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Canadian Spine Society

15th Annual Scientific Conference

Halifax Marriott Harbourfront Hotel

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Abstracts

Accreditation

This event is an accredited group learning activity (Section 1) as defined by the Maintenance of Certification Program of the Royal College of Physicians and Surgeons of Canada, approved by the Canadian Orthopaedic Association.

Course objectives

The annual scientific conference of the Canadian Spine Society provides a comprehensive perspective on the state of spine care in Canada. It includes presentations on both adult and pediatric spinal issues and highlights recent advances in both surgical and non-operative treatment. Symposia on diagnosis and management of metastatic disease of the spine, cervical spine fixation in the pediatric patient and on both techniques and evidence for non-operative invasive interventions such as facet ablation or epidural steroids.

01.1.1: Surgery versus standardized nonoperative care for the treatment of lumbar disc herniations: a Canadian trial. ***Chris Bailey,*[*†] *Stewart Bailey,*[*†] *Patricia Rosas-Arellano,*[*†] *Shauna Dehens,*[*†] *Keith Sequeira,*[†‡] *Tom Miller,*[†‡] *Jim Watson,*[†‡] *Fawaz Siddiqi,*[*†] *Kevin Gurr,*[*†] *Jennifer Urquhart.*[*†] **From [*]London Health Sciences Centre, London, Ont., [†]Western University, London, Ont., [‡]St. Joseph's Health Care, London, Ont.**

Background: The beneficial treatment effect surgery demonstrates over conservative care for radiculopathy secondary to acute lumbar disc herniation (LDH), occurs in the first 3 to 6 months; thereafter outcomes are recognized to be similar. This is not surprising given the favourable natural history; 90% will experience gradual resolution of their symptoms within 4 months. In Canada, owing to the inherent wait time to see a surgeon and the referring physician's expectation that most patients will improve without surgery, symptomatic patients presenting to surgeons are often the 10% that have remained symptomatic longer than the expected 4 months. The purpose is to determine whether surgery is superior to conservative care in a patient population that has had persistent symptoms for more than 4 months, and therefore create a study population which is generalizable to the Canadian health care experience. **Methods:** This single blinded (assessor) RCT enrolled 18- to 60-year-old patients with a unilateral, single radiculopathy from a posterolateral L4–5 or L5-S1 disc herniation. Radiculopathy duration was longer than 4 months but less than 12 months. Patients on a waiting list to see surgeons at 1 academic hospital centre were randomized to early microdiscectomy or standardized nonoperative care, including medications, education, physiotherapy and steroid injections. Patients were excluded if they had previously received these conservative modalities. The primary outcome was intensity of sciatica (scale 0–10) measured at 6 months following randomization. Secondary outcome measures included back pain, Oswestry Disability Index (ODI), SF-36, work status and satisfaction. **Results:** This interim analysis reports on 40 nonoperative and 39 surgical patients. No difference existed between their demographic or preoperative data. At 6 months follow-up 32 of 39 surgical patients and 36 of 40 nonoperative patients had data available. Treatment effect for all outcome measures favoured surgery for the intent-to-treat, as-treat and last-value carried forward analysis ($p < 0.05$). To date 13 of 40 nonoperative patients have undergone microdiscectomy (performed after the primary outcome measure of 6 mo); they have had persistent inferior scores than early surgical patients ($p < 0.05$). **Conclusion:** At the interim analysis microdiscectomy is superior to nonoperative care for patients presenting with sciatica secondary to LDH. This study will continue to confirm robustness and validity of results.

02.1.1: Wait times for elective spine surgery across Canada: data from the Canadian Spine Outcomes and Research Network. ***Alexandra Stratton,*[*] *Ken Thomas,*[*] *Greg McIntosh,*[†] *Lauren Hirsch.*[*] **From [*]University of Calgary, Calgary, Alta., the [†]Canadian Spine Outcomes and Research Network.**

Background: Wait time data from the CSS registry were obtained on patients with lumbar radiculopathy or neurogenic claudication at participating sites across Canada. The objectives were to 1) determine the national median for wait times for elective spine surgery, 2) determine the most lengthy wait time, 3) compare individual sites' wait times to the national median and 4) investigate wait times in relation to motor deficit. **Methods:** Wait time data collected between October 2008 and October 2014 ($n = 631$) from 11 participating sites were used to determine the national median. Eight sites with more than 10 patients were used to compare 4 wait time periods: time between initial referral and first appointment with a spine surgeon (T1), time between first appointment with a spine surgeon and date of surgical booking (T2), time between surgical booking and surgery date (T3), and total wait time. **Results:** The median national wait time in days was 56 for T1, 1 for T2, and 54 for T3, with a total median wait time of 213 days. Comparison of individual sites' median wait times to the national median revealed the following: for T1 and T2, 1 site was below and 4 were above the national median; and for T3, 1 site was below and 5 were above the national median. The median wait times in days of patients with motor deficit were 33.5 days for T1, 0 for T2, 30 for T3 and total 114 days, all significantly shorter than the national medians for patients without motor deficits ($p < 0.01$). **Conclusion:** The time from first appointment with a spine surgeon to the date of surgical booking (T2) is where spine surgery candidates spend the least time. There is considerable regional variation for all waiting periods. Those with a motor deficit have significantly shorter wait times than the national mean, suggesting that these patients may be given relative priority.

