Spine Deformity

www.spine-deformity.org

Spine Deformity xx (2018) 1−8

Improving Complex Pediatric and Adult Spine Care While Embracing the Value Equation

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Received 13 February 2018; revised 2 April 2018; accepted 12 August 2018

Abstract

Introduction: Value in health care is defined as the quotient of outcomes to cost. Both pediatric and adult spinal deformity surgeries are among the most expensive procedures offered today. With high variability in both outcomes and costs in spine surgery today, surgeons will be expected to consider long-term cost effectiveness when comparing treatment options.

Methods: We summarize various methods by which value can be increased in complex spine surgery, both through the improvement of outcomes and the reduction of cost. These methods center around standardization, team-based and collaborative approaches, rigorous outcomes tracking through dashboards and registries, and continuous process improvement.

Results: This manuscript reviews the expert opinion of leading spine specialists on the improvement of safety, quality and improvement of value of pediatric and adult spinal surgery.

Conclusion: Without surgeon leadership in this arena, suboptimal solutions may result from the isolated intervention of regulatory bodies or payer groups. The cooperative development of standardized, team-based approaches in complex spine surgery will lead to the high-quality, high-value care for patients.

Keywords: Safety; Value; Spine surgery; Teams; Quality

Introduction

The value of health care interventions is increasingly a part of the decision-making process by payer groups and government bodies in a world of ever growing focus on resource use in health care. Value is defined as the quotient of outcomes to cost. Both pediatric and adult spinal deformity surgeries are among the most expensive procedures offered today. With high variability in both outcomes and costs in spine surgery today, surgeons will be expected to consider

Author disclosures: RKS (none), VY (none), SAS (none), NDF (none), JF (none), VL (none), FS (none), MH (none), MD (none), LM (none), JCL (none), MV (none).

Institutional Review Board: Policies and procedures at participating institutions were followed.

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https://doi.org/10.1016/j.jspd.2018.08.006

long-term cost effectiveness when comparing treatment options. Herein, we discuss methods to help standardize protocols for patient safety and effectiveness as a means to improve outcomes, reduce unnecessary costs and ultimately drive up the value of complex spine care. Ultimately, systemwide improvements will be crucial to the improvement of value delivered in complex spine surgery.

This manuscript will describe standard pathways in pediatric and adult complex spine care specifically focusing on methods to achieve these pathways. We will describe team-based strategies to improve health care specifically documenting the experience of a pediatric spine OR team with further emphasis on the cultural aspects of team building. Finally we will address the topic of two attending surgeons, mentoring, and continuous improvement of outcomes via registry experience.

Standardization and Standard Pathways: The Pediatric Experience

Transition to more standardized postoperative care pathways following posterior spinal fusion for adolescent idiopathic scoliosis have increased in popularity based on the homogeneity of this patient population and the potential benefits offered by less variability in care. A variety of published techniques exist to guide hospitals in the creation of a postoperative pathway including more standardized methods focused on limiting wasted steps (ie, LEAN/Six Sigma) [1-3] and creating standardized processes involving stakeholders from multiple service lines [4-11]. Much of this work has been championed in complex adult spine cases by Rajiv Sethi and his team in Seattle and has led to the designation of ''centers of excellence'' by American payer groups where complex spine cases are referred to centers on the basis of quality and value. Commonalities exist among these pathways. Patients are typically sent to the surgical floor rather than the intensive care unit [12] and are initially placed on intravenous (IV) narcotics/antispasmodics for pain control. Oral intake, usually with liquids beginning immediately after surgery, is advanced as tolerated rather than waiting on a return of bowel function. Transition to oral pain medications occurs early, usually as soon as the patient is tolerating liquids, often on postoperative day (POD) 1. An epidural catheter is usually avoided because of difficulty mobilizing patients. Published pathways encourage regular physical therapy two to three times per day and ambulation beginning as soon as POD 0 [9] or POD 1 [4-6,8,10]. Aggressive bowel regimens are begun on POD 1 and patients are typically discharged before their first bowel movement. Expectations are established regarding length of stay beforehand, with most patients being discharged on the second or third postoperative day. All published reports have shown low complication rates and few returns to the system for gastrointestinal or pain control problems. Cost savings with these strategies will come through reductions in length of stay and potential improvement in readmissions.

