Eligibility of Outpatient Spine Surgery Candidates in a Single Private Practice

Kingsley R. Chin, MD,† Fabio J.R. Pencle, MBBS,† André V. Coombs, MBBS,‡ Corrine F. Packer, MBBS,‡ Elijah A. Hothem, MD,‡ and Jason A. Seale, MBBS†*

Study Design: Level III.

Purpose: To retrospectively review the eligibility of surgical patients meeting predetermined outpatient surgery criteria in a single-surgeon private practice.

Summary of Background Data: There is a burgeoning awareness among patients, surgeons, and insurers of the cost benefits and safety of outpatient spine surgeries. At the end of 2014, Centers for Medicare & Medicaid Services have released its final 2015 payment rules and codes for spinal decompression and fusion. This move confirms the safety of procedures being performed in the ambulatory surgery centers (ASCs).

Methods: We conducted a database review between 2008 and 2014 and identified 1625 orthopedic procedures. All nonsurgical spine procedures were excluded from the study. Eligibility for outpatient spine surgery was based on criteria generated from a combination of published standard of care for major operations and the chief surgeon's experience. A matched cohort based on type of surgery in each facility of all spine surgery patients was created, group 1 (hospital patients) and group 2 (ASC patients).

Results: A total of 708 patients underwent spinal surgery during this time period with a 53% female population. A total of 557 of 708 (79%) patients were eligible for outpatient spine surgery. There were 210 surgical procedures in group 1 (inpatient) comprised of 72 decompression and 138 fusion procedures. In group 2 (outpatient), there were 347 procedures made up of 150 patients undergoing decompression and 197 undergoing fusion or disc replacement. To confirm that hospital procedures are eligible to be performed in the ASC, the χ^2 test was performed. We found that ASC-eligible hospital patients can indeed be done in an ASC ($P = 0.037$).

Conclusions: Outpatient spine surgery is feasible in 79% of patients in this single-surgeon private practice. On the basis of these results, a majority of spine procedures can be performed in an outpatient setting following our eligibility criteria.

Key Words: eligibility, spine surgery, outpatient, ambulatory surgery center, surgical candidates

(*Clin Spine Surg* 2016;00:000–000)

There has been a surge in the desire for safer, faster, and more affordable health care within recent times and with the imminent transformation of the health care system in the United States, this trend is expected to increase exponentially. The role of ambulatory surgery centers (ASCs) in satisfying both surgical and patient-reported outcomes has been well established in many surgical specialties[1–5] and as such, ASCs are increasing in popularity among patients as well as insurers with the anticipation of these benefits. ASCs account for the fastest growing type of hospital-owned and/or physician-owned facility that participates in Medicare. In 2008, over 3 million Medicare beneficiaries relied on approximately 5200 ASCs across the United States for surgical procedures.[6] There have been updates by the Center for Medicare & Medicaid Services with regards to billing codes, fee structure, and payments to be made to ASCs as it relates to spine surgery.[7]

There are currently in excess of 5000 ASCs in operation in the United States.[8] Advantages and disadvantages of both ASCs and hospital-based spine surgery have been compared and contrasted in the literature.[9,10] Studies examining the prevalence of indications and contraindications for spinal surgery procedures have been reported[11,12]; however, the authors found no studies, which specifically investigated the eligibility of surgical candidates for outpatient spine surgery in general. The focus of this paper was therefore, to examine the potential candidacy of all patients within a single private practice, who met basic criteria for ambulatory spinal surgery.

METHODS

We reviewed the database of a single spine surgeon in private practice between 2008 and 2014 and identified 1625 spinal procedures. Procedures also done during this period, which were not considered for this study included, shoulder and knee arthroscopies, carpal tunnel release, and lipoma excisions. The primary aim was to determine

Received for publication April 29, 2015; accepted February 16, 2016.
From the *Herbert Wertheim College of Medicine at Florida International University and Charles E. Schmidt College of Medicine at Florida Atlantic University; †Less Exposure Surgery Specialists Institute (LESS Institute); and ‡Less Exposure Surgery Society (LES Society).
The authors did not seek or receive any funding from the National Institutes of Health (NIH), Wellcome Trust, Howard Hughes Medical Institute (HHMI), or others for this work.

