



Future endeavors in ambulatory spine surgery

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Abstract: Due to the high societal and financial burden of spinal disorders, spine surgery is thought to be one of the most impactful targets for healthcare cost reduction. One avenue for cost-reduction that is increasingly being explored not just in spine surgery but across specialties is the performance of surgeries in ambulatory surgery centers (ASCs). Despite potential cost-savings, the utilization of ASCs for spine surgery remains largely limited to high-volume centers in the US, and predominantly for single- or two-level lumbar microdiscectomy and anterior cervical discectomy and fusion (ACDF) procedures. Factors most commonly cited for the lack of wider adoption include the risk of life-threatening complications, paucity of guidelines, and limited accessibility of these procedures to various patient populations. Thus, the future growth and adoption of ambulatory spine surgery depends on addressing these concerns by developing evidence-based guidelines for patient- and procedure selection, creating risk-stratification tools, devising appropriate discharge recommendations, and optimizing care protocols to ensure that safety, efficacy and outcomes are maintained. Other avenues that may allow for more widespread use of ASCs include the use of electronic health tools for post-operative monitoring after discharge from the ASC, increasing accessibility of ambulatory procedures to eligible populations, and identifying systemic inefficiencies and implementing process-improvement measures to optimize patient-selection, scheduling and peri-operative management. The success of ambulatory surgery ultimately depends not only on the surgical procedure, but also on its organization upstream and downstream. It provides an exciting and burgeoning avenue for innovation, cost-reduction and value-creation.

Keywords: Ambulatory surgery; ambulatory surgery centers (ASCs); guideline; risk-stratification; accessibility

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The exponential and unsustainable growth (1) of United States healthcare expenditure has led to a shift towards a value-based healthcare that emphasizes cost-reduction. Value in healthcare, from the global perspective, is determined by measuring benefit to the patient (patient perspective) per dollar spent (payor and societal perspective) (2). In this context, spine surgery is thought to be one of the most impactful targets for cost reduction (3), primarily due to the high societal and financial burden of spinal disorders (4) attributable to the significant morbidity and disability caused by these disorders, coupled with their widespread prevalence (5). This is further evidenced by the

Global Burden of Disease 2010 report, which states that low back pain and neck pain rank 1st and 4th highest respectively in terms of global disability and 6th and 21st in terms of overall burden (6). With the estimated annual cost of spine care in the United States being over \$100 billion (7), there is a broad scope for cost-saving in various avenues of care.

With over 54 million outpatient surgical procedures being performed annually (5) and a 60% increase in the number ambulatory surgery centers (ASCs) in the past ten years (8), it is evident that one avenue for cost-reduction increasingly being explored not just in spine surgery but across specialties is the performance of surgeries in

an ambulatory surgery setting (9-11). The transition to ambulatory procedures has been made possible by advances in surgical techniques, with less invasive surgical procedures that result in decreased peri-operative morbidity and reduced post-operative pain and improved anesthetic and analgesic protocols that optimize pain-management while minimizing associated complications. ASCs are thought to achieve efficiencies of cost through specialization of care and consistency of the care team, smaller size, reduced administrative costs and the scope for rapid implementation of process improvements (12), while avoiding staff- and equipment-associated costs that are typically encountered with prolonged post-operative monitoring of patients in the hospital setting.

Although the current literature shows a trend towards more spine surgeries being performed in the outpatient or ambulatory setting, a majority of these reports have originated from the US, likely from high-volume centers and have largely been limited to single- or two-level lumbar microdiscectomy and anterior cervical discectomy and fusion (ACDF) procedures. Factors most commonly cited for the lack of more extensive adoption of spinal surgeries on an ambulatory basis include the risk of life-threatening complications such as epidural or retropharyngeal hematomas, paucity of evidence-based guidelines for patient- and procedure-selection, post-operative management and discharge criteria, and limited accessibility of these procedures to various patient populations. Thus, the future growth and adoption of ambulatory spine surgery depends on addressing these concerns and optimizing care protocols to ensure that safety, efficacy and outcomes are maintained, while reducing costs, enhancing feasibility and increasing accessibility of these procedures.