Standardization and Standard Pathways: The Adult Experience

As surgeons, we have a tendency to focus on preoperative and intraoperative optimization as a means of decreasing complications. It is important that both of these pathways have intersecting value streams and bring all team members to the discussion. From the patient's standpoint, however, the most relevant timepoints may be the in-hospital stay and the postoperative recovery. Efforts to standardize the discharge and recovery pathway for patients have been successful in general and gynecologic surgery, primarily through the use of Enhanced Recovery After Surgery (ERAS) protocols [13,14]. These protocols include a focus on early ambulation, early removal of drains, and a standardized follow-up plan to ensure that early complications are captured and treated. These types of in-hospital pathways have been applied to pediatric scoliosis patients with improvements in length of stay without an increase in complications or readmissions [9,11,15]. These early discharges lead to a significant cost savings, and one that may eclipse savings derived from changes to intraoperative variables [9,15,16].

The adult population presents novel challenges to the application of these pathways, however. Numerous studies have demonstrated that increasing age is associated with an elevated risk of discharge to a nonhome facility even for nonfusion lumbar procedures [17-19]. Adult patients have more complicating medical issues that delay discharge to home or require discharge to a rehabilitation facility, including delirium, increased risk of urinary retention, decreased ambulation, and an increased comorbidity score [17,19-21]. The complexity of these patients may require development of comanagement pathways coordinating care between surgical and medical teams, analogous to the care typically provided for pediatric patients by an orthopedic spine team and general pediatric service. Early attempts at co-management for geriatric patients have led to promising results, with a decrease in immobilization time after surgery, a shorter length of stay, and an increase in the number of patients discharged to home rather than another inpatient facility [22].

Lean Operating Room Teams

Lean methodology developed in the manufacturing industry as a way to increase output while decreasing costs. These methods are increasingly being used in health care to similarly drive value through improving outcomes while decreasing costs. At a major tertiary children's hospital in the United States, the spine team created an interdisciplinary, dedicated team for spinal fusion for scoliosis. Members developed standardized protocols for anesthetic management, transport, patient positioning, prep, draping, imaging, and

wake-up. These protocols were initially implemented with a small interdisciplinary team, including one surgeon (Phase 1), then expanded (Phase 2). The team compared Dedicated Team cases to cases performed without a Dedicated Team (Casual Team). Because of the heterogeneous nature of PSF for scoliosis, they developed a novel case categorization system: Category 1—relatively homogeneous, patients with ⩽12 level fusion, no osteotomies, and body mass index <25; Category 2—more heterogeneous, patients with >12 level fusion, and/or ⩾1 osteotomy, and/or body mass index >25. Dedicated Team cases used significantly less OR time for both Category 1 and 2 ($p<0.001$). In Category 1 cases, the average reduction was 111.4 minutes (29.7%); in Category 2 cases, it was 76.9 minutes (18.5%). The effect of the Dedicated Team was scalable: the reduction in OR time was significant in both Phase 1 and 2 ($p<0.001$). The Dedicated team cases had no complications. Cost reduction averaged $8900 for Category 1 and $6000 for Category 2 cases. By creating a Dedicated Team and standardizing several aspects of PSFs for scoliosis, the team achieved a large reduction in OR time. This increase in team efficiency was significant, consistent, and scalable. The team now routinely complete two Category 1 PSFs in the same OR with the same team in standard block time (unpublished results). As clinical teams embrace LEAN principles to reduce waste and enhance cost effectiveness, it also behooves others like implant companies and hospital administrations to lower costs and deliver greater value to the patient.

Team-Based Approaches

Building a cohesive team is crucial for the coordination of care for patients undergoing these complex surgeries. Comprehensive Unit Based Safety Program (CUSP) were originally developed as a framework for improving safety and teamwork in the intensive care unit (ICU) setting (ahrq.gov). After remarkable success in reducing rates of central line–associated bloodstream infections (CLABSIs) and catheter-associated urinary tract infections (CAUTIs) across hundreds of ICUs [23,24], CUSP has now been adapted to many health care settings. Implementation of CUSPs in perioperative care has been associated with lower surgical site infection (SSI) rates, fewer surgical errors, fewer operating room delays, and improvements in surgical unit culture [25-28]. Surgical CUSP implementation addresses two critical barriers to surgical outcomes improvement: (1) protocols and checklists used to standardize practice, although necessary, are not sufficient to maximize quality and safety [29-32], and (2) poor teamwork and communication culture, while associated with worse surgical outcomes, are challenging to address [33-37].

