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DEFORMITY

Defining Rates and Causes of Mortality Associated With Spine Surgery

Comparison of 2 Data Collection Approaches Through the Scoliosis Research Society

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Study Design. Retrospective review of prospectively collected databases.

Objective. To compare 2 approaches for assessment of mortality associated with spine surgery.

Summary of Background Data. The Scoliosis Research Society collects morbidity and mortality data from its members. Previously, this included details for all spine cases and all complications. To reduce time burden and improve compliance, collection was changed to focus on a few major complications (death, neurological deficit, and blindness) for specific deformity diagnoses (scoliosis, spondylolisthesis, and kyphosis) and only for cases with complications.

Methods. Data were extracted from the Scoliosis Research Society from 2004–2007 (detailed system) and 2009–2011 (simplified system). As an anchor for comparison, mortality rates were compared between the systems.

Results. Between 2009 and 2011, the number of deformity cases reported were 87,162, with 131 deaths (1.50/1000 cases). The mean age of these 131 patients was 50, mean American Society of Anesthesiologists grade was 2.8, 10% were smokers, and 18% had diabetes. Rates of death (per 1000 cases) were: idiopathic scoliosis (0.4), congenital scoliosis (1.3), neuromuscular scoliosis (3.6), other scoliosis (3.1), spondylolisthesis (0.6), and kyphosis (4.7). Common causes of mortality included respiratory (48), cardiac (32), sepsis (12), organ failure (9), and blood loss (7). Compared with the detailed system, the simplified system had greater surgeon compliance (79% *vs*. 62%, $P < 0.001$), greater number of deformity cases per reporting surgeon per year (139 *vs*. 90, $P < 0.001$), and modest but significantly lower mortality rates (1.50 *vs*. 1.80/1000 cases; $P < 0.001$). Causes of death were comparable between the 2 systems.

Conclusion. On the basis of the simplified collection system, the rate of mortality for spinal deformity surgery was 1.50 per 1000 cases. Compared with the detailed system, the simplified system had significantly improved compliance and similar mortality rates. Although the simplified system is limited by less data collected, it achieves better compliance and may prove effective, especially if supplemented with focused data collection modules.

Key words: adult, complications, mortality, pediatric, spine surgery.

Level of Evidence: 4

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Despite great advances in the safety and effectiveness of surgical care, all surgical procedures continue to have inherent risks of morbidity and mortality (M&M).[1,2] From its inception, the Scoliosis Research Society (SRS) has placed substantial emphasis on collecting and assessing M&M as a means of improving future care. One of the hallmarks and expectations of membership in the SRS continues to be the routine submission of surgical case data, including M&M. These efforts have resulted in multiple reports that have summarized the submitted data.[3–22] These data are not only applicable to the SRS membership but also of interest to the spine community in general because they may be useful for surgical planning, patient counseling, and ongoing efforts to improve the safety of patient care.

The means of M&M data collection used by SRS has evolved during the past 30 years, from initial collection and

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storage of data based on punch cards to the current form of data submission using a secure Internet-based data entry form. The type and amount of data collected have also changed during the past decades. With the conversion of data collection to an electronic online system, the amount of data collected was substantially increased. This reached a maximum between the years 2004 and 2007. During this period, members were expected to submit data for all operative spine cases, including those not having a deformity diagnosis. The data collected were extensive and included demographics, clinical history, details of surgical procedures performed, and complications. Although this relatively detailed collection of data enabled multiple reports describing rates of complications and potential risk factors, the magnitude of the data collected required substantial effort from the membership. The SRS M&M collection is not funded and relies on the goodwill volitional contribution from the SRS membership. Smith *et al*[13] estimated that the dataset of more than 108,000 cases collected from 2004–2007 represented a minimum of 18,000 work-hours.

From the years 2009 through 2011, a modified M&M data collection system was applied. The new system reflected efforts to reduce the time burden of the membership and to improve compliance. Surgeons were no longer required to submit all operative spine cases, but instead the data collection focused only on operative spine deformity cases. In addition, only 3 major complications (new neurological deficit, blindness, and death) were collected, and demographic, clinical, and operative data were only collected for the cases with one of these 3 complications. Although this undoubtedly reduced the time required for data submission, it does result in a substantially more limited data set.