Devising patient-care guidelines and protocols

Patient selection

Numerous studies have assessed the safety, feasibility and clinical outcomes of cervical (11,13-20) and lumbar (11,20-28) spine surgeries performed in the ambulatory setting. All published studies reiterate that patient selection is of utmost importance to ensure safety of these procedures. Despite this consensus amongst surgeons, there is a dearth of evidence-based guidelines to assist with patient selection; this is largely attributable to the fact that most published studies are either small, single-center retrospective studies that may not be adequately powered to

detect rare complications and cannot conclusively identify appropriate patient selection criteria, or large database studies that lack the level of granularity required for this purpose. Thus, large prospective studies are principal to establishing safety and appropriate selection criteria.

Criteria that are commonly cited in the current literature, predominantly based on anecdotal evidence, include age, body mass index (BMI), comorbidities and anesthesia risk, distance of stay from the hospital and the availability of a responsible adult for the first 24 hours (13,21,22,28-32).

Recently published results from a Delphi Panel on Best Practices for Outpatient Anterior Cervical Surgery (33) provide a list of best practice statements regarding pre-operative decision-making, peri-operative care, and anesthetic and surgical technique. In terms of patient selection, this panel identified 21 criteria that had a consensus of over 75%; a majority of these criteria reflect what has been reported in retrospective studies in terms of patient demographics, comorbidities and social factors that allow for ambulatory surgery. These criteria, conceived by a multi-disciplinary panel, can serve as a useful guide for healthcare providers and institutions when establishing ambulatory surgery practices.

While some of these guidelines may be helpful in terms of general risk stratification, they have been devised specifically for anterior cervical surgeries and are not directly translatable to other types of procedures. Bearing in mind the variety of surgical procedures, techniques, and approaches that are utilized in spine surgery, it is a logical inference that the types of complications and risk factors for complications vary widely. Thus, a similar expert panel consensus that provides guidelines for other surgical procedures that can be performed on an ambulatory basis would increase surgeon comfort and confidence in instituting these procedures in their own practice.

Thus large prospective studies and expert panel guidelines are required to provide direction, especially in settings where such procedures are not prevalent. In addition, individual clinician insight, judgement, experience and comfort will be critical in guiding appropriate and safe patient selection.

Peri-operative care and analgesia

Poorly controlled pain is one of the most commonly cited reasons for failure of same-day discharge, emergency room visits, delayed functional recovery and patient dissatisfaction

following ambulatory spine surgery (26,29,34). In addition, complications of narcotic pain medication such as urinary retention, and post-operative nausea and vomiting are also significant causes of delayed discharge. Multimodal analgesia has been shown to significantly impact post-surgical narcotic consumption and length of stay and thus has the potential to improve outcomes in the ambulatory setting (11). A multi-disciplinary approach with the involvement of the anesthesiologist (to formulate an appropriate multi-modal analgesia protocol), post-anesthesia care unit nursing staff (to ensure compliance with the analgesia regimen) and the surgeon (to ensure applicable pre-operative patient-education and counseling) are vital to address this subject. The transition of care to the ambulatory setting does not involve a change in the practice of the surgeon alone, but of the care team as whole. Thus, continuous engagement and feedback of all those involved is important to ensure seamless integration and continual improvement. Future effort on this aspect focusing on the development of guidelines to optimize pain control, standardize analgesic regimens, and limit opioid consumption and its side-effects will likely contribute significantly to decreasing the number of unplanned admissions, re-admissions and emergency room visits, and will subsequently reduce unnecessary healthcare utilization in this context.