The training elements of CUSP programs provide team members with core concepts of process defect identification and teamwork/communication known to enhance surgical safety culture [37,38]. Each multidisciplinary CUSP team—with members ranging from scrub technicians, to surgical and anesthesia attendings—then engages in creating a front-line provider driven learning health systems infrastructure within the unit [38,39]. This is accomplished through developing strategies for briefing/debriefing on surgical cases [40,41], collecting reliable data for surveillance, and building trust-accountability processes [27]. Researchers affiliated with the Safety in Spine Surgery Program (S3P) and the Pediatric Orthopedic Society of North America Quality Safety Value Initiative (POSNA QSVI) have been actively studying CUSP implementation in complex spine surgery units with promising preliminary results in SSI prevention, culture, and other quality metrics.

Continuous Mentorship and Dual Attending Approaches

The breadth and complexity of techniques in deformity surgery has grown in recent years. As a result, more trainees are completing multiple fellowships [42-45]. There is also increased interest in the role that the first assistant plays in surgical outcomes [46,47]. Some authors have reported shorter operative times and less blood loss with a dual surgeon strategy [48,49], whereas others have not found such advantages [50]. One aspect of dual surgeon surgery not assessed in current literature is the potential of an accelerated learning curve for junior surgeons. Another aspect that is not addressed by the literature is the seniority or experience of each of the two attending surgeons when dual attending surgeon approaches are discussed.

There is currently no test of neuromuscular aptitude during the selection of spine fellows by programs or for more prestigious memberships like the Scoliosis Research Society. Future educational assessments need to be standardized and developed around such skills that are essential for spinal deformity surgeons. Also, many fellowships vary in the experience they provide their respective fellows. This may not be known to the fellow applicant or to the practice that hires the spine fellowship graduate.

Cahill et al. [51] showed increasing surgeon experience is related to better surgical outcomes. Perhaps a paradigm shift is needed in which senior surgeons commit time to the continued training of junior partners during the initial years of the younger surgeon's practice. The reality of fee-for-service medicine in the United States often precludes this in many centers.

Responsibilities can be shifted from the senior to junior surgeon during complex cases. Initially the senior surgeon takes the lead on complex cases. The decision making is gradually shifted to the junior partner, with the senior surgeon providing a supportive role during subsequent cases. Over time, the junior surgeon accumulates knowledge from the senior partner and can pass that experience on to the next junior surgeon. The model allows early career surgeons to have ultimate responsibility for their patients while providing a senior surgeon "safety net" to facilitate patient safety during the junior surgeon's learning curve. Recognition of the safety and value added to patient care through accommodative reimbursement is paramount to surgeon support of such a

model. As discussed above, payment models do not adjust for this type of training and many senior surgeons would be seen as ''less productive'' when helping junior partners since they are not doing their own cases.

Tracking Outcome Metrics Through Dashboards

Efforts to improve value while maintaining quality in complex pediatric and adult spine care are critical to control costs, provide access and ensure sustainability. The electronic medical record (EMR) provides robust, readily accessible data for analysis and evidence-based decision making, but assembling the myriad of information in an effective, useful way was challenging. A dashboard is a data-driven clinical decision support tool that can query, assemble, and distill multiple databases and present a visual representation of key performance indicators in a single report, much like the dashboard display in your automobile. These easy-to-read, color-coded clinical decision support tools can be used to promote data-driven decision making and improve adherence to evidence-based practice guidelines, organizational goals, manage specific conditions, or monitor concerted efforts for complication reduction. The dashboard as a reporting application fits well into the value-based health care model promoted by Porter [52].

The five basic principles regarding dashboards are as follows: type of database integration, visual properties (color coded, intuitive, allowing at-a-glance interpretation), purpose (benchmarking, notification or warning, feedback for clinical decision making), time focus (retrospective, real-time, or predictive), and type of process monitored (patient safety, structure, process, or outcomes oriented) [53]. Numerous authors have described EMR integration, methodology of dashboard development, physician engagement, actionable intelligence, usage principles, and continuous improvement of the dashboard that are critical for success that ultimately enhances learner performance, patient care, and outcomes [54,55].

Dashboards have been used in the corporate suite for institutional decision making and now at all levels of health care organizations. Successful use of dashboards has improved workflow in patient care departments, such as emergency rooms, operative suites, and maternity wards and to support clinical decision making.