03.1.1: Presurgical physician utilization in elective thoracolumbar spine surgery candidates: a nationwide analysis from the CSORN database. ***Neil Manson,*[*†] *Edward Abraham,*[*†] *Alana Green,*[*†] *Greg McIntosh.*[‡] **From [*]Canada East Spine Centre, Horizon Health Network, Saint John, N.B., [†]Dalhousie Medicine New Brunswick, Saint John, N.B., [‡]Canadian Spine Outcomes and Research Network.**

Background: Our objective was to assess the frequency of physician utilization in spine surgery candidates in the 6 months before surgical booking, and present differences by region. **Methods:** We conducted a retrospective analysis of prospectively collected data from the Canadian Spine Outcomes and Research Network (CSORN). Twelve spine surgery sites across Canada contributed data for spine surgery candidates from 2008 to 2014. Patients ($n = 537$) had degenerative spinal pathology or deformity of the thoracolumbar region. Frequencies of physician visits (excluding the attending spine surgeon) were tabulated to estimate some of the

health care utilization consumed by spine surgery candidates before surgeon consultation. **Results:** Patients reported 1–2 physician visits 572 times, 3–10 visits 366 times, and 10 or more visits 81 times. This equals at least 2561 visits, and a conservative maximum (if > 10 = 11) of 5695 visits. Not surprisingly, family doctors accounted for the most visits and naturopaths the fewest. Consultations with another spine surgeon represented the second-highest utilization; this "doctor shopping" was most prevalent in Ontario ($p < 0.05$). Analysis by region revealed twice as many emergency department visits in Saint John as in Vancouver. Saint John and Vancouver had significantly fewer pain management visits than other sites, and Quebec had significantly fewer family doctor visits ($p < 0.05$). For patient-reported disability (Oswestry Disability Index; ODI), patients who never saw an emergency physician reported significantly less disability than those who saw an emergency physician ($p < 0.05$). There were no differences in baseline ODI for other spine surgeon, rheumatologist, family doctor, naturopath or "other." Patients who never saw a pain management specialist reported significantly less disability than those who saw one more than 10 times ($p < 0.05$). There were no differences in baseline pain ratings or health score for those who went to another physician, with the exception of family doctors; those with more than 10 visits had higher baseline leg pain and lower health scores ($p < 0.05$). **Conclusion:** Given the similarities in baseline characteristics pertaining to pain, disability and health state in this study, spine patient utilization of physician resources is high and variable. A focused strategy to provide appropriate, targeted care to spine patients is needed across Canada. Future research should investigate the impact of spine triage systems on decreasing the number of visits to other physicians.

04.1.2: Activities performed and treatments conducted prior to consultation with a spine surgeon: Are patients and clinicians following evidence-based clinical practice guidelines? ***Elliot Layne,*[*] *Darren Roffey,*[*†] *Courtney Wilson,*[*] *Stephen Kingwell,*[*‡] *Eugene Wai.*[†‡] **From [*]University of Ottawa Spine Program, the Ottawa Hospital, Ottawa, Ont., [†]Clinical Epidemiology Program, Ottawa Hospital Research Institute, Ottawa, Ont., the [‡]Division of Orthopaedic Surgery, University of Ottawa, Ottawa, Ont.**

Background: Clinical practice guidelines (CPGs) are designed to ensure that evidence-based care is easily put into action. Whether patients and clinicians follow these guidelines is equivocal. What is clear is a) Canadian spine surgeons receive a large amount of referrals, and b) there is no indication to suggest patients are adequately undertaking conservative treatments that can manage — or diminish — their conditions. We examined how many patients reporting low back pain (LBP) underwent evidence-based treatment in line with CPG recommendations before consultation with a spine surgeon. **Methods:** This is a subanalysis of a prospective randomized controlled trial. Eligible adult lumbar spine patients aged 18–80 years with no defective conditions (e.g., scoliosis) were restricted to those triaged as P2 ("routine") or P3 ("nonurgent"); P1 ("urgent") patients were excluded. Questionnaires were sent immediately after referral from a primary physician was received by 1 of 2 spine surgeons at The Ottawa Hospital. Data collected included health care utilization, exercise specifics, medication usage and general demographics. **Results:** Out of 210 patients analyzed, 65% reported exercising for an average of 3.72 hours/week. Walking/running (59%), stretching/yoga (19%) and cycling (14%) were the most common exercise modalities. The main reason among the 35% of patients who did not exercise was "too painful." Out of 220 patients analyzed, 52% underwent active rehabilitation (i.e., physiotherapy), 28% massage therapy, and 23% spinal manipulation (i.e., chiropractor). Pain medications for LBP were taken by 75% of the 230 patients (over-the-counter [OTC] medications: $n = 36$; prescription medications: $n = 71$; OTC + prescription medications: $n = 65$). **Conclusion:** Evidence-based treatments are not being taken advantage of before consultation. If more patients were to undertake CPG-endorsed conservative activities, it may result in fewer unnecessary referrals and patients might not degrade as much while on wait lists. Further studies incorporating knowledge translation to patients and clinicians are necessary.

