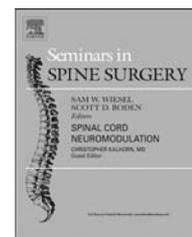


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Volume-outcome relationships in spine surgery – does increasing caseload co-relate with reduced complications?

Azeem Tariq Malik, and Safdar N. Khan

Division of Spine, Department of Orthopaedics, Department of Integrated Systems Engineering, Clinical Faculty, Spine Research Institute, The Ohio State University Wexner Medical Center, Columbus, OH, United States

ABSTRACT

With the advent of value-based models of healthcare and introduction of alternative payment models, there has been a renewed interest towards the consideration of regionalization policies revolving around ‘concentrating’ spine surgeries to high volume providers in an attempt to reduce complication rates and promote delivery of quality care. The current paper reviews pertinent evidence on the surgeon volume-outcome relationship in spine surgeries, with particular reference to complication rates. The review also provides valuable information on the unintended ramifications of regionalization of care on the healthcare system.

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1. Introduction

The concept that higher surgical volume translates to better outcomes is not new. In fact, the first evidence of a volume-outcome relationship in orthopaedic surgery was established in the 1970s, by Luft et al showing a significant inverse relationship between increasing hospital volume and mortality rates following total hip arthroplasty.¹ This landmark paper was shortly followed by a ‘flood’ of studies over the next three decades investigating the impact of increasing surgeon and hospital volume on post-operative morbidity and mortality following various orthopaedic procedures, including hip fracture fixations,^{2–5} elective total joint arthroplasties^{6–9} and spine surgeries.^{10–13}

While understanding the effect of various patient-level factors (e.g. co-morbidities, age, body mass index) on post-operative outcomes is essential in the current evolving healthcare climate, one should not overlook the inherent need of identifying various provider-level factors (such as surgeon/hospital

volume) that may influence the delivery and subsequently impact the quality of care. Due to the inherent variability seen in severity of presentation, as well as the myriad of surgical techniques available for correction of various spine-related pathologies, it can be safely said that no spine surgical patient is the same. More than often surgical protocols, such as approach, have to be individualized based on severity of disease and/or patient presentation. Needless to say, surgeons who are regularly exposed to spine patients would likely have mastered various surgical/exposure techniques and may have better outcomes. Likewise, hospitals that frequently take care of a large proportion of spine patients may have a better adherence to processes-of-care and/or would be more adept at identifying and managing complications early on in the course of care.

Much like a manned production line where processes become more efficient with increased experience, one can surmise that a similar ‘practice-makes-perfect’ phenomenon would apply in the case of a newly minted spine surgeon or even a budding new hospital system. Another explanation for

From The Ohio State University Medical Center
E-mail address: Safdar.Khan@osumc.edu (S.N. Khan).

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the so-called volume-outcome relationship could be due to 'selective-referral', where certain healthcare systems and/or providers may build a reputation and eventually become a center/hub for performing certain surgeries. This would lead to a form of a channeling where these providers would 'pull' cases from surrounding catchments. In contrast to practice-makes-perfect hypothesis where 'volume drives quality', the selective-referral system is based on 'quality drives volume'. Conversely, one can argue that if the selective-referral system indeed exists, then it is likely that these so-called 'hubs' or centers-of-excellence would also have a higher number of complex referrals. Given that these centers maintain the quality-of-care while dealing with a sicker case-mix; it can be inferred that the 'practice-makes-perfect' hypothesis does indeed come into play irrespective of any underlying 'referral pattern'.