Two applications for dashboards in spine surgery are discussed here. The Harms Study Group comprises 10 institutions of high-volume pediatric spinal deformity surgery and prospectively collects demographic, radiographic, and patient-related outcomes data, as well as intra- and post-operative process measures and complications. Dashboards reports are circulated biannually to allow surgeons to gauge their performance and outcomes benchmarked relative to the group and determine adherence to best practice guidelines. These dashboards have improved operative times, decreased intraoperative blood loss, and decreased length of stay after implantation and sustained improvement or reduction three and five years later [56]. Furthermore, the dashboards have identified high performers who can help formulate best practice guidelines and, alternatively, have highlighted outliers more prone to complications and practice variability that have taken advantage of opportunities to improve quality and standardize processes. The Department of Neurosurgery at the University of California, Los Angeles, created a quality dashboard and demonstrated that it was a powerful tool to help manage process measures, quality and safety, patient satisfaction, improvement strategies, and monitor impact [57].

Concerns about dashboards include human and capital expenditure, sustainability, user anxiety, use of this information to compare providers or institutions in a negative light, information overload, and technology overload. Furthermore, ongoing efforts should be made to ensure that the data being collected is, in fact, an accurate and timely representation of the process or outcome being measured or studied. Although there is concern about the loss of physician autonomy in an era where more spinal surgeons are employed, active involvement of surgeons in the creation of dashboard metrics based on the principles of evidence-based medicine will enhance safety, quality, and value.

Rigorously Monitoring Outcomes Through Registries

Standardization of treatment outcomes measurement, including systematic and continuous outcome monitoring from a patient's perspective is important to assess the value of care delivered, that is, outcomes relative to cost, and future reimbursement [52]. Treatment outcomes are thought to matter most to patients, reflect the end result of all aspects of care [52], and could be regarded as a proxy for quality of care. In two recent AOSpine knowledge forum deformity studies concerning the appropriateness of surgical care for adolescents with idiopathic scoliosis and adults with spinal deformity, international consensus was reached to systematically monitor patient-related outcomes (ie, patient-reported outcome measures [PROMs] and clinician-based outcome measures), including factors for risk assessment and surgical planning [58]. In order to support the evolvement of appropriateness of care, patient outcomes should be closely monitored and prospectively documented in a registry [58].

Outcomes monitoring through a registry is expected to contribute to quality improvement. An outcome registry is an organized system that uses observational study methods [59]. The data could be used to describe care patterns, including appropriateness of care and disparities in the delivery of care [59]. Although promising, the systematic review showed a lack of evidence that outcome registries actually have an impact on the quality of spine care [59]. In order to improve the quality of evidence of current outcome registries, various recommendations were reported. These recommendations are related to the organization and methodology of a (spine) outcome registry, the outcomes and related contributing case-mix and risk factors that should be registered, data analysis, reporting of results, and practical issues.

Following these recommendations, outcome registries could serve different goals: individual patient care evaluation, continuous evaluation of quality of care delivered in a defined subgroup of patients, case-mix, and risk-corrected benchmark between professionals and institutions, value-based health care, research (eg comparative effectiveness), and more specifically decision support. To enhance standardization and the quality of spine deformity care, we recently reached international consensus on a standard set of outcomes for adolescents and young adults (AYA) with a spine deformity undergoing reconstructive surgery [60]. Currently, we perform a large project to achieve a comparable international consensus-based standard set of outcomes for adult spine deformity, based on a systematic review [61].

In Sint Maartenskliniek (a Netherlands-based clinic), all patients undergoing spine deformity surgery are systematically monitored over time and registered in an online web-system since March 2014 that is connected to the patients' electronic medical records. Routinely, for AYA undergoing deformity surgery, relevant patient characteristics and outcomes following the standard set [60], radiologic, and perioperative parameters are measured and captured. Recently, the short-term outcomes of surgery at one-year follow-up were presented [60]. The clinical relevancy of patient-reported outcomes is determined by means of previously reported minimal clinical important changes (condition-specific health-related quality of life; Scoliosis Research Society−22r questionnaire scores) and a satisfactory symptom state, comparable to healthy persons (ODI v2.1a). Patients undergoing surgery for idiopathic scoliosis experience a relevant improvement in functioning, health-related quality of life, self-image, and satisfaction. The number of registered complications and revision surgeries are relatively low [60]. A two-year follow-up study is currently being performed.