K.R.C. is a shareholder in and receives other benefits from SpineFrontier Inc. The remaining authors declare no conflict of interest.
Reprints: Kingsley R. Chin, MD, Professor of Clinical Orthopedics, Less Exposure Surgery Specialists Institute (LESS Institute), 1100 W. Oakland Park Blvd. Suite #3, Fort Lauderdale, FL 33311 (e-mail: kingsleychin@thelessinstitute.com).

the proportion of cases within this practice, which would be suitable candidates to have had spine surgery performed in an ASC. Our secondary goal was to provide a list of basic general criteria, which can serve as a guide for surgeons considering outpatient surgery in selected cases based on our 6-year experience with both minor and major outpatient spine procedures.

All appropriate preoperative evaluations were conducted including history and physical examinations, plain radiographs, and magnetic resonance imaging, by the attending spine surgeon. A minimum of 6 months of conservative therapy was completed before consideration for surgery in all patients, except in cases of acute disc herniation in which case 6 weeks of nonoperative therapy was offered. Nonoperative therapy included anti-inflammatory medications, physical therapy, therapeutic steroid injections, and for patients with suspected facet-mediated axial back pain, radiofrequency rhizotomies. All patients were medically cleared by their family practitioner and/or specialist where applicable and regarded fit for surgery by the anesthesiologists.

A matched cohort based on type of surgery in each facility of all spine surgery patients was created, group 1 (hospital patients) and group 2 (ASC patients). Analysis was performed on the patients eligible for surgery using SPSS version 22 (IBM Corp., New York, NY). The χ^2 test was used to calculate significance which accepts or rejects the null hypothesis. If $P < 0.05$, the null hypothesis is accepted.

Exclusions

We excluded from our analysis, all cervical and lumbar epidural steroid injections as well as discograms, rhizotomies, and nonspine orthopedic procedures (total 917), which were considered minimally invasive nonsurgical spinal procedures. There were 708 combined cervical and lumbar procedures remaining.

Inclusions

The eligibility of outpatient surgery candidates was defined as the proportion of all patients in this private practice who met inclusion criteria list 1 for outpatient surgery and was calculated as a percentage (Table 1).

List 1

Inclusion criteria for outpatient spine surgery used in this study is the following.

(1) Patient must be living or staying within 30 minutes of a hospital.[13]
(2) BMI $\leq$ 42.[13,14]
(3) All patients with chronic medical illnesses must be stable and be cleared by their family practitioner and/or specialist where applicable.[13,15]
(4) Patients with a history of heart disease must be cleared through cardiologist evaluation including echocardiogram and/or stress test.[13,15]
(5) Patients must have a responsible adult living with, or staying with them, who is available to provide basic care and supervision for at least 24 hours after surgery.[13]
(6) Low to moderate anesthesia risks (ASA criteria 1–3).[13,16]

RESULTS

The study data revealed that of the 708 total spine surgery cases, 361 (51%) of all spine surgeries were performed in group 1 (hospital setting) and 347 (49%) in group 2 (ASC) (Fig. 1). Females represented 53% of the overall patient population. Mean BMI overall was 27.9 ± 0.3; hospital patients' mean BMI was 27.7 ± 0.3; and ASC patients' 28.5 ± 0.5, $P > 0.05$. The mean age of hospital patients was 57.0 ± 1.1 versus a mean age of 45.5 ± 0.8 in the ASC population, $P > 0.05$.

There were 557 of 708 (79%) patients that were eligible for surgery in ASC using our outpatient criteria. A total of 151 hospital patients were not deemed eligible for spine surgery at the ASC and are summarized in Table 2. There were 210 surgical procedures in group 1 (inpatient) that comprised of 72 decompression and 138 fusion procedures. In group 2 (outpatient) there were 347 procedures made up of 150 patients undergoing decompression and 197 undergoing fusion or disc replacement (Table 3). To confirm the hospital procedures eligibility to be performed in the ASC, the χ^2 test was performed. The null hypothesis stating the procedures performed that fit the criteria outlined are independent of setting therefore can be done in the ASC. Using a 2×2 contingency

TABLE 1. Eligibility of Instrumented and Noninstrumented Cervical and Lumbar Spine Procedures Eligible for Outpatient Surgery