05.1.2: Patient-reported disability versus objective physical performance measures in assessing patient recovery. ***Melissa McKeon,*[*] *Neil Manson,*[*‡] *Edward Abraham,*[*‡] *Emily Taylor,*[*†] *Joshua Murray,*[§] *Wayne Albert.*[†] **From [*]Canada East Spine Centre, Horizon Health Network, Saint John, NB, [†]University of New Brunswick, Fredericton, NB, [‡]Dalhousie Medicine New Brunswick, Saint John, NB, [§]Research Services, Horizon Health Network, Saint John, NB.**

Background: Degenerative thoracolumbar spine pathologies may cause compression of adjacent neurologic structures, leading to lower extremity pain and disability. Previous literature suggests discordance between surgeon/patient perception of outcomes and true physical performance. The purpose of this study was to compare standard subjective patient questionnaires to objective functional measurements and range of motion (ROM) in patients following elective thoracolumbar spine surgery. **Methods:** Measurements were collected during standard clinical follow-up ($n = 141$). Subjective questionnaires included the Oswestry Disability Index (ODI), Numerical Rating Scale for back (NRS-back) and leg pain (NRS-leg) and SF-36 Physical and Mental Component Summaries (PCS; MCS). A Fastrak electromagnetic motion-capture system (polhemus.com) was used to monitor thoracolumbar ROM during flexion, axial twist and lateral bend tests. The association between subjective and objective measures was analyzed using linear regression. Due to the high dimentionality of Fastrak measurements, principal components analysis was used before the linear regression was performed. **Results:** As expected, subjective questionnaire scores were significantly correlated. NRS-back was associated with ODI (estimate [est] = 5.9, $p < 0.001$), PCS (est = –2.0, $p < 0.001$) and MCS scores (est = –1.2, $p < 0.01$). Similarly, NRS-leg was related to ODI (est = 3.7, $p < 0.001$), PCS (est = –1.8, $p < 0.001$) and MCS scores (est = –1.2, $p < 0.001$). Variance explained ranged from 23%–55%. The association between ODI and Fastrak measurements, however, was weak. Although some minimum and maximum Fastrak ROM measures reached statistical significance, the variance explained was < 6%. Diagnostic linear regression plots demonstrated a lack of model fit. **Conclusion:** These results suggest that patient-reported disability and functional capacity may not have the linear association we anticipated. It appears that each assessment provides different insight regarding patient recovery. Future research should assess the value of using both measurements together to provide a more comprehensive understanding of

postoperative function. In addition, further investigations are required to understand the time-specific nature of the findings.

06.1.2: Risk factors for work status in low back pain patients: a cross-sectional analysis of patients presenting to the Ontario Inter-professional Spine Assessment and Education Clinics. ***Simon Harris, Raja Rampersaud*. From University Health Network, Toronto Western Hospital, University of Toronto, Toronto, Ont.**

Background: It is estimated that 25% of low back pain (LBP) patients account for 75% of the societal cost, with productivity losses representing the majority of the cost. The purpose of the study was to identify independent risk factors for work status in a cohort of LBP patients presenting to the Ontario Inter-professional Spine Assessment and Education Clinics (ISAEC). We hypothesized that the STarT Back chronicity risk tool would be predictive of work status. **Methods:** This is a cross-sectional study at initial ISAEC consultation using comprehensive demographic, clinical and functional data. Work status for those eligible to work (study subpopulation) was our primary outcome and dichotomized as employed (E) or under-employed (UE; unemployed, modified work duty or disability). Multivariate logistic regression modelling was used to determine independent predictor variables for UE. **Results:** Data on 462 (E = 344, UE = 118) consecutive patients underwent univariate analysis. This identified 9 statistically significant variables ($p < 0.01$), including the presence of a legal/insurance claim (LIC; legal, insurance, Workers' Compensation Board), LBP at rest and with activity (Numerical Pain Rating Scale [NPRS] 1–10), opioid use, lower utilization of allied health practitioners, depression, smoking, a higher Oswestry Disability Index (ODI) and a high-chronicity risk score (STarT Back). Multivariate analysis identified LIC (odds ratio [OR] 2.77, 95% confidence interval [CI] 1.0503–7.3181]), depression (OR 2.28, 95% CI 1.15–4.54), smoking (OR 3.80, 95% CI 2.43–6.43) and higher STarT Back score (OR 1.19, 95% CI 1.07–1.32) as independent predictors for UE. Owing to co-linearity and/or mediation effects between the STarT Back and ODI scores, they were modelled separately (ODI: OR 1.05, 95% CI 1.03–1.09). **Conclusion:** Smoking, involvement with litigation/insurance, depression and a higher STarTBack or ODI score are independent predictors of a negative working status in the LBP population. This study confirms the psychosocial association of LBP and working status and confirms the utility of multidimensional screening tools such as the STarT Back.