Conclusions

Critically examining value is a crucial component of improving the delivery of complex spine care. Improving value in turn requires us to examine both quality and cost of care. Value can be improved through either the improvement of quality or the reduction of cost. However, as we have demonstrated, many value-based initiatives

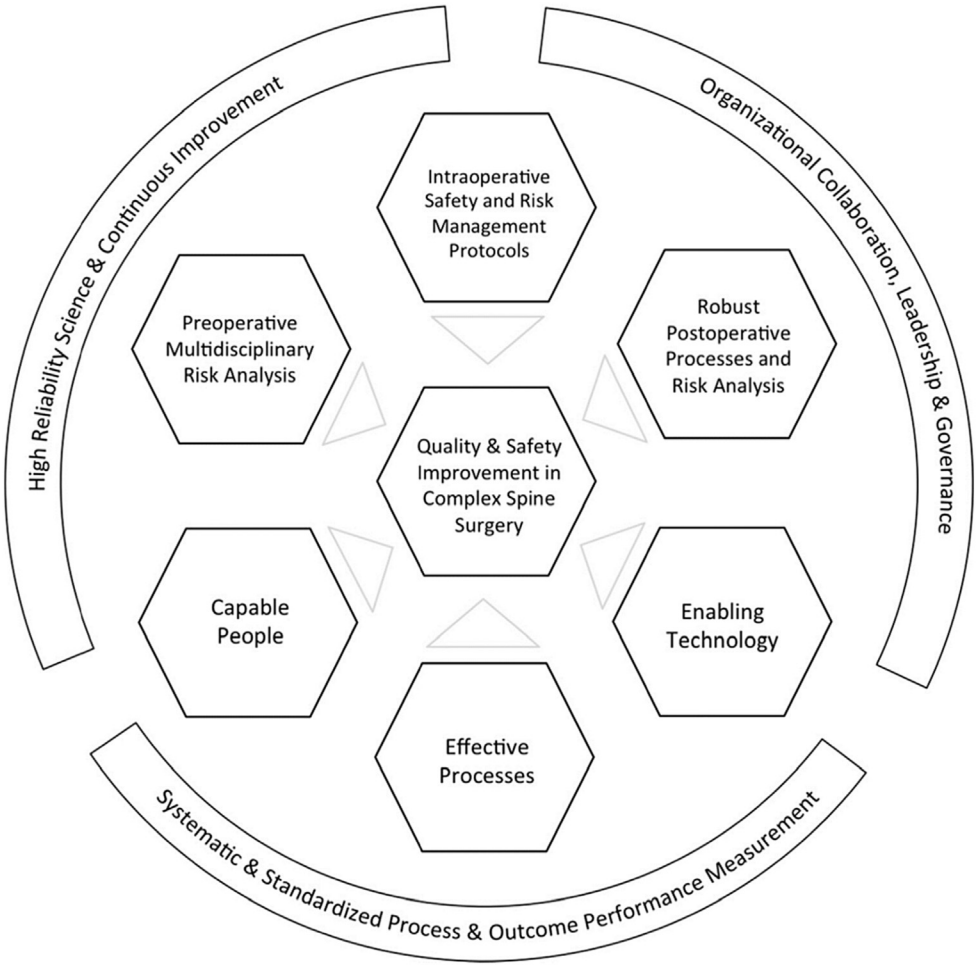

Fig. 1. The Spine Safety Improvement Model—Conceptual (SpineSIM-C). Adapted with permission from Sethi R et al. Quality and safety improvement initiatives in complex spine surgery. Semin Spine Surg 2017.