Surgery	Total Number in Private Practice	Total Cases Eligible to be Done in ASC	Eligibility of Outpatient Candidates (%)
ACD	66	57	88
ACDF	192	153	80
Posterior cervical decompressions	4	0	0
Cervical TDR	39	39	100
Thoracic fusions	5	0	0
Lumbar decompressions	192	165	85
PLIF/TLIF, LLIF	210	143	68
Procedure Total	708	557	79

ACD indicates anterior cervical decompression; ACDF, anterior cervical decompression and fusion; ASC, ambulatory surgery center; LLIF, lateral lumbar interbody fusion; PLIF, posterior lumbar interbody fusion; TDR, total disc replacement; TLIF, transforaminal lumbar interbody fusion.

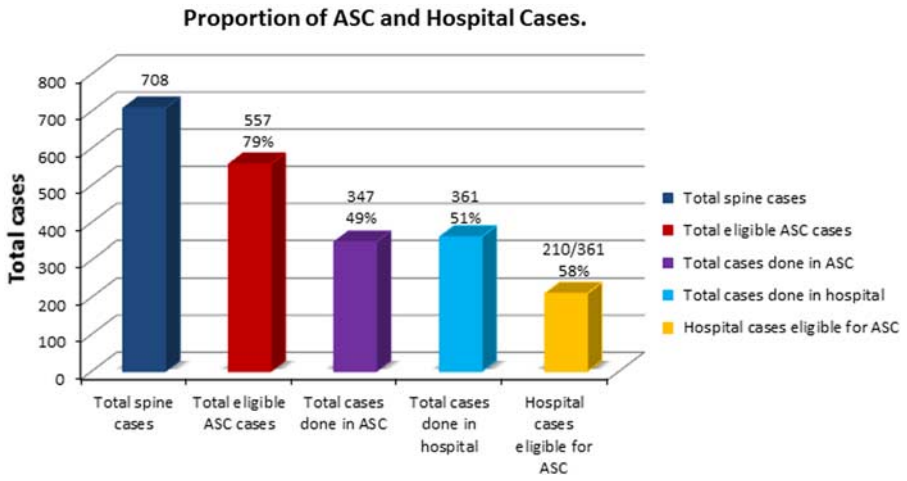

FIGURE 1. Proportions of ambulatory surgery center (ASC) and hospital cases done in this spine practice. full color online

table (Table 3), we found that ASC-eligible hospital patients can indeed be performed in an ASC ($P = 0.037$). The eligibility of cases performed in the hospital setting using the criteria is 58% (210/361) and summarized in Table 4. The surgeries performed in the ASC included anterior cervical decompression, anterior cervical decompression and fusion (ACDF), cervical total disc replacement, lumbar decompression, and lumbar fusion are summarized in Table 5.

Figures 2A, 2B, 3A, and 3B illustrate typical single-level ACDF cases done in the hospital and ASC, respectively.

Of all the 1-level procedures done, 92% (420/455) were eligible for surgery in the ASC. Of all the 2-level procedures, 84% (137/164) were surgical candidates for outpatient surgery.

TABLE 2. Summary of Cases Deemed Ineligible for Outpatient Spine Surgery

Excluded	Total (n)
Cervical	
BMI > 42	0
> 2-level ACDF	19
> 2-level ACD	6
Laminoplasty	4
H/o cancer, spinal infections, congenital diseases, major acute trauma, major deformities, PE	23
Total cervical	52
Thoracic	
Thoracic fusions	5
Lumbar	
BMI > 42	3
> 2-level lumbar fusion	20
> 2-level lumbar decompression	17
H/o cancer, spinal infections, congenital diseases, major acute trauma, major deformities, PE	54
Total lumbar	94
Total	151

ACD indicates anterior cervical decompression; ACDF, anterior cervical decompression and fusion; BMI, body mass index; PE, pulmonary embolism.

Revision surgery was performed in 97/708 patients (14%) of the overall patient population. Of these, 19 were cervical (20%) and 78 lumbar (80%). The main reasons for reoperation included adjacent segment disease which occurred both in the cervical and lumbar spine, as well as intractable pain, pain after lumbar decompression only, pseudarthrosis, and migration of interbody cage causing radiculopathy. The numbers of cases are summarized in Figure 4. One inpatient had urgent revision after cauda equina syndrome confirmed on computed tomography and magnetic resonance imaging. Significantly more revisions were performed for hospital patients, $P = 0.044$. Using our selection criteria for surgery in the ASC, 60 (62%) of these inpatient revision procedures could have been done in the ASC.