07.1.3: Comparison of symptomatic, functional and demographic characteristics of postsurgical versus nonoperative LBP patients. ***Greg McIntosh,*[*] *Hamilton Hall,*[*] *Tom Carter,*[*] *Chris Gregg.*[†] **From [*]CBI Health Group, Toronto, Ont., [†]The Back Institute, Wellington, New Zealand.**

Background: The purpose of this study was to compare the characteristics and symptoms of 2 distinct groups of low back pain (LBP) patients commencing rehabilitation: 1) those with a recent history of spine surgery ($n = 1097$) and 2) those without surgical intervention ($n = 2092$). **Methods:** This prospective study of LBP cases was a collaborative effort of spine care rehabilitation clinics in New Zealand and Canada. Patient enrolment occurred between January 2008 and October 2012. Baseline data were recorded at the initial assessment across a range of demographic and symptomatic variables for each patient. All patients had mechanical LBP as determined by the Saskatchewan Spine Pathway triage methodology. **Results:** There were 929 cases from New Zealand and 2260 from Canada. At initial rehabilitation assessment, the 2 groups differed in several characteristics: the postsurgical group had less sleep disturbance ($p < 0.001$) and slightly lower pain levels ($p < 0.001$), but had a significantly longer symptom duration (mean 195 d v. 86 d, $p < 0.001$), poorer baseline function ($p < 0.001$), were more likely to have leg dominant pain ($p < 0.001$), positive straight leg raise ($p < 0.001$) and were more likely to be off work ($p < 0.001$) than the nonsurgical group. Similarities included likelihood of intermittent pain ($p < 0.001$), never using medication ($p < 0.001$) and abnormal illness behaviour ($p < 0.001$). **Conclusion:** The rehabilitation priorities for patients recovering from spine surgery differ from those that are managed nonoperatively. Postoperative patients have lower functional ability and are less likely to be working and therefore require a higher focus on functional and vocational reactivation.

08.1.3: Are primary care patients with different patterns of low back pain epidemiologically distinct? ***Lauren DellaMora,*[*†] *Anthony V. Perruccio,*[*‡] *Elizabeth M. Badley,*[†§] *Y. Raja Rampersaud.*[*] **From [*]University Health Network, Toronto Western Hospital, Toronto, Ont., [†]University of Toronto, Dalla Lana School of Public Health, Toronto, Ont., [‡]Institute of Health Policy, Management and Evaluation, University of Toronto, Toronto, Ont., [‡]Division of Healthcare and Outcomes Research, Toronto Western Research Institute, Toronto, Ont.**

Background: Our objective was to characterize and compare a persistent low back pain (LBP) primary care population based on 4 clinical pain patterns. **Methods:** This is a cross-sectional study of patients from 220 primary care practitioners in 3 cities in Ontario, Canada, seeking care for LBP. Inclusion criteria were LBP symptoms lasting from 6 weeks to 12 months or unmanageable recurrent symptoms, and age 18 years or older. We excluded patients who were pregnant or 1 year postpartum; were involved in active litigation or injured in a motor vehicle accident; and had emergent spinal presentations, established pain disorder, work injury claim, or symptoms persisting longer than 12 months. Descriptive statistics for demographic and health characteristics were generated and stratified by 4 pain pattern subgroups: back-dominant pain aggravated by flexion (P1) or extension (P2), or leg-dominant constant (P3) or intermittent (P4) pain. Multinomial logistic regression analysis investigated adjusted associations between demographic and health characteristics and clinical subgroups (multinomial outcome; referent: P1). **Results:** The sample consisted of 1020 individuals (41% P1, 31% P2, 17% P3 and 11% P4). The P2 and P4 groups had greater proportions of older individuals and individuals with comorbidities (high cholesterol, high blood pressure, diabetes and obesity). The P3 group reported greater activity limitations/disability. From adjusted models, older age was significantly associated with greater odds of being in the P2 and P4 groups (odds ratios [OR] 1.02 and 1.07, respectively, $p < 0.001$). Male sex was associated with greater odds of being in the leg-dominant pain groups (OR 1.68, $p < 0.04$). Increasing numbers of comorbidities was more strongly associated with being in the P2 and P4 groups ($p < 0.05$). **Conclusion:** Low back pain subgroups classified according to

pain patterns appear to have distinct epidemiological profiles, suggesting potentially unique risk factors and underlying etiology. A stratified approach rather than the conventional homogeneous approach to LBP is supported in both the clinical and research setting.