In this study, we provide comparison between the previous more detailed data collection system (2004–2007) and the more recent simplified data collection system (2009–2011). Our hypotheses in this study were 2-fold. First, we hypothesized that with reduced time burden for data submission, the surgeon compliance rate for M&M reporting would be higher for the simplified system than the more detailed collection process. Second, we hypothesized that the rates and distribution of causes of reported mortalities between the 2 systems would be similar.

MATERIALS AND METHODS

Patient Population

For surgeons to achieve fully active membership in the SRS, it is necessary to complete 5 years of candidate membership. During this 5-year period, candidate members are required to submit M&M data for their operative spine cases. Although submission of this data is a requirement to remain in good standing as a candidate member and to ultimately progress to fully active membership, whether active membership is granted is not influenced by the number or types of complications reported. Fully active members are also strongly encouraged to submit M&M data for their operative spine cases, and to encourage submission a monetary penalty has been recently imposed for noncompliant active members, with the money being directed to an organizational research fund.

Candidate and active members from North American and non-North American countries submit deidentified data using a secure Internet-based entry form. This study focuses on data collected from 2009–2011, with comparisons with previously published data from the years 2004–2007.[15] The version of the data entry system in place during the years 2009–2011 focused only on operative cases of specific spinal deformities and only collected data on 3 major complications: death, neurological deficit, and blindness. The collected spinal deformity diagnoses included: idiopathic scoliosis (<10, 10–18, and >18 yr of age), congenital scoliosis, neuromuscular scoliosis, other scoliosis, spondylolisthesis (isthmic, degenerative, and dysplastic), and kyphosis (congenital, Scheuermann's, and other). For each calendar year, surgeons reported the total number of patients operated for these diagnoses. On the basis of a grid format, surgeons reported the number of each of the 3 major complications that occurred for their operative cases based on each diagnosis (Figure 1). For each complication reported, members were prompted to enter additional information, including patient demographics, comorbidities, deformity characteristics, and surgical parameters. These additional details were not collected for the cases in which none of the 3 major complications occurred.

The SRS M&M database was queried for all cases reported from the years 2009 through 2011. Extracted data included

	Total # Cases	# Deaths	# Blindness	# Neurological Deficit
Idiopathic Scoliosis				
<10 y/o				
10–18 y/o				
>18 y/o				
Congenital scoliosis				
Neuromuscular scoliosis				
Other scoliosis				
Spondylolisthesis				
Isthmic				
Degenerative				
Dysplastic				
Kyphosis				
Congenital				
Scheuermann's				
Other				
Totals				

Figure 1. Illustration of online data entry format for reporting of morbidity and mortality through the Scoliosis Research Society from the years 2009–2011. Members complete this grid annually. For each complication reported, members are prompted to enter corresponding demographic, clinical, and operative information.

patient age, sex, American Society of Anesthesiologists grade, diagnosis, whether a spinal fusion was performed, whether implants were used, and whether the case was complicated by death and if so, the reported cause of mortality. Deaths occurring within 60 days and complications within 60 days of surgery that resulted in death were assessed in this study. Rates and causes of mortality for corresponding diagnoses from the SRS M&M Database for the years 2004 through 2007 were extracted from previously published data[15] and compared with those derived from the years 2009 through 2011 in this study.

The SRS M&M database design was submitted to the Hospital for Special Surgery (New York, NY) Institutional Review Board and was determined to be exempt from the Institutional Review Board approval based on use of deidentified data (no. 29045).

Data and Statistical Analyses

Statistical analysis was performed using SPSS version 19.0 software (SPSS Inc., Chicago, IL). Frequency distributions and summary statistics were calculated for clinical and demographic data. For categorical variables, cross-tabulations were generated and the Fisher exact tests were used to compare distributions. All statistical analyses were 2 sided. $P < 0.05$ was considered significant. Mortality rates were calculated and were reported as rates of death per 1000 patients. Rates and causes of mortality for corresponding diagnoses from the SRS M&M database for the years 2004 through 2007 were extracted from previously published data[15] and compared with those derived from the years 2009 through 2011 in this study. Rates of surgeon compliance for M&M reporting were calculated as the number of surgeons submitting M&M divided by the number of members. Rates of reporting compliance were compared between the 2 reported periods, 2004–2007 and 2009–2011.