The overall complication rate was 35/708 (5%). Major complications included dysphagia 5/35 (13%), motor weakness grade 5−/5, and dermatome numbness after cervical spine surgery compared with lumbar spine surgery which included dermatome numbness 17/35 (49%), inability to walk, urinary retention, and motor weakness grade 4+/5. The numbers of cases are summarized in Figure 4. There was no intergroup significance in complications, $P = 0.704$. Postoperative emergency room visits were not common among our patients operated on in the ambulatory setting, 14/347 (4%) which included dysphagia, weakness, dermatome numbness, and urinary retention.

TABLE 3. Summary of Eligible Cases Based on Procedure and Setting

	Procedure		
Location	Decompression	Fusion	Total
Setting			
Hospital (inpatient)	72	138	210
ASC (outpatient)	150	197	347
Total	222	335	557

ASC indicates ambulatory surgery center.

TABLE 4. Hospital Cases Eligible for ASC

Surgery	Cases
ACD	12
ACDF	64
Lumbar decompressions	60
Lumbar Fusions (PLIF/TLIF, LLIF)	74
Procedure total	**210**

ACD indicates anterior cervical decompression; ACDF, anterior cervical decompression and fusion; ASC, ambulatory surgery center; LLIF, lateral lumbar interbody fusion; PLIF, posterior lumbar interbody fusion; TLIF, transforaminal lumbar interbody fusion.

A summary of cases eligible for outpatient spine surgery and actual cases performed in ASC are depicted (Figs. 5, 6).

DISCUSSION

The growing interest in outpatient spine surgery among health care seekers, providers, and insurers has presented a need for more research into the feasibility of performing everyday spine surgery in an ambulatory setting. The literature is replete with data on the epidemiology and outcomes of every spine operation in a hospital-based setting,[17–21] however, very little is shown about the eligibility of surgical candidates for whom an outpatient procedure can be offered. The significance of our paper is to provide the literature with a glimpse of the eligibility of patients in a typical spine surgery private practice who meet basic criteria for which outpatient spine surgery can be a safe and viable option.

Discussion of Results

This study based on eligibility criteria outlined has demonstrated that 79% of spine surgery patients can have their procedures in the ambulatory setting. Cases included single and 2-level procedures in the cervical and lumbar spine.

Lumbar surgeries had the highest number of excluded patients, 94/151(62%) and thus represent the greatest opportunity to increase outpatient surgery candidacy by changing techniques or criteria to be safer. For example, we propose weight reduction before surgery, limiting surgery by treating the worst clinical level(s) first in patients with >2 level disease as 1 possible option.

TABLE 5. Proportion of Cases Done in ASC of All Eligible Cases

Surgery	Total Cases Eligible	Total Cases Done in ASC
ACD	57	45
ACDF	153	89
Cervical TDR	39	39
Lumbar decompressions	165	105
PLIF/TLIF, LLIF	143	69
Procedure Total	**557**	**347**

ACD indicates anterior cervical decompression; ACDF, anterior cervical decompression and fusion; ASC, ambulatory surgery center; LLIF, lateral lumbar interbody fusion; PLIF, posterior lumbar interbody fusion; TDR, total disc replacement; TLIF, transforaminal lumbar interbody fusion.

As our current data reveal, in the absence of BMI > 42, major trauma, deformity, infection, and malignancy, all patients who underwent single and 2-level cervical and lumbar procedures fulfilled criteria for outpatient surgery. We limited our fusion surgeries to no more than 2 levels in the ASC. Three or more level cervical and lumbar fusion surgeries involve the increased risk of a prolonged operation, increased blood loss, complications, postoperative pain, and dysphagia which should be done in the hospital setting.

Less invasive procedures and improved anesthesia techniques have enabled the expansion of spine surgery into the outpatient setting.[22–24] The authors used a more personalized perioperative care plan, with an emphasis on reducing risks commonly seen in the hospital setting, including exposure to nosocomial infections and iatrogenic complications from medical errors.[1,2,25] Eliminating these risks became easier to accomplish through adherence to the outlined outpatient criteria as well as the ability for the surgeon to choose a consistent surgical team in the ASC. Although age was not a factor considered in our preoperative selection criteria for ambulatory surgery, based on the results of this retrospective review, we do not recommend any patient over the age of 80 to be considered for outpatient spine surgery, as we do not have data to support that it has and can be done safely in this setting.