1.1. Surgeon volume-outcome relationships in cervical spine surgeries

To date, only few studies ($N=4$) have explored volume-outcome relationships in the context of spine surgeries. Cole et al., was the first to delve into a commercial insurance dataset to find that surgeons who performed at least 30 elective anterior cervical discectomy and fusions (ACDFs) annually, had a lower rate of experiencing any 30-day complication (with the exception of revision surgery which was found to be insignificant).¹³ Similar studies, conducting using the Nationwide Inpatient Sample (NIS) dataset, also noted similar observations. De La Garza Ramos et al., concluded that surgeons who performed more than 47 ACDFs/year vs. those performing only 12 ACDFs/year had lower rates of inpatient all-cause and surgical complications.¹² Basques et al. found that surgeons performing between 5–67 ACDFs annually had lower rates of various inpatient adverse events (such as surgical site infections, pneumonia, sepsis, UTI, myocardial infarctions and in-hospital mortality).¹⁴

While these studies point out important observations, when presented with this kind of data – the question still remains: How many ACDFs/years can be considered a marker of proficiency? Or – at what benchmark threshold does complication rates reduce significantly? Only one study has so far utilized a comprehensive analytical method, involving the creation of multiple sub-groups and analyzing complication rates using receiver operating curves, to identify that surgeons should consider at least 40 ACDFs/year or at least 30 PCFs/year as benchmarks that positively impact the rates of 90-day complications and readmissions seen in their patients.¹⁵

1.2. Surgeon volume-outcome relationships in lumbar spine surgeries

The study by Farjoodi et al., published in 2011, is possibly the very first lumbar spine specific volume-outcome study performed using a large nationally representative sample.¹⁶ Analyzing over 200,000 patients undergoing lumbar decompression with or without fusion between 1992–2005, the authors found that high volume surgeons (defined as 9–22 surgeries/year) had lower rates of complications (9.4% vs. 21.8%) and mortality (0.3% vs. 3.4%) than lowest volume surgeons (1 surgery/year). Using updated data from 2005–2008 on the same study

population, Dasenbrock et al. found a similar relationship with high volume surgeons (>81 surgeries/year) having lower rates of inpatient postoperative complications (8.6% vs. 11.6%) as compared to low volume surgeons (<15 surgeries/year).¹⁷

In perhaps, the most clinically relevant volume-outcome spine study to date, Schoenfeld et al. analyzed over 185,000 patients undergoing four common lumbar spine surgical procedures (discectomies, decompression alone, interbody fusions and posterolateral fusions) to define evidence-based volume thresholds for providers to use as a means of benchmarking.¹¹ The study concluded that in order to maintain clinical acumen, providers should consider an average of four discectomies/month, four interbody fusions/month, three posterolateral fusions/month and at least one decompression surgery bi-weekly as benchmarks. For surgeons who failed to meet the said volume-benchmarks, the study noted the following change in complication rates for each of the four procedures – 63% increase in decompressions, 56% increase in discectomies, 15% increase in interbody fusions and 47% increase in posterolateral fusions.

1.3. Surgeon volume-outcome relationships in adult and pediatric spine deformity

Current evidence revolving around the volume-outcome relationship in corrective surgery for adult and pediatric spine deformity is scarce. This observation can be largely due to the low volume of spine deformity surgery being carried out nationally, as compared to other elective spinal surgeries for degenerative spine diseases. Furthermore, while elective spine cases are a routine practice of every spine surgeon, not every spine surgeon is a 'deformity' surgeon to begin with. A decent proportion of deformity cases being referred to large academic medical centers where the provision of high-grade technology and biomechanical research labs allows appropriate pre-operative planning to take place. Paul et al., analyzed around 140,000 adult spinal deformity surgeries (ASDS) and found that surgeons who performed between 58–441 surgeries/year and lower rates of complications (9.0% vs. 16.1%) as compared to surgeons who performed at most 8 surgeries/year.¹⁸ The authors also carried out a similar analysis on patients undergoing primary and revision spinal fusion for adolescent idiopathic scoliosis, neuromuscular scoliosis and congenital scoliosis, and noted a similar decreasing trend in complication rates as the average surgeon caseload increased.¹⁹ No study has yet explored optimum volume-thresholds/benchmarks based on complication rates for adult or pediatric spine deformity surgeries, and it certainly remains an avenue for future studies to explore.

