for tailored quality-improvement efforts. Our institution and division have invested in both systems.

Our results have demonstrated that neither system is more or less effective than the other at driving quality improvement; however, efforts to harmonize definitions of adverse events need to be undertaken. Based on our experience with the Clavien-Dindo–inspired TM&M system, we suggest that ACS NSQIP consider objectively characterizing the severity of complications in addition to documenting incidence. Quantification of severity of postoperative AEs is possible using ACS NSQIP and can be useful in assessing surgical outcomes.^{33,34} In our division, severity grading has helped to assess overall complication burden, in comparison with considering

only events. This approach underscores the substantial impact of higher-grade or major complications. Although grade I and II complications represent the majority of complications in our patient population, they contribute the least burden to hospital resources. On the contrary, grade III to V complications comprise a minor portion of complications, but the majority of the burden.

There are a number of limitations in this study. First, the data are derived from a single institution, limiting generalization of our results. Second, a direct comparison of the 2 systems is difficult due to differences in recording methodologies and differences in definitions of postoperative AEs between the 2 systems. As discussed here, these inherent differences might have contributed to our findings. Third, although there is a difference in target patient populations between the 2 systems (ie, TM&M contains data on all thoracic surgical patients, and ACS NSQIP targets a specific sample of the inpatient and outpatient settings), we strived to ensure the 2 patient populations were analogous.

CONCLUSIONS

Both ACS NSQIP and TM&M systems have strengths and limitations and offer complementary value. Harmonization of definitions, including the addition of definitions relevant to the thoracic surgical subspecialty, along with a severity classification of postoperative complications, would enhance quality-improvement programs.

Author Contributions

Study conception and design: Ivanovic, Seely, Sundaresan
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