Unfortunately, the most strict selection criteria and a consistent operating team cannot eliminate all risk associated with spine surgery in an outpatient setting, thus, additional precautions were implemented to maximize patient safety and comfort. All outpatients should be discharged from the recovery room with a responsible adult to drive them home only after they were deemed to be fully alert by an experienced registered nurse and the attending anesthesiologists and were neurologically intact by the attending spine surgeon. Patients are evaluated in the recovery room for 1½–2 hours before being discharged. If additional monitoring is required, overnight observation at a skilled nursing facility is used for more frequent assessments and administration of medication. Patients were offered additional monitoring if they had no relative available, patient preference, if they were the last case on list, and lived >30 minutes from the ambulatory center or nearest hospital, or at the discretion of the surgeon and the anesthetist. The benefits included decreased cost for overnight hospital stay and decreased risk of nosocomial infections. Transfer agreements should be in place between the ASC and with neighboring hospitals within 30 minutes, for hospital admission if patients developed any serious problems. A Penrose drain was used for all outpatient cervical cases, however, no lumbar drains were used. Drains were then removed within 24 hours postoperatively under aseptic conditions and steristrips applied. Oral analgesics are provided to each

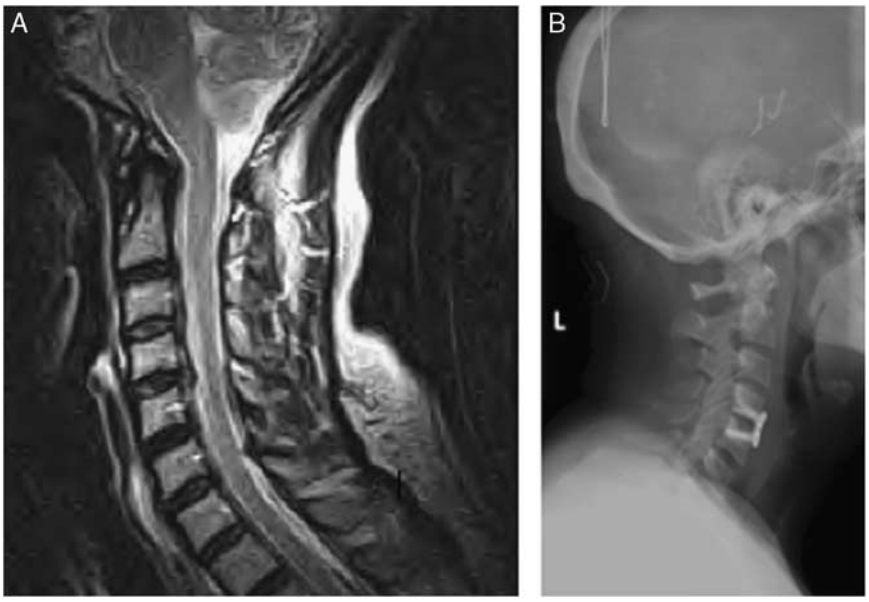

FIGURE 2. A and B, C4–C5 anterior cervical decompression and fusion (ACDF) done in the hospital setting. A, Preoperative magnetic resonance imaging (sagittal view) showing herniated C4–C5 disc. B, Two-week postoperative plain radiograph (lateral view).

patient postoperatively based on weight. For lumbar surgeries patients also receive a lumbar brace as most pain is experienced while moving from the sitting to standing position, there is, however, controversy on the effectiveness of postoperative bracing.[26] The less invasive approach to surgeries, however, decreases overall postoperative pain[13] although no direct correlation study has been performed to confirm these findings.[27] A postoperative instruction guide should be provided to all patients. In addition, a routine follow-up protocol was implemented. The authors consistently followed this protocol for all outpatients.[13]

Follow-up

(1) Patients were instructed on postoperative protocol (Summary 1).
(2) Patients were called the night of surgery after being discharged and again the morning after surgery.
(3) The first clinic follow-up visit was at 1–2 weeks postoperatively. Follow-up continued at 6 weeks, 3, 6, and 12 months.