1.4. Surgeon volume-outcome relationship in surgery for spinal metastases

Using data from the 2003–2009 NIS database, De La Garza Ramos et al. performed a linear regression analyses of patients undergoing surgery for spinal metastases and noted that with increasing surgeon volume the odds of experiencing an inpatient post-operative complication decreased significantly.²⁰ This finding was further supported by a recent Florida statewide database study published in the *Journal of Bone*

and Joint Surgery showing that surgeons who performed less than 49 spinal metastases surgeries/year had statistically higher rates of 90-day complications as compared to high-volume surgeons (≥ 49 surgeries/year).²¹

1.5. The future in 'volume-outcome' research

The relative dearth of updated/recent literature on this crucial topic is largely attributable to databases. For instance, majority of the current literature is based out of the NIS database – which is the comprehensive national stratified 20% sample of all national hospitals. Unfortunately, beginning from 2009 – the NIS database discontinued the recording of surgeon identifiers in their dataset. Therefore, researchers have now resorted to using statewide databases as a means of studying volume-outcome relationships and identifying benchmark thresholds – however, the generalization of these statewide databases to the national population still remains a matter of debate. We, the authors, feel that as much more clinically comprehensive surgeon-led registries begin to take over administrative databases, the inclusion of unique surgeon and hospital identifiers, in privity to HIPAA laws, should be promoted. This would ultimately pave-way to more clinically granular and important studies.

1.6. Health-policy implications of volume-outcome regionalization

With abundant literature showing the increase in provider volume to improve outcomes following surgeries, health-policy makers have progressively pushed towards the adoption of 'regionalization' policies in an effort to improve the quality-of-care. While the volume-outcome relationship is universally accepted to be a valid element, the large-scale implementation of such regionalization of surgeries to high-volume providers remains a matter of much debate. Due to the nature of the US healthcare system, such large-scale 'regionalization' may have several implications. Firstly, while regionalization aims to promote the quality-of-care, it may have an unintended effect of the introduction of socio-economic and racial disparities in the health-care system. For instance, Schoenfeld et al. observed that African Americans and Hispanics were less likely to be treated by a high-volume provider as compared to White individuals.²¹ This observation has also been compounded by similar findings in other specialties as well.²² High-volume surgeons would probably be located in specific large tertiary care academic medical center that would act as major referral hubs for cases from surrounding areas. Patient would ultimately need to travel to these tertiary care centers, in order to get appropriate surgical care. This would indirectly influence the financial burden (gasoline, hotel, parking costs etc.) and time burden (time spent travelling and days off work) on patients, and may serve as potential barrier to accessing surgical care. Indeed, in a recent SEER-Medicare study based on complex cancer surgeries, researchers noted that patients living furthest away from the index hospital (where they received the surgery) had higher readmission rates and emergency department visits, suggesting that the travel distance may be a potential barrier to post-operative care at office visits.²³

While regionalization promotes the quality-of-care through provision of services through high-volume providers, it may have deleterious effects on low-volume surgeons. As cases get referred to high-volume providers for management, it is plausible that low-volume providers begin to have even poorer outcomes, due to deterioration in skill over time. For high-volume surgeons, regionalization may restrict them to doing the same type of surgeries (lumbar/cervical fusions) due to high caseload. Due to the limited diversity of procedures and longer work-hours to meet the increased caseload, these high-volume surgeons may be at a higher risk of burnout. This can affect the overall number of orthopaedic residents choosing spine surgery as sub-specialty and subsequently decrease the spine surgery work-force.

If regionalization is indeed to become a national policy, health-policy makers need to understand the negative downstream consequences that it may have on the current health-care system before sweeping changes in health-care systems can be set into motion.

Disclosures

The authors report no proprietary or commercial interest in any product mentioned or concept discussed in this article.

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