09.1.3: Lack of prognostic model validation in low back pain prediction studies. ***Greg McIntosh,*[*] *Ivan Steenstra,*[†] *Hamilton Hall,*[*] *Tom Carter.*[*] **From *CBI Health Group, Toronto, Ont., †Institute for Work & Health, Toronto, Ont.**

Background: An essential factor to evaluate when critically appraising clinical prediction papers is the occurrence of prospective validation. The minimum standard should be statistical validation of the predictor variables in patients in whom the model was developed, but prospective validation in a different group is essential. Without validation, so-called prediction models are only described traits or characteristics of the sample studied. These studies have limited generalizability (external validity). The purpose of this review was to examine the frequency with which LBP prediction studies utilize either statistical or prospective methods of prognostic model validation. **Methods:** A literature search was conducted of all articles published in *Spine* or *The Spine Journal* between January 2013 and January 2014. An initial screen of prognosis or prediction papers identified 56 potential studies (*Spine* = 44, *The Spine Journal* = 12); 32 were excluded (21 not prediction studies, 11 review articles). Based on the standards set by Wasson and Laupacis and colleagues, full texts of the remaining 24 articles were further scrutinized for prediction study quality. **Results:** Of the 24 included papers, 16 were surgical studies. None of the studies used any methods of statistical validation (reproducibility of predictor variables, or of the final model). Based on the study designs and lack of statistical validation, only 2 studies used the correct terminology for describing associations/relationships between independent and dependent variables; the other studies provided no validation for the predictors that they documented. **Conclusion:** Surgeons and researchers must consider sophisticated and rigorous methods of statistical/external validity for prediction/prognostic findings; otherwise, incorrect assumptions and conclusions may be made about some patients in your clinical practice. Without any validation methods, studies that claim to have developed prediction models actually only describe traits or characteristics of the studied sample.

10.1.4: Larger scoliosis curve magnitude is associated with increased surgical and perioperative complications: a multicentre analysis of 1173 adolescent idiopathic scoliosis curves. ***Firoz Miyanji,*[*] *Tracey Bastrom,*[†] *Amer Samdani,*[‡] *Burt Yaszay,*[†] *David Clements,*[¶] *Suken Shah,*[¶] *Michelle Marks,*[†] *Randal Betz,*[‡] *Harry Shufflebarger,*[**] *Peter Newton.*[†] **From [*]British Columbia Children's Hospital, Vancouver, BC, [†]Rady Children's Hospital, San Diego, Calif., [‡]Shriners Hospital, Philadelphia, Pa., [§]Cooper Medical School of Rowan University, Camden, N.J., [¶]Nemours/Alfred I. DuPont Hospital for Children, Wilmington, Del., [**]Miami Children's Hospital, Miami, Fla.**

Background: Timely access to surgery is a challenge in some healthcare systems, leading to increasing spinal deformity in the setting of adolescent idiopathic scoliosis (AIS). Treatment of larger curves has been suggested to increase perioperative complexity and involve more extensive surgery. Limited data exist focusing on complications in such patients. The aims of our study were to quantify the association between curve magnitude and the rate of complications in AIS surgery and to identify potential predictors associated with an increased complication rate. **Methods:** A prospective, longitudinal multicentre study identified a homogeneous population of AIS patients with a main thoracic curve of 50° or greater. Univariate analysis explored the association between curve severity and complication rate by dividing patients into 4 subgroups based on 10° increments in curve magnitude. Multivariate regression identified potential predictors and a logistic regression determined the odds ratio for the likelihood of complications within each group compared with the group with the smallest curve magnitude. **Results:** There were 298 complications (25.4%) in 1173 patients. Curve magnitude was associated with a significantly higher complication rate in larger curves (≥ 70°) compared with smaller ones (50°–59°). Multivariate logistic regression found curves of 70° or greater to have a 1.5-fold increase (95% confidence interval [CI] 1.0–2.3) and curves of 80° or greater to have a 2.1-fold increase (95% CI 1.27–3.63) in the overall complication rate. The odds of a medical, neurologic or pulmonary complication; intraoperative neuromonitoring (IONM) event; excessive blood loss; blood transfusion risk; and multiple complications significantly increased with increasing curve size. **Conclusion:** Treatment of larger curves was associated with significantly higher complication rates, number of complications and the odds of experiencing a complication. Curves of 70° or greater were 1.5 to 2.1 times more likely to experience a complication compared with curves between 50° and 59°, suggesting that delayed identification and any prolonged delay for corrective AIS surgery may negatively influence the surgical care of these patients.