Summary 1

(1) Most incisions are closed with subcuticular sutures that will dissolve on the own.

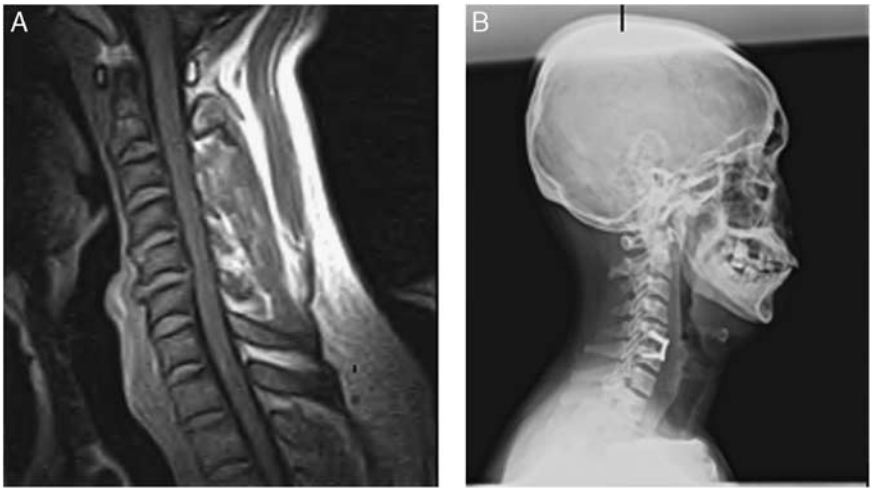

FIGURE 3. A and B, C5–C6 anterior cervical decompression and fusion (ACDF) done in the ambulatory surgery center. A, Preoperative magnetic resonance imaging (sagittal view). B, Two-week postoperative plain radiograph (lateral view).

Revision	Cervical		Lumbar	
	Hospital	Outpatient	Hospital	Outpatient
ASD	12	2	34	5
Intractable Pain	5	0	9	2
Pseudarthrosis	0	0	2	0
Migration of Interbody	0	0	5	0
Pain after simple decompression	0	0	20	0
Cauda Equina syndrome	0	0	1	0
Total	17	2	71	7
Complications				
Dysphagia	3	2	0	0
Motor weakness	2	0	3	2
Dermatome numbness	2	1	10	7
Urinary Retention	0	0	0	2
Inability to walk	0	0	1	0
Total	7	3	14	11

FIGURE 4. Summary table of revisions and complications. ASD indicates adjacent segment disease.

(2) Cover area to avoid getting incision wet for 2–3 days.
(3) While showering avoid allowing water to hit incision directly, apply water-resistant bandage.
(4) Cover the incision with dry sterile gauze dressing daily and cover with paper tape, until advised at first postoperative appointment.
(5) Call if concerned with wound. Pain, reddened, increased drainage.
(6) Steri-strips fall off in 10–12 days
(7) Monitor temperature daily. Fever $>101.5 \geq$ F, please call.
(8) Pain is expected after surgery. If pain is not relieved by pain medications or getting progressively worse, call office to let us know. Weakness and tingling in extremities can be part of healing process especially after surgery.

To our knowledge, we have provided the first study of a spine surgeon's private practice database, identifying a 79% eligibility of surgical candidacy for outpatient surgeries based on our basic outpatient criteria. The transition from inpatient to outpatient surgery is based on several factors; inclusive of surgeon experience, patient selection, and type of practice (private vs. academic tertiary referral). The academic tertiary referral center consists of an amalgamation of multidisciplinary clinics, clinical services with a large support staff, and operating rooms, in a single setting. There is a deconstruction of this in the private setting, with surgeons' clinics separated

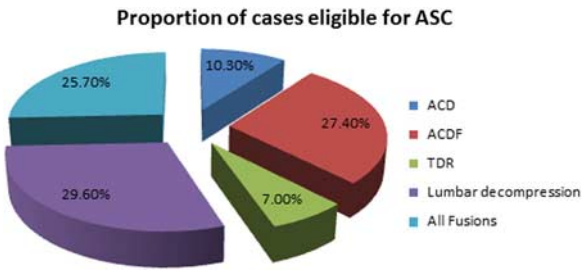

FIGURE 5. Proportions of cases eligible for ambulatory surgery center (ASC). full color online