Discharge recommendations

As with patient-selection criteria, discharge recommendations are predominantly based on anecdotal evidence and single-surgeon series. For anterior cervical surgeries, these reports (15,30,35), as well as the Delphi panel (33) have recommended that the patient is alert and neurologically intact, able to swallow, can ambulate with minimal assistance, has no signs of respiratory distress, has acceptable pain scores and has been provided detailed information, particularly regarding the early recognition of serious complications and the need for emergent care in these situations. Typically the post-operative monitoring for these patients ranges from 6–10 hours, with the general consensus being that a minimum of 4–6 hours is generally adequate to detect most life-threatening hematomas occurring in the early post-operative period. For lumbar surgeries, discharge criteria described in the literature include: the patient is alert and neurologically intact, has passed urine, has acceptable pain scores and is able to mobilize safely (22,23,26,28).

Although these criteria have proven to be appropriate in these small series, their generalizability is restricted.

This is attributable to the fact that due to the small sample size, these studies have limited statistical power to detect life-threatening complications such as retropharyngeal or epidural hematomas, and a majority of these reports have originated from high-volume centers; As a result, these criteria may not be applicable in the community setting. Thus, an important aspect that needs to be addressed in order to establish the safety and outcomes of ambulatory surgery, not just in specialized centers but in the community as a whole, is to formulate setting-specific and procedure-specific discharge criteria. This will allow for more widespread adoption of ambulatory surgery, while reducing the incidence of readmissions and complications.

Use of e-health tools

Although the first case of outpatient spinal surgery was performed almost 35 years ago (36), it is only recently that legislative changes have been instituted (37) to promote more widespread adoption of this practice. One of the most common barriers to outpatient surgery has been the fear of complications in the absence of prolonged in-hospital monitoring. While in-hospital monitoring is still the norm, advances in technology can now allow for remote monitoring and follow-up through the use of various electronic tools. This global opportunity to leverage advances in information and communication technologies to improve healthcare is reflected in the resolution on digital health that was passed at the 71st World Health Assembly, 2018 as well as the 2016 mobile health (mHealth) report which stated that mHealth has been shown to increase access to health information, services and skills, as well as promote positive changes in health behaviours and manage diseases (139th Executive Board, 2016; Geneva, Switzerland) (38).

With over 2.5 billion people in the world and over 80% of US adults now owning a smartphone (39), the use of innovative technologies such as healthcare and mobile applications is becoming increasingly feasible; this is reflected by the growing number of reports in the literature on the use of digital health tools in various medical subspecialties. Despite these advancements, a majority of these reports focus on long-term follow-up of chronic disease management, with little evidence to assess their utility in the acute post-operative setting (29). One such study in the field of ambulatory spine surgery is by Debono *et al.* (29), which evaluated the utility of a mobile health application for post-operative monitoring after ambulatory

lumbar discectomy in a series of 60 patients. They reported that all twenty-nine alerts generated by patients were resolved without the need for emergency hospitalization or in-person consultation. In addition, they found high rates of patient acceptance and satisfaction with regard to the use of a mobile application for post-operative monitoring.

While larger studies are warranted to determine the benefit of these technologies with greater confidence, it is likely that they will become an integral part of post-operative monitoring and follow-up. Ambulatory surgery in particular represents an opportunity for immense growth in this field. Thus, dedicating resources towards the development of these tools will likely result in increased adoption of ambulatory procedures, a decrease in unnecessary hospital visits and greater patient satisfaction.

Expanding indications

Although initial reports on ambulatory surgery have been relatively conservative in patient selection, a number of recent reports have shown that patient selection criteria are relatively flexible and should be tailored to each individual. These studies report that ambulatory surgeries have demonstrated feasibility and safety in some elderly patients, as well as those with a slightly greater anesthetic risk (American Society of Anesthesiologists class 2 and 3) (13,14,29). While it is fair to surmise that ambulatory surgery will predominantly be performed in patients who have a low risk of complications, these studies demonstrate that it is possible to gradually expand selection criteria based on clinician judgement and offer these procedures to a greater number of patients if they are likely to benefit from it.