RESULTS

A total of 87,162 deformity cases were reported by the SRS membership from 2009 through 2011, including 50,553 cases of scoliosis, 28,160 cases of spondylolisthesis, 8448 cases of kyphosis, and a single case without specification of diagnosis (Table 1). A total of 131 deaths were reported, resulting in an overall mortality rate of 1.50 per 1000 cases. The mean age of these 131 patients was 50 years (range: 2–92 yr), and the distribution of these patients across age groups with stratification based on primary diagnosis is shown in Table 1. Of the 131 mortalities, approximately one-half (48%) were among males, 10% were smokers, and the mean American Society of Anesthesiologists grade was 2.8 (range: 1–4) (Table 2). Body mass index was reported for 88 (67%) of the patients and the mean was 28.2 (range: 11.6–71.0). Of the comorbidities collected through the database, the most common were hypertension (50.4%), vascular disease (25.2%), coronary artery disease (19.8%), diabetes (17.6%), pulmonary restrictive lung disease (16.8%), and chronic obstructive pulmonary disease (9.2%) (Table 3). Figure 2 provides an overview of the magnitudes of deformity among the cases of scoliosis (Figure 2A) and kyphosis (Figure 2B) complicated by mortality. The scoliosis curve magnitudes with the greatest representation were in the 31° to 40° and the greater than 100° categories. Of the 16 cases of spondylolisthesis cases complicated by death, 8 (50%) were grade I, 7 (44%) were grade II, and 1 (6%) was grade IV.

The vast majority of the procedures complicated by mortality (94%) included spinal fusion and implants, and the most common fusion categories were posterior/posterolateral only (51%), transforaminal lumbar interbody fusion ± posterolateral (18%), and same day anterior and posterior (18%) (Table 2). Osteotomies were used in 27 (67.5%) of the kyphosis cases (3 vertebral column resections, 13 pedicle subtraction osteotomies, 3 anterior corpectomies, and 8 Smith-Petersen

TABLE 1. Numbers of Reported Mortalities Among 87,162 Spinal Deformity Surgical Procedures Stratified by Patient Age and Primary Diagnosis

Age Range, yr	Number of Deaths	Deaths per 1000 Cases by Primary Diagnosis		
		Scoliosis (50,553)	Spondylolisthesis (28,160)	Kyphosis (8448)
0–19	37	34	1	2
20–39	8	4	0	4
40–49	4	1	0	3
50–59	17	6	3	8
60–69	26	15	2	9
70–79	30	12	9	9
80–89	8	2	1	5
90+	1*	*	*	*
Total	131*	74	16	40

*1 death was reported in a patient >90 yr of age but was not linked to a primary diagnosis.

TABLE 2. Numbers of Reported Mortalities Among 87,161 Spinal Deformity Surgical Procedures Stratified by Demographic, Clinical, and Surgical Parameters

Parameters	Number of Deaths (%)
Sex	
Male	63 (48)
Female	67 (51)
Not reported	1 (1)
ASA grade	
1	11 (8)
2	30 (23)
3	60 (46)
4	22 (17)
5	0 (0)
Not reported	8 (6)
Smoker	
Yes	13 (10)
No	118 (90)
Spinal fusion performed	
Yes	123 (94)
No	7 (5)
Not recorded	1 (1)
Fusion category	
Posterior/posterolateral only	63 (51)
TLIF ± posterolateral	22 (18)
Anterior and posterior (same day)	22 (18)
PLIF ± posterolateral	6 (5)
Anterior only	5 (4)
Posterior-anterior-posterior (same day)	3 (2)
Limited fusion at anchor site for growing rod	1 (1)
Not reported	1 (1)
Spinal implants	
Yes	123 (94)
No	8 (6)

TLIF indicates transforaminal lumbar interbody fusion; PLIF, posterior lumbar interbody fusion; ASA, American Society of Anesthesiologists.