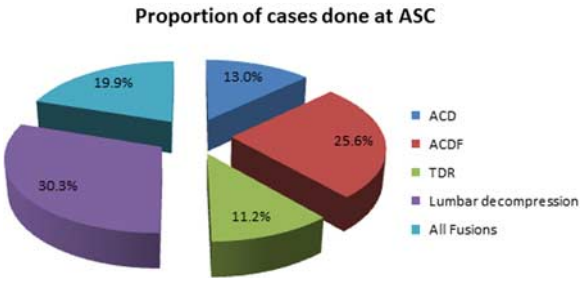

FIGURE 6. Proportions of cases done at the ambulatory surgery center (ASC). full color online

from the freestanding ASCs. The application of these basic criteria can therefore be easily translated to the academic tertiary referral center. A study by Lang et al[28] demonstrated the use of a protocol for transitioning from the overnight hospital admission to the outpatient setting in a tertiary institute decreasing overall admission rates. There are no direct comparison studies assessing type of facility with outcomes for both the private and tertiary setting. However, facilities that are accredited demonstrate a direct correlation with improved outcomes and a high level of accreditation.[29]

CONCLUSIONS

Our investigation of this single-surgeon practice revealed that 79% of all spine surgeries fit our criteria for the ASC. Confirmation of hospital patients that were eligible for the ASC has been shown with significance based on the χ^2 test. Only 4% of ASC patients visited an emergency room within 48 hours for additional treatment. We propose with strict inclusion criteria and less invasive techniques the vast majority of elective spine surgeries could be safely done in an outpatient surgery center. With improvements in technologies, less invasive techniques, long-acting pain medications, meticulous anesthesia management, and strict postoperative follow-up, we project that the percentage of outpatient spine surgery candidates should be over 90%. Although these results are in no way representative of all spine surgery practices, it is desired that this paper may provide a guide for surgeons seeking to make the transition to an ASC safely, based on a consistent assessment of their own practice.

