Guest Editorial: Predictive Analytics, Calculators and Cost Modeling in Spine Surgery

Treatments for patients with spinal disorders has become increasingly costly, driven both by the demands of an aging population and by the supply of numerous technological advancements directed toward the spine. As a result, there has been a great deal of focus on the *value* actually provided to patients by various treatment modalities. Simply put, value is directly related to the technical or clinical benefit provided to the patient, often vaguely described as clinical outcome. Value is also directly related to the service provided to the patient or the patient's overall "experience." Conversely, value is indirectly related to cost. Although the definitions of a "good" clinical outcome or a "satisfying" patient experience are not readily available, direct and indirect costs can usually be measured. Therefore, health systems have sought to limit costs while maintaining or improving outcomes. Minimizing costs has been critically examined in the United States dating back at least to the end of the 20th century with the passage of the Balanced Budget Act of 1997.[1] Interest in this issue of cost containment has only increased over the first 2 decades of the 21st century with the continued growth of medical spending[2] and the passage of the Affordable Care Act in 2010.[3] Spine surgery is no exception to this rule. Given the high expenditures associated with spine care—estimated to approach $100 billion annually in the United States[4]—payors have placed increased scrutiny on providers in an attempt to maximize the value of delivered care.

To address this issue of cost containment and defining value within spine care, we devote the first portion of our issue to articles on this topic. These articles focus on current compensation models in spine surgery and the current evidence for various spine technologies, including cemented-augmented pedicle screws for patients with low bone density and spinal cord stimulator implantation for failed back syndrome. The full list of topics includes:

"Bundled Payment Models in Spine Surgery" by Hines et al

"Achieving Value in Spine Surgery: 10 Major Cost Contributors" by Philipp et al

"Applications of Machine Learning to Imaging of Spinal Disorders: Current Status and Future Directions" by Merali et al

"Is Less Really More? Economic Evaluation of Minimally Invasive Surgery" by Chung et al

"The Value of Cement Augmentation in Patients With Diminished Bone Quality Undergoing Thoracolumbar Fusion Surgery: A Review" by Kolz et al

"Spine Instrumented Surgery on a Budget—Tools for Lowering Cost Without Changing Outcome" by Eli et al

"Recoup From Home? Comparison of Relative Cost Savings for ACDF, Lumbar Discectomy, and Short Segment Fusion Performed in the Inpatient Versus Outpatient Setting" by Mikhail et al

"A Systematic Review of the Cost-Utility of Spinal Cord Stimulation for Persistent Low Back Pain in Patients With Failed Back Surgery Syndrome" by McClure et al

"Cost-Effectiveness of Adult Spinal Deformity Surgery" by Alvarado et al

In an effort to further characterize clinical outcome and/or patient experience, many health care scholars and administrators now lean heavily on patient-reported outcomes (PROs). These outcomes are the very ones used in determining hospital reimbursement[5-7] and in a sense are the only real way surgeons have of determining whether the surgery performed met the goals of the patient. Previous literature has demonstrated that outcomes on standardized PRO measures correlate with functional outcomes.[8] Those with greater self-reported health on standardized PRO measures, such as the Patient-Reported Outcomes Measurement Information System (PROMIS), are found to perform better on objective functional measures, such as

gait analysis.[9] Therefore, emphasizing patient-reported outcomes while maintaining low levels of perioperative complications and minimizing procedural morbidity will doubtlessly enhance the quality of care delivered. But such quality improvements are easier said than done. To achieve these ends, it is necessary to understand the drivers of positive patient satisfaction and high PRO scores. Previous studies have identified several predictors, including overall health, patient education, substance use, and concurrent psychological distress.[10] But only recently have patient preoperative expectations for surgery been shown to predict satisfaction. Recent work by Soroceanu et al[11] and others[12,13] have suggested that failure of the surgeon to meet these expectations strongly correlates with poorer patient satisfaction and lower PRO scores.

Expectation management using preoperative education sessions has been demonstrated to improve postoperative patient satisfaction and to reduce postoperative healthcare utilization.[14] While nearly all interventions described to date make use of aggregate statistics and general procedural teaching, it seems likely that individualized education sessions may provide additional benefit by informing each patient of his/her specific procedural risks and likely benefits. Such thinking has been the impetus behind efforts such as the National Surgical Quality Improvement Program (NSQIP) risk calculator published by the American College of Surgeons (https://riskcalculator.facs.org/RiskCalculator/), which utilizes data from hundreds of institutions to give patients an individualized risk profile. Such calculators often miss the granularity of spine procedures though and have been suggested to be inaccurate predictors of outcomes among spine surgery patients.[15] For this reason, there has been a drive to develop and deploy disease- and surgery-specific predictive tools for spine surgery patients. We highlight these tools in the second part of this issue, with a pair of systematic reviews. The first by Lubelski et al ("Prediction Models in Degenerative Spine Surgery: A Systematic Review") looks at the use of predictive analytics in the adult degenerative spine surgery population and the second by Lehner et al ("Narrative Review of Predictive Analytics of Patient-Reported Outcomes in Adult Spinal Deformity Surgery") examines predictive analytic use within the adult spinal deformity population.

Like other business ventures, medicine seeks to maximize productivity while reducing costs. However, unlike other sectors, in medicine, the "profit" can be thought of as the sum total increase in years lived and quality of life gained by all patients treated by the system.[7] To maximize this profit and increase the value provided by the system, it is therefore necessary to reduce expenditures and to leverage all available tools to maximize the benefit to the patient. In this issue we have attempted to highlight both issues with articles focusing on cost containment, predictive analytics, and risk profiling in spine surgery. In the background of ongoing concerns about healthcare spending and value-based compensation, investigation into these topics is likely to continue and we hope that the present issue can serve as a starting point for interested parties.

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Abbreviations

NSQIP: National Surgical Quality Improvement Program; PRO: Patient-reported outcome; QALY: Quality-adjusted life-year

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