11.1.4: Superior extension of upper instrumented level in distraction-based surgery: a surrogate for clinically significant PJK. ***Nadim Joukhadar,*[*] *David Skaggs,*[†] *John Heflin,*[‡] *Mohamad Yasin,*[§] *Ron El-Hawary.*[§] **From [*]Dalhousie University, Faculty of Medicine, Halifax, N.S., [†]Keck School of Medicine of USC, Los Angeles, Calif., [‡]Davis Hospital and Medical Center, Layton, Utah, McKay-Dee Hospital Center, Ogden, Utah, [§]IWK Health Centre, Halifax, N.S.**

Background: Our objective was to determine the rate of clinically significant proximal junctional kyphosis (PJK) during rib-based distraction surgery in a cohort of children from an early onset scoliosis (EOS) registry. A secondary goal was to define the proximal junctional angle (PJA) at the time of revision surgery, with the hypothesis that PJA will be increased in this group of patients. **Methods:** This is a retrospective clinical/radiographic review of a multicentre registry for children with EOS. All children treated with rib-based distraction surgery with minimum 2 year follow-up, were evaluated in order to identify the rate of clinically significant PJK (i.e., children who required a revision surgery that involved superior extension of the upper instrumented level (UIL). Two definitions of PJA were used: PJA-A referred to the angle between the caudle end plate of the upper instrumented vertebrae (UIV) to the cephalad end plate 2 vertebrae above UIV, and PJA-B referred to 2 levels below UIV to 2 levels above UIV. **Results:** We identified 397 children. At the

time of implantation, the mean age was 5.5 years, mean scoliosis was 69.9° and mean kyphosis as 49.8°. Forty of these children required revision surgery that involved superior extension of the UIL (10.1% rate of clinically significant PJK). Despite being younger (4.9 v. 5.5 yr, $p < 0.05$), the revision group had preimplantation characteristics similar to the entire study population, with mean scoliosis of 70.0° and mean kyphosis of 50.0°. Average time to revision was 2.3 years, with mean scoliosis of 66.7° and mean kyphosis of 54.7° at time of revision. The PJA-A was 5.6° preoperatively and 11.8° at the time of revision ($p < 0.05$), and PJA-B was 13.1° preoperatively and 21.4° at the time of revision ($p = 0.07$). **Conclusion:** A 10% rate of clinically significant PJK was found within this group of children who were treated with rib-based distraction surgery. At the time of revision, PJA-A had increased significantly from preoperative values.

12.1.4: The optimal surgical approach for Lenke 5 curves: Is the anterior approach ready for a comeback? ***Firoz Miyanji,*[*] *Tracey Bastrom,*[†] *Amer Samdani,*[‡] *Burt Yaszay,*[†] *Jahangir Asghar,*[§] *Suken Shah,*[¶] *Randal Betz,*[‡] *Harry Shufflebarger,*[§] *Peter Newton,*[†] *Christopher Reilly.*[*] From [*]British Columbia Children's Hospital, Vancouver, B.C., [†]Rady Children's Hospital, San Diego, Calif., [‡]Shriners Hospital, Philadelphia, Pa., [§]Miami Children's Hospital, Miami, Fla., [¶]Nemours/Alfred I. DuPont Hospital for Children, Wilmington, Del.**

Background: Historically, the anterior approach was the treatment of choice for Lenke 5 curves. Recently the posterior approach has gained popularity for its ease, versatility and correction with screw fixation. The objective of this study was to prospectively compare both radiographic and clinical outcomes between anterior and posterior instrumented fusions in Lenke 5C curves. **Methods:** A prospective, longitudinal multicentre surgical adolescent idiopathic scoliosis (AIS) database identified consecutive patients with Lenke 5C curves treated either by open anterior instrumentation and fusion (ASIF) with a dual rod system or posterior instrumentation and fusion (PSIF) with a pedicle screw–rod construct and wide posterior release. Preoperative and 2-year postoperative radiographic data, Scoliosis Research Society (SRS) outcome scores and perioperative comparisons were made between the two approaches. **Results:** Sixty-nine patients were treated with ASIF (2002–08) and 92 with PSIF (2002–11). The stable and end vertebrae were similar in the 2 groups ($p = 0.91$ and $p = 0.62$, respectively). The only differences preoperatively were a greater curve flexibility and coronal trunk shift in the anterior group ($p = 0.008$ and $p = 0.05$, respectively). Postoperatively the lowest instrumented vertebrae (LIV) distribution in the ASIF group was L1: 2.9%, L2: 23.2%, L3: 69.6% and L4: 4.3%, compared with L2: 5.4%, L3: 67.4% and L4: 27.4% for the posterior cases ($p < 0.001$). There were no differences between the ASIF and PSIF groups in the percent correction (59.2% v. 59.6%, $p = 0.82$), length of hospital stay (5.6 d v. 5.7 d, $p = 0.75$), postoperative days to conversion to oral pain medication (3.2 d v. 3.2 d, $p = 0.66$) and SRS outcome scores ($p = 0.10$). Although the number of levels fused was significantly lower in the anterior group (4.7 v. 6.3, $p < 0.001$), PSIF resulted in significantly less disc angulation below LIV (ASIF: 3.4, PSIF: 1.8, $p = 0.008$), greater lordosis ($p < 0.001$) and greater percent correction of lumbar prominence ($p = 0.01$). **Conclusion:** Although ASIF resulted in shorter fusions this was at the expense of increased disc angulation below the LIV, less lumbar lordosis and a lower percent correction of the lumbar prominence than PSIF.