TABLE 3. Frequencies of Specific Comorbidities Reported Among 131 Patients Treated With Spinal Surgery That Was Complicated by Mortality

Comorbidity	Number of Patients With Comorbidity (%)
Hypertension	66 (50.4)
Vascular disease	33 (25.2)
Cardiac history with	
Coronary artery disease	26 (19.8)
Positive stress test	0 (0)
Prior infarct	5 (3.8)
Prior CABG	7 (5.3)
Prior stent	5 (3.8)
Prior valve replacement	1 (0.8)
Diabetes	
Type I	4 (3.1)
Type II	19 (14.5)
Pulmonary restrictive lung disease	22 (16.8)
COPD	12 (9.2)
Reactive airway disease	5 (3.8)
Prior deep venous thrombosis	5 (3.8)
Emphysema	4 (3.1)
Asthma	4 (3.1)
Prior pulmonary embolism	2 (1.5)
Pulmonary hypertension	1 (0.8)

CABG indicates coronary artery bypass graft; COPD, chronic obstructive pulmonary disease.

osteotomies), 27 (36.5%) of the scoliosis cases (1 vertebral column resection, 10 pedicle subtraction osteotomies, 2 anterior corpectomies, and 14 Smith-Petersen osteotomies), and 2 (12.5%) of the spondylolisthesis cases (both Smith-Petersen osteotomies). The distribution of operative times for the cases complicated by mortality is summarized in Table 4, and the most commonly represented operative times were in the 2- to 6-hour category, followed by the 6- to 9-hour category. The mean and median operative blood loss estimates were 1514 mL and 1100 mL, respectively (range: 10 mL–12 L). The time of death relative to the time of surgery was reported for 127 (97%) cases and is summarized in Figure 3. Fifteen (11.8%) of the deaths occurred intraoperatively, and the greatest number of deaths occurred between 3 and 7 days after surgery (26.8%).

The reported causes of mortality, stratified by primary diagnosis, are summarized in Table 5. The most commonly represented causes were related to respiratory/pulmonary issues (36.6%), cardiac events (24.4%), sepsis (9.2%), and multisystem organ failure (6.9%). The causes for 13 of the deaths were classified into the other category and included bowel perforation (3 cases), narcotic overdose (2 cases), bowel infarction, unrecognized abdominal compartment syndrome,

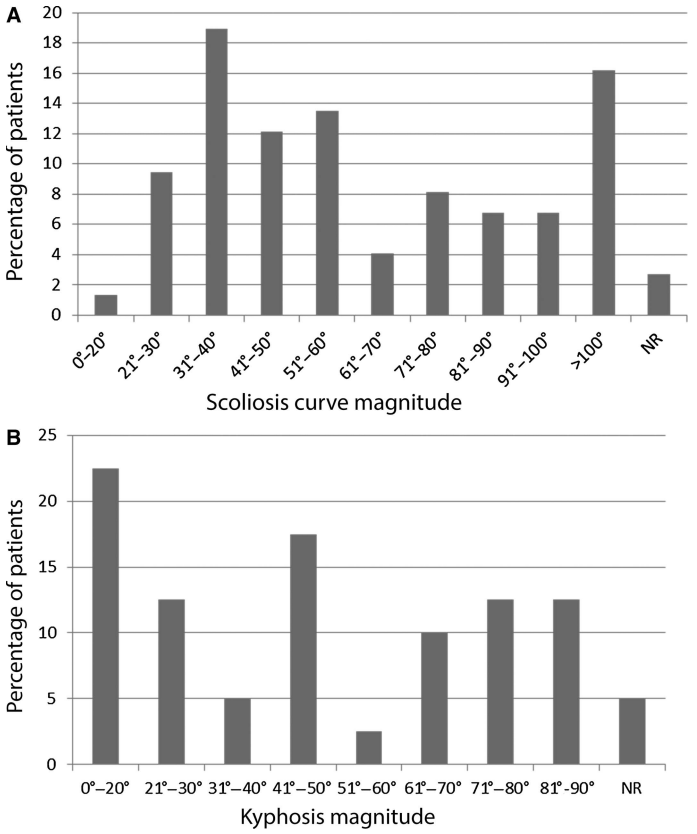

Figure 2. Distribution of deformity magnitude among 74 patients with scoliosis (**A**) and 40 patients with kyphosis (**B**) treated with surgery complicated by mortality.

irreversible intracranial hypertension, brain edema, cranial shunt failure, failure to thrive, hepatic necrosis, and acute baclofen withdrawal. Of the 131 total deaths, autopsy was performed for 24, not performed for 100, and the surgeon did not indicate whether an autopsy was performed for 7 cases. The rates of mortality per 1000 cases by primary diagnosis were: 4.73 for kyphosis, 1.46 for scoliosis, and 0.57 for spondylolisthesis (Table 5).