Cervical surgery

Cervical spine surgery performed on an ambulatory basis has largely focused on ACDF procedures, limited to 1–2 levels of surgery. Despite the success of single-level ACDF in the ambulatory setting, concerns over post-operative complications have curtailed the performance of multi-level ACDF in the same setting. Even in studies that included 1- and 2-level procedures, 60–70% of reported cases were single-level surgeries (35,40–42). Thus, there is little evidence to determine whether a greater number of operative levels is likely to result in an increased risk of complications and warrant a longer observation period. A recently published study by Vaishnav *et al.* (13) addresses

this question by retrospectively comparing outcomes and complications of 2-level ACDF performed at an ASC versus the hospital setting. The findings of this study indicate that in an appropriately selected patient, 2-level ACDF performed in the ambulatory setting does not increase the risk of complications and results in equivalent patient-reported outcomes compared to the hospital setting. Larger prospective studies are required to ascertain this with greater confidence, and may result in more 2-level and multi-level surgeries being transferred to the ambulatory setting.

In recent years, cervical disc arthroplasty (CDA) has been gaining popularity as a motion-preserving alternative to ACDF in select patients. Despite evidence of clinical success and technical commonalities with ACDF, there is a limited body of evidence regarding CDA in the ambulatory setting. A majority of these studies, which were limited to single-level procedures have demonstrated favorable clinical outcomes (15,30,43) and thus support the performance of more of these surgeries in the ambulatory setting. Furthermore, a recent study by Hill *et al.* (14) has also demonstrated the safety of 2-level ACDF in the outpatient setting. Few studies have also reported their experience with performing posterior cervical foraminotomy in the ASC setting with morbidity similar to that reported with inpatient procedures and no perioperative mortality (11). Thus, performance of these surgeries in an appropriately selected patient represents an opportunity to expand the scope of ambulatory cervical spine surgery.

Lumbar surgery

Since the first report of outpatient lumbar discectomy performed in 1985 (36), numerous studies have reported feasibility, favorable outcomes and cost-savings of ambulatory discectomy/microdiscectomy procedures (23,26,28,29,32), with some evidence for endoscopic and other decompression surgeries as well (11,27). In contrast, reports on lumbar fusion surgeries in this setting have been largely limited to small, single-institution retrospective series. These studies have demonstrated lateral lumbar interbody fusion (21,44), transforaminal lumbar interbody fusion (22,25) and posterior lumbar fusion (24) can be performed on an ambulatory basis with an acceptable rate of complications and good clinical outcomes. Although current evidence for ambulatory fusion surgery is limited, it is likely that as minimally invasive approaches, microsurgical techniques and anesthetic protocols continue to be refined

and more widely adopted, more of these procedures will become increasingly feasible in the ASC setting on a larger scale.

Lewandroski (32) also evaluated the incidence of and risk factors for recurrent disc herniation and postoperative complications following outpatient lumbar decompression. Similar studies that identify factors that may be predictive of poor outcomes following ambulatory surgery are an important topic of future study.

As with all surgical procedures, revision spine surgery carries greater risk than a primary surgery because it is a more complex and technically challenging procedure due to obfuscation of normal anatomy as a result of post-surgical scarring. Due to this elevated risk, most surgical procedures performed in the ambulatory setting have been limited to primary procedures. However, a recent study (45) comparing inpatient versus ambulatory minimally invasive (MIS) lumbar microdiscectomy found similar perioperative outcomes between the two cohorts. It is likely that the favorable outcomes, minimal perioperative morbidity and low-rate of complications in both cohorts are at least in part due to the MIS approach that has been shown to be advantageous for revision procedures. As a result the generalizability of the findings of this study is limited. Despite this limitation, this study demonstrates that relatively simple revision surgery can be a potential candidate for ambulatory surgery, and that this avenue to expand the scope and indications of spine surgery should be explored further.