REFERENCES

1. Koenig L, Gu Q. Growth of ambulatory surgical centers, surgery volume, and savings to medicare. *Am J Gastroenterol*. 2013;108: 10–15.
2. Hollenbeck BK, Hollingsworth JM, Dunn RL, et al. Ambulatory surgery center market share and rates of outpatient surgery in the elderly. *Surg Innov*. 2010;17:340–345.
3. Pugely AJ, Martin CT, Gao Y, et al. Outpatient surgery reduces short-term complications in lumbar discectomy: an analysis of 4310 patients from the ACS-NSQIP database. *Spine (Phila Pa 1976)*. 2013;38:264–271.
4. Billing PS, Crouthamel MR, Oling S, et al. Outpatient laparoscopic sleeve gastrectomy in a free-standing ambulatory surgery center: first 250 cases. *Surg Obes Relat Dis*. 2014;10:101–105.
5. Clark N, Schneider DF, Vrabec S, et al. Increased efficiency of endocrine procedures performed in an ambulatory operating room. *J Surg Res*. 2013;184:200–203.
6. Medicare Fee for Service Payment: ASC Payment. https://www cmsgov/Medicare/Medicare-Fee-for-Service-Payment/ASCPayment/Downloads/C_ASC_RTC-2011pdf, 2011.
7. Medicares 2015. Final Rule Released. http://wwwascassociationorg/asca/aboutus/latestnews/newsarchive/2014/october/medicares2015finalrulereleased, 2014.
8. Manchikanti L, Parr AT, Singh V, et al. Ambulatory surgery centers and interventional techniques: a look at long-term survival. *Pain Physician*. 2011;14:E177–E215.
9. Goz V, Koehler SM, Egorova NN, et al. Kyphoplasty and vertebroplasty: trends in use in ambulatory and inpatient settings. *Spine J*. 2011;11:737–744.
10. Walid MS, Robinson JS 3rd, Robinson ER, et al. Comparison of outpatient and inpatient spine surgery patients with regards to obesity, comorbidities and readmission for infection. *J Clin Neurosci*. 2010;17:1497–1498.
11. Auerbach JD, Jones KJ, Fras CI, et al. The prevalence of indications and contraindications to cervical total disc replacement. *Spine J*. 2008;8:711–716.
12. Chin KR. Epidemiology of indications and contraindications to total disc replacement in an academic practice. *Spine J*. 2007;7: 392–398.
13. Chin KR, Coombs AV, Seale JA. Feasibility and patient-reported outcomes after outpatient single-level instrumented posterior lumbar interbody fusion in a surgery center: preliminary results in 16 patients. *Spine (Phila Pa 1976)*. 2015;40:E36–E42.
14. Hofer RE, Kai T, Decker PA, et al. Obesity as a risk factor for unanticipated admissions after ambulatory surgery. *Mayo Clin Proc*. 2008;83:908–916.
15. Fleisher LA, Fleischmann KE, Auerbach AD, et al. 2014 ACC/AHA guideline on perioperative cardiovascular evaluation and management of patients undergoing noncardiac surgery: a report of the American College of Cardiology/American Heart Association Task Force on practice guidelines. *J Am Coll Cardiol*. 2014;64: e77–e137.
16. Fu KM, Smith JS, Polly DW Jr, et al. Correlation of higher preoperative American Society of Anesthesiology grade and increased morbidity and mortality rates in patients undergoing spine surgery. *J Neurosurg Spine*. 2011;14:470–474.
17. Powell ET, Krengel WF 3rd, King HA, et al. Comparison of same-day sequential anterior and posterior spinal fusion with delayed two-stage anterior and posterior spinal fusion. *Spine (Phila Pa 1976)*. 1994;19:1256–1259.
18. Haher TR, Merola A, Zipnick RI, et al. Meta-analysis of surgical outcome in adolescent idiopathic scoliosis. A 35-year English literature review of 11,000 patients. *Spine (Phila Pa 1976)*. 1995;20: 1575–1584.
19. Rosenfeld HE, Limb R, Chan P, et al. Challenges in the surgical management of spine trauma in the morbidly obese patient: a case series. *J Neurosurg Spine*. 2013;19:101–109.
20. Nuno M, Drazin DG, Acosta FL Jr. Differences in treatments and outcomes for idiopathic scoliosis patients treated in the United States from 1998 to 2007: impact of socioeconomic variables and ethnicity. *Spine J*. 2013;13:116–123.
21. Nandyala SV, Marquez-Lara A, Fineberg SJ, et al. Comparison between cervical total disc replacement and anterior cervical discectomy and fusion of 1 to 2 levels from 2002 to 2009. *Spine (Phila Pa 1976)*. 2014;39:53–57.
22. Slucky AV, Brodke DS, Bachus KN, et al. Less invasive posterior fixation method following transforaminal lumbar interbody fusion: a biomechanical analysis. *Spine J*. 2006;6:78–85.
23. You R-j, Zheng W-z, Chen K, et al. Long-term effectiveness of total hip replacement with the collum femoris preserving prosthesis. *Cell Biochem Biophys*. 2014;72:43–47.
24. Aichmair A, Lykissas MG, Girardi FP, et al. An institutional six-year trend analysis of the neurological outcome after lateral lumbar interbody fusion: a 6-year trend analysis of a single institution. *Spine (Phila Pa 1976)*. 2013;38:E1483–E1490.
25. Mulloy D, Hughes R. Wrong-Site Surgery: A Preventable Medical Error. In: Hughes R, ed. *Patient Safety and Quality: An Evidence-Based Handbook for Nurses*. Rockville, (MD), (US): Agency for Healthcare Research and Quality; 2008:381–395.
26. Jegede KA, Miller CP, Bible JE, et al. The effects of three different types of orthoses on the range of motion of the lumbar spine during 15 activities of daily living. *Spine (Phila Pa 1976)*. 2011;36: 2346–2353.
27. Spoor AB, Oner FC. Minimally invasive spine surgery in chronic low back pain patients. *J Neurosurg Sci*. 2013;57:203–218.
28. Lang SS, Chen HI, Koch MJ, et al. Development of an outpatient protocol for lumbar discectomy: our institutional experience. *World Neurosurg*. 2014;82:897–901.
29. Alkhenizan A, Shaw C. Impact of accreditation on the quality of healthcare services: a systematic review of the literature. *Ann Saudi Med*. 2011;31:407–416.