For the cases collected from 2009–2011, the rates of death per 1000 cases stratified on the basis of primary diagnosis are summarized in Table 6. These rates range from 0.44 for idiopathic scoliosis to 4.73 for kyphosis. Corresponding rates for the cases collected from 2004–2007 are also shown in Table 6. The overall rate of deaths per 1000 cases was modestly but significantly lower for the 2009–2011 *versus* 2004–2007 collection periods (1.50 *vs*. 1.80, $P < 0.001$). The relative distribution of deaths based on primary diagnosis was similar between the collection periods (Table 6). For both collection periods, the highest rate was for the diagnosis of kyphosis, followed by neuromuscular scoliosis, and the lowest rate was for idiopathic scoliosis.

TABLE 4. Reported Operative Time for 130 Surgical Cases of Spinal Deformity Complicated by Death, Stratified on the Basis of Primary Diagnosis*

Time (hr)	Kyphosis	Scoliosis	Spondylolisthesis
<2	0	2	0
2–6	21	46	13
6–9	11	15	0
9–12	3	8	1
>12	3	0	1
Not reported	2	3	1

**1 additional death was reported but was not linked to a primary diagnosis.*

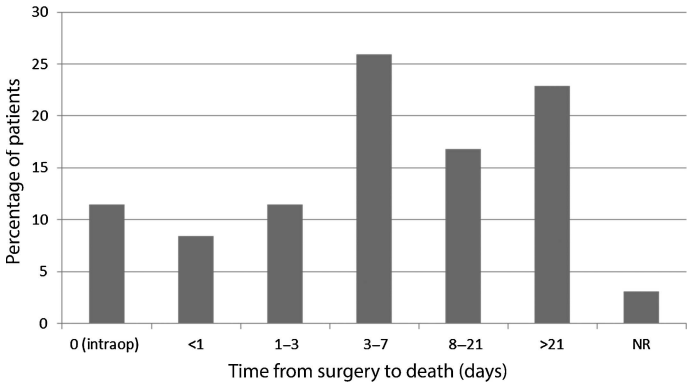

Figure 3. Time of death relative to surgery for 131 patients treated with surgery for spine deformity complicated by mortality.

Compared with the collection system used from 2004–2007, the system used from 2009–2011 had greater average annual surgeon reporting compliance (625/787 [79%] *vs*. 446/725 [62%], $P < 0.001$) and had greater number of deformity cases reported per surgeon per year (139 *vs*. 90, $P < 0.001$).

DISCUSSION

With the institution of health care reform in the United States, there has been an increased emphasis on improvement of quality and safety of care. One of the means by which data are collected to aid in this process is through data registries. When designing and implementing clinical data registries, it is important to balance the need for the detail and magnitude of data to be collected and the time burden involved for those contributing the data. Without sufficient detail, the data collected may prove insufficient to address the questions of interest, but if the time commitment to contribute data is too burdensome, the compliance rate of those submitting data may suffer.

The SRS has a long history of collecting M&M data from its membership in an effort to improve the quality and safety of patient care. The format of data collection and the amount of data collected have varied over time, and more recently has been substantially simplified relative to an immediately preceding period of detailed data collection. In this study, we provide comparison between the previous more detailed data collection system (2004–2007) and the more recent simplified data collection system (2009–2011). Our hypotheses in this study were 2-fold. We hypothesized that with reduced time burden for data submission, the surgeon compliance rate for M&M reporting would be higher for the simplified

TABLE 5. Reported Causes of Mortality, Stratified by Primary Diagnosis for Cases Collected on the Basis of the New System (2009–2011)