13.1.5: Improving quality and safety in pediatric spine surgery: the team approach. ***Firoz Miyanji, John Choi, Janice Mok, Michael Nitikman, Sameer Desai, Christopher Reilly.* From British Columbia Children's Hospital, Vancouver, BC.**

Background: The operative care of pediatric spinal disorders remains among the most complex and complication-ridden surgeries. There is growing evidence that standardized system and institutional team approaches can help reduce risk and improve safety following such complex procedures. Our aim was to evaluate the quality and safety improvement of pediatric spine surgery following the implementation of an institutional pediatric spine surgical team (PSST) approach. **Methods:** A retrospective consecutive case review of all pediatric spine surgeries done pre- (January 2008–December 2009) and postimplementation (January 2012–December 2013) of the PSST was performed. A comparative analysis of a priori determined outcome variables to include surgical site infection (SSI), operative time (ORT), estimated blood loss (EBL), length of hospital stay (LOS), unplanned staged procedures and blood transfusion rates was performed for cases pre-PSST and post-PSST. The PSST consisted of a homogeneous core group of spine OR nurses, pediatric spine anaesthesiologists and neuromonitoring technicians. **Results:** We compared 130 cases pre-PSST with 277 post-PSST. No significant difference in age, sex, BMI, preoperative major Cobb and number levels instrumented existed between the groups. We found statistically significant differences in SSI, ORT, LOS, allogenic blood transfusion volume and unplanned staged procedures between the groups. There was a 94% decrease in the rate of SSIs following PSST implementation (6.9% pre-PSST v. 0.4% post-PSST). Patients post-PSST had, on average, a reduction in ORT by 53 ± 7.7 min ($p = 0.013$), LOS by 5.4 ± 1.8 days ($p = 0.019$) and allogenic blood transfusion volume by 226.3 ± 28.4 mL ($p < 0.001$). There were significantly more unplanned staged procedures pre-PSST than post-PSST (6.2% v. 2.9%, $p = 0.001$). **Conclusion:** The implementation of a homogeneous and consistent PSST significantly improves surgical and perioperative outcomes in pediatric spine surgery, namely SSI, ORT, LOS, allogenic blood transfusion rates and unplanned staged procedures. In addition to quality and safety, other benefits may relate to efficiency of care and reduction in hospital costs.

14.1.5: Posterior vertebral column resection in pediatric deformity: the advantages of staging. ***Firoz Miyanji, Sameer Desai, Siddesh Doddabasappa, Christopher Reilly.* From British Columbia Children's Hospital, Vancouver, BC.**

Background: Vertebral column resection (VCR) through a single all posterior approach has been described for the treatment of severe rigid spinal deformity. Due to the length and complexity, some surgeons favour a planned staged approach for posterior VCR procedures. The aim of our study was to evaluate radiographic and perioperative outcomes of patients who underwent a planned 2-stage VCR (PS-VCR) compared with those who had a single-stage procedure (SS-VCR). **Methods:** After institutional

IRB approval, a retrospective consecutive case review of 35 patients who underwent an all-posterior VCR procedure between 2007 and 2014 was performed. The charts were reviewed for patient demographic data, operative time (ORT), estimated blood loss (EBL), length of hospital stay (LOS) and surgeon-reported intraoperative, immediate postoperative and most recent follow-up complications. Radiographic measurements were made preoperatively and at most recent follow-up. **Results:** Eleven patients were in the PS-VCR group and 24 were in the SS-VCR group. The PS-VCR and SS-VCR groups were comparable preoperatively. Postoperatively, the PS-VCR group had significantly better mean percent curve correction (57.8%) than the SS-VCR group (46.1%). No statistical significant differences were found in EBL and LOS between the groups ($p = 0.79$ and $p = 0.64$, respectively). Operative time was significantly longer in the PS-VCR group ($p = 0.001$); however, the PS-VCR group had on average a significantly lower complication rate (36.4%) than the SS-VCR group (58.4%). Four patients in the SS-VCR group had their procedures aborted due to intraoperative complications. **Conclusion:** Although staging posterior VCR surgeries resulted in significantly longer ORT, there was no difference in EBL and LOS compared with SS-VCR procedures. Staging has the advantage of a significantly lower complication rate with better deformity correction compared with SS-VCR procedures.