Increasing accessibility

A majority of reports on ambulatory spine surgery have been from large-volume centers that can implement specialized care pathways for these surgeries. The paucity of studies from low-volume community settings is likely due to one of two factors—first, the performance of ambulatory surgeries is limited to centers where the surgical volume is high enough to have dedicated, trained staff specifically for these surgeries, or second, ambulatory surgeries are being performed in the community setting, albeit at a lower rate than larger institutions, but these set-ups lack the administrative and research support required to collect and publish these data. The current literature supports the former, with a large database study reporting a significantly greater odds of outpatient surgery being performed at a high-volume hospitals (46). Further studies evaluating the cause of this disparity are required to understand the degree

of accessibility of these procedures to patients, and to devise methods to address this gap.

A retrospective study (46) that analyzed data from large state-wide administrative databases of four U.S. states to investigate factors associated with patient selection for ambulatory lumbar discectomy found that in addition to factors such as age and comorbid status that medically necessitate inpatient admission, socio-economic factors including coverage by Medicaid and African American or other minority race are associated with decreased odds of outpatient procedures. Although this study was limited to four states and may not reflect nation-wide trends, it highlights the importance of mapping differences in access to health care, identifying the underlying cause and targeting specific populations in an attempt to diminish disparities. Increasing accessibility of these procedures to eligible populations is a vital step in the future of ambulatory spine surgery as it will not only aid in understanding the feasibility of these procedures in a range of healthcare settings, but will also bolster benefits and cost-savings on a larger scale.

Process-improvement

A few retrospective studies of patients undergoing lumbar microdiscectomy have reported that the 13–14% of patients who met selection criteria for ambulatory surgery stayed overnight for post-operative monitoring only because their surgery was scheduled for later in the day (23,26). These reports highlight the need for establishing appropriate care protocols and facilitating inter-departmental cooperation in order to maximize the impact and success of new interventions.

While this is one example, numerous systemic inefficiencies related to scheduling, staffing concerns, insurance limitations and other non-clinical factors often prevent full utilization of ambulatory surgery, and thus limit maximization of associated cost-savings. As ambulatory surgery becomes more widespread, it will become imperative for healthcare institutions to address these inefficiencies by creating a system to identify day-case patients in advance of their procedure, plan an appropriate surgical schedule and ensure efficient peri-operative management of these patients. This will allow for a greater number of qualified patients to undergo these procedures.

Identifying systemic inefficiencies and implementing process-improvement measures are critical aspects of value creation; the true value and effectiveness of ambulatory

spine surgery on a population level can be realized only when its' accessibility and administration are optimized to reach the maximum number of eligible patients.

Conclusions

Given the favorable results and cost-savings that have been demonstrated thus far, the upward trend of ambulatory spine surgery is likely to continue, with a foreseeable expansion of the indications for which it is deemed feasible and safe. Although inpatient admission will likely remain the norm for comorbid patients, it is probable that in the foreseeable future, ambulatory surgery will become the standard of care for less invasive procedures performed in younger and relatively healthy patients, and inpatient admission will only occur when imperative.

The future growth and adoption of ambulatory surgery will likely depend on addressing concerns regarding the risk of complications, paucity of evidence to guide decision-making, and lack of accessibility. Optimization of care protocols and risk-stratification tools will be required to ensure safety, efficacy and outcomes, while reducing costs, enhancing feasibility and increasing accessibility of these procedures. The success of ambulatory surgery ultimately depends not only on the surgical procedure, but also on its organization upstream and downstream. It provides an exciting and burgeoning avenue for innovation, cost-reduction and value-creation.

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Footnote

Conflicts of Interest: Dr. Steven J. McAnany: Currently receiving Consulting Fees from Titan, Nuvasive, Stryker K2M. AS Vaishnav has no conflicts of interest to declare.

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