Reported Causes of Mortality	Primary Diagnosis (No. of Cases)			
	Kyphosis (8448)	Scoliosis (50,553)	Spondylolisthesis (28,160)	Total (87,161)
Respiratory/pulmonary	18	24	6	48
Respiratory failure	7	6		13
PE	2	9	4	15
Presumed PE	3	3	2	8
Pneumonia	2	3		5
Aspiration	3	2		5
ARDS	1	1		2
Cardiac	7	19	6	32
Cardiac failure	1	9	2	12
Cardiac arrest	2	4	3	9
Myocardial infarction	4	6	1	11
Sepsis	4	7	1	12
MSOF	3	4	2	9
Stroke	1	5		6
Blood loss		7		7
Other	7	5	1	13
Unknown		3		3
Total	40	74	16	130*
Deaths per 1000 cases	4.73	1.46	0.57	1.50*

**One additional mortality was reported (myocardial infarction) for a total of 131 mortalities; however, no link to a primary diagnosis was reported for this additional patient. Thus, this patient was not included in the total number of deaths by diagnosis (130), but was included in the overall calculation of deaths per 1000 cases (1.50).*

PE indicates pulmonary embolism; ARDS, acute respiratory distress syndrome; MSOF, multisystem organ failure.

system than the more detailed collection process. The findings support this hypothesis, because the compliance rate significantly improved from 62% to 79% ($P < 0.001$) from the 2004–2007 system to the 2009–2011 system. This hypothesis is further supported by the significant increase in number of deformity cases reported per surgeon per year (139 *vs*. 90, $P < 0.001$). Although this latter observation could simply reflect that SRS members are doing more deformity cases, it is not likely that the membership has increased deformity case volume by this magnitude (50%). It is possible that the increased compliance could be due in part to changes in reporting requirements for fully active members. In the past, fully active members were encouraged to submit M&M data at a minimum of every third year, but more recently this was changed to be every year.

Our second hypothesis, that the rates and distribution of causes of reported mortalities between the 2 systems would be similar, is also supported by the data. The overall rate of death per 1000 cases was modestly but significantly lower for the 2009–2011 *versus* 2004–2007 collection periods (1.50 *vs*. 1.82, $P < 0.001$), and the relative distribution of deaths based on primary diagnosis was similar between the collection periods. It is possible that the lower mortality rate reported during the more recent time period could reflect results from a substantial educational effort through the SRS regarding complication avoidance and emphasis on safety.

Although 3 major complications were collected in the simplified system (new neurological deficit, blindness, and death), in this study we chose to focus on rates of mortality as an anchor for comparison between the 2 data collection systems. Because of the rarity of blindness as a complication of spine surgery and the potential subjective interpretation and breadth of neurological deficits associated with spine surgery, neither of these complications was considered sufficient as anchors to compare between the 2 data collection systems. In contrast, the occurrence of death is not subject to interpretation and may be less likely to have recall bias. Subsequent studies will assess the rates of the other 2 major complications.

The simplified data collection system used from 2009 through 2011 provided details regarding the cases in which one of the collected 3 major complications occurred. In this study, demographic, clinical, radiographical, and surgical details are summarized for the cases complicated by mortality. However, the data set does not permit comparison of these

TABLE 6. Rates of Death on the Basis of Primary Diagnosis; Comparison of the New (2009–2011) and Old (2004–2007) Systems for Data Collection Through the Scoliosis Research Society

	New System (2009–2011)			Old System (2004–2007)		
Diagnosis	No. of Cases	No. of Deaths	Deaths per 1000 Cases	No. of Cases	No. of Deaths	Deaths per 1000 Cases
Idiopathic	29,368	13	0.44	14,229	9	0.63
<10 yr	2914	0	0.00	624	0	0.00
10–18 yr	17,522	6	0.34	10,612	2	0.19
>18 yr	8932	7	0.78	2993	7	2.34
Neuromuscular scoliosis	6870	25	3.64	5147	21	4.08
Congenital scoliosis	4543	6	1.32	2182	6	2.75
Other scoliosis	9772	30	3.07	4201	11	2.62
Spondylolisthesis	28,160	16	0.57	10,775	9	0.84
Isthmic	7143	0	0.00	3197	0	0.00
Degenerative	20,090	8	0.40	7414	9	1.21
Dysplastic	927	1	1.08	164	0	0.00
Kyphosis	8448	40	4.73	3567	16	4.49
Congenital	1042	1	0.96	379	1	2.64
Scheuermann	1444	1	0.69	871	3	3.44
Other	5962	38	6.37	2317	12	5.18
Not specified	1	1				
Total	87,162	131	1.50	40,101	72	1.80