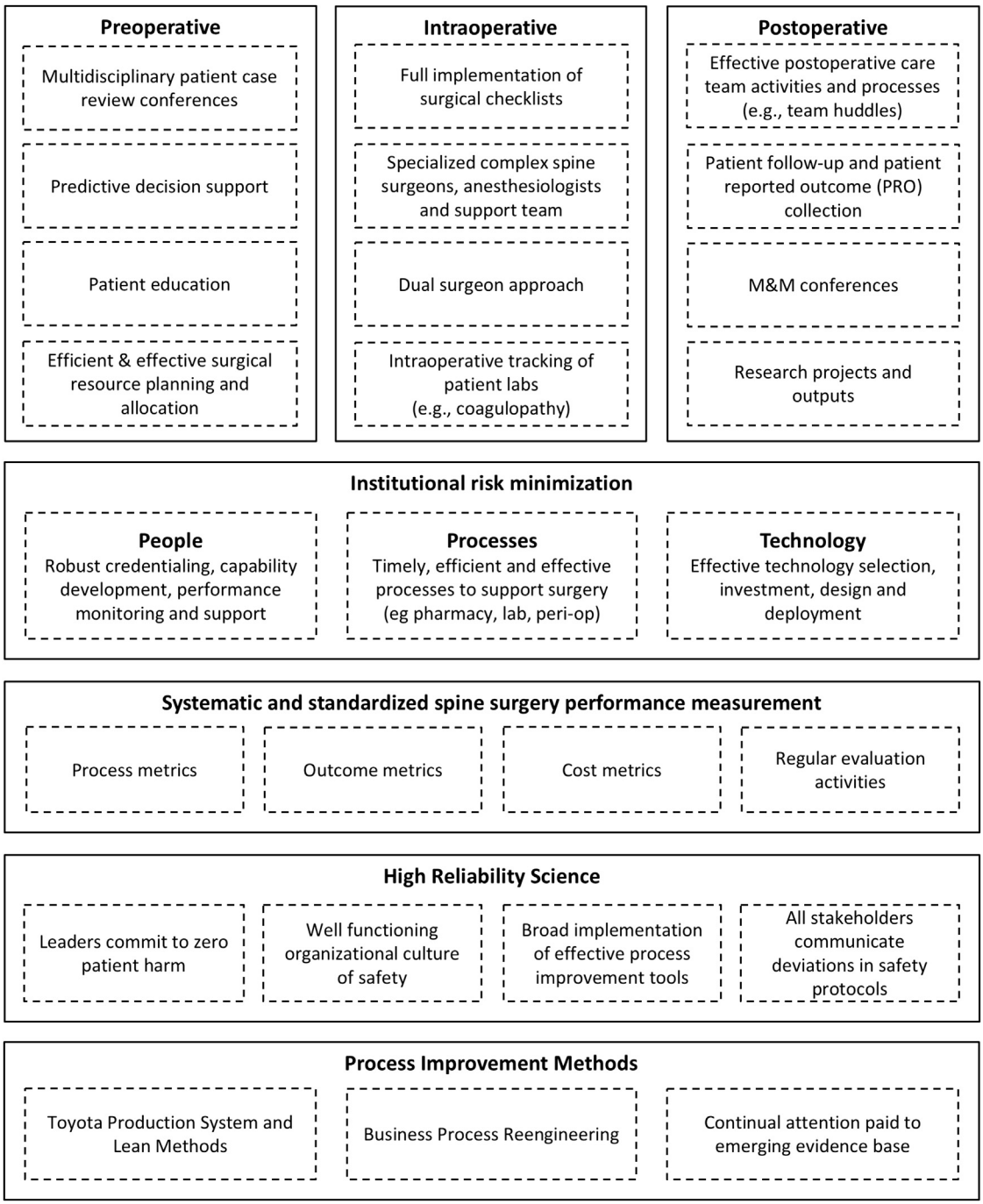

Fig. 2. The Spine Safety Improvement Model—Detailed (SpineSIM-D). Adapted with permission from Sethi R et al. Quality and safety improvement initiatives in complex spine surgery. Semin Spine Surg 2017.

simultaneously address both of these contributors to the value equation. Standardization and team-based approaches simultaneously strive to deliver consistent high-quality results while reducing unnecessary costs that do not contribute to the desired outcomes. Similarly, eliminating variability through lean methods and continuous process improvement can lead to ever-increasing value. In an era of value-conscious care, surgeons have the unique opportunity to drive these initiatives in a way that is focused on delivering the best patient care possible. The authors of this study represent pediatric and adult academic complex spine surgeons. Many of the authors focus on health services research where systems are studied in detail. Sethi et al. have recently published their algorithmic approach for a spine safety improvement model [62,63]. Figure 1 demonstrates the conceptual framework and Figure 2 demonstrates a more detailed analysis. Dashboards and registries will allow users to assess whether the items in Figure 2 are

leading to less variability and more predictable outcomes. It is clear from this work that multiple interweaving efforts as those discussed in this manuscript will enhance the patient experience and increase value.

Without surgeon leadership in this arena, suboptimal solutions may result from the isolated intervention of regulatory bodies or payer groups. The cooperative development of standardized, team-based approaches in complex spine surgery will lead to the high-quality, high-value care for patients.

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