factors between the cases that were and were not complicated by mortality, because no details are collected for patients without this complication. In contrast, the previous report from Smith *et al*[15] that detailed the rates and causes of mortality in spine surgery based on the more detailed data collected from 2004–2007 was able to provide rates of mortality based on patient age and to define risk factors for mortality.

This study suggests that a simplified clinical data collection system, although limited by less data collected, can achieve significantly better submission compliance and may prove an effective approach in balancing the need for quality improvement data and time burden for data submission. Previous studies using the SRS M&M data based on earlier collection periods have been successful in defining basic rates of complications and potential risk factors, although the breadth of details collected was limited, because these data were collected for all operative spine cases. The factors related to some complications are particularly complex and to more effectively define these complications and associated factors, the SRS is currently exploring the use of specific focused modules. For example, the SRS M&M Committee has designed and implemented a supplemental data collection module that collects details on wound infections, including administration of prophylactic intraoperative antibiotics, cultured organisms, and treatment approaches. It is hoped that using the current simplified data approach with limited use of a series of supplemental focused modules will enable the SRS M&M data collection efforts to further explore specific complications in greater detail.

This study has several strengths, including the large number of cases reported and representation of less common spinal deformities. The spine surgeons contributing cases reflect a broad range of experience levels, and the multicenter design that includes academic and private centers predominantly from throughout North America enhances the generalizability of the data. This study also has limitations. Although the data were collected on the basis of a prospective data base, the study was designed and conducted retrospectively. Because of the deidentified data submission process, it is not possible to determine the number of deaths per institution or surgeon, and there is currently no means of determining the completeness of the data submission, nor the accuracy of reporting. In addition, there is a tendency for retrospective reviews to underestimate complication rates compared with true prospectively acquired studies. Furthermore, given that only a minority of patients underwent a formal autopsy, it is possible that in some cases the reported cause of death does not fully or accurately reflect the true cause of death.

CONCLUSION

On the basis of the simplified SRS M&M data collection system used from 2009–2011, the rate of mortality for spinal deformity surgery was 1.50 per 1000 cases, and the most common causes of mortality were respiratory and cardiac related.

Compared with the previous, more detailed, data collection system (2004–2007), the simplified system had a modestly but significantly lower mortality rate and a significantly higher surgeon compliance rate for case submission. Importantly, the simplified approach does not enable estimation of risk of complications based on patient and surgical parameters, because these data are not collected for patients without one of the major complications assessed. Although analyses based on the simplified system are limited by less data collection, it achieves better compliance and may prove effective, especially if supplemented with focused data collection modules.

➢ Key Points

- ❑ The SRS collects M&M data from its members. Previously this included details for all spine cases and all complications (detailed system). To reduce time burden and improve compliance, starting in 2009, collection was changed to focus on a few major complications for specific deformity diagnoses and only for cases with complications (simplified system).
- ❑ On the basis of the SRS M&M simplified system from 2009 through 2011, 87,162 surgical cases for spine deformity were reported, with an overall mortality rate within 60 days of surgery of 1.50 per 1000 patients.
- ❑ The relative distribution of deaths based on primary diagnosis was similar between the collection periods that used the detailed and simplified systems. For both collection periods, the highest mortality rate was for the diagnosis of kyphosis, followed by neuromuscular scoliosis, and the lowest rate was for idiopathic scoliosis.
- ❑ Compared with the detailed system, the simplified system had significantly improved compliance rates and similar mortality rates.
- ❑ Importantly, the simplified approach does not enable estimation of risk of complications based on patient and surgical parameters, because these data are not collected for patients without one of the major complications assessed. Although the simplified system is limited by less data collected, it does achieve better compliance and may prove effective, especially if supplemented with focused data collection modules.

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