15.1.5: Minimally invasive surgery in adolescent idiopathic scoliosis: lessons learned at mean 2-year follow-up. ***Firoz Miyanji, Michael Nitikman, Sameer Desai.*** **From British Columbia Children's Hospital, Vancouver, BC.**

Background: Previous reports of minimally invasive surgery (MIS) in adolescent idiopathic scoliosis (AIS) have found favourable outcomes in the early postoperative period. However, longer-term follow-up data are limited. The aim of this study was to compare perioperative, radiographic and clinical outcomes between MIS and standard open posterior spinal instrumentation and fusion (PSIF) at mean 2-year follow-up. **Methods:** After IRB approval, a retrospective chart review of patients with AIS who underwent MIS was performed. The MIS patients were matched for age, sex, Lenke classification, curve size, date of procedure and single-surgeon with conventional PSIF. Preoperative, perioperative and most recent follow-up data were evaluated. The Scoliosis Research Society (SRS)-22 scores were available preoperatively and at final follow-up. **Results:** Fify-five patients (27 MIS and 28 PSIF) with an average 2.5-year follow-up were analyzed. Preoperatively, the MIS group had a lower mean major Cobb angle (52.9° v. 61.6°). Operative time (ORT) was significantly shorter in the PSIF group, on average by 149.1 ± 4.7 min ($p < 0.001$). Estimated blood loss (EBL), cell saver volume transfused and length of hospital stay (LOS) were all significantly reduced in the MIS group ($p < 0.05$). At average 2 years postoperative, percent curve correction was significantly better in the PSIF groupthan the MIS group (73.2% v. 60.9%, $p < 0.001$). There were 8 reported complications (2 hardware failure, 4 delayed infections, 2 pseudarthrosis) in the MIS group compared with 3 complications (2 delayed infections, 1 adding-on) in the PSIF group. The SRS scores at average 2-year follow-up did not differ significantly between the groups ($p = 0.52$). **Conclusion:** Advantages of MIS in AIS relate to intraoperative blood loss, transfusion rates and LOS; this needs to be carefully weighed against the significant increase in ORT, limited percent curve correction and higher complication rate of MIS compared with standard PSIF. Despite these variations, no clinical differences in SRS-22 scores were found at a mean 2 year follow-up.

16.2.1: Development of a Canadian competency-based spine surgery fellowship education curriculum. ***Jeremie Larouche,[*] Scott Paquette,[†] Charles Fisher,[†] Ian Domisse,[†] Veronica Wadey,[*] Hamilton Hall,[*] Joel Finkelstein,[*] Jacques Bouchard,[‡] John Hurlbert,[‡] Robert Broad,[§] Richard Fox,[§] Doug Hedden,[§] Andrew Nataraj,[§] Tim Carey,[¶] Chris Bailey,[¶] Michael Chapman,[**] Paul Moroz,[††] Don Chow,[††] Eugene Wai,[††] Eva Tsai,[††] Sean Christie,[‡‡] Kris Lundine[§§], Jacques Paquet,[¶¶], Jan Splawinski,[***] Brian Wheelock,[†††] Michael Goytan,[‡‡‡] Henry Ahn,[*] Eric Massicotte,[*] Michael Fehlings,[*] Albert Yee[*].*** **From [*]University of Toronto, Toronto, Ont., [†]University of British Columbia, Vancouver, B.C., [‡]University of Calgary, Calgary, Alta., [§]University of Alberta, Edmonton, Alta., [¶]Western University, London, Ont., [**]Scarborough Hospital, Scarborough, Ont., [††]University of Ottawa, Ottawa, Ont., [‡‡]Dalhousie University, Halifax, N.S., [§§]Royal Jubilee Hospital, Victoria, B.C., [¶¶]Université Laval, Laval, Que., [***]Vernon Jubilee Hospital, Vernon, B.C., [†††]Saint John Orthopaedics, Saint John, N.B., [‡‡‡]University of Manitoba, Winnipeg, Man.**

Background: A recent CSS membership survey motivated the development of a nationally based spine surgery fellowship education curriculum. Our purpose was to develop competency-based curricula through an expert consensus method as a tool for educators and trainees. **Methods:** A fellowship working group of 32 spine surgeons from across the country was assembled. A modified Delphi approach refined an initial curriculum list (108 cognitive, 84 procedural competencies). This list was generated by reviewing Canadian and U.S. accreditation standards, continuing medical education and fellowship content through national/international spine societies as well as perceived gaps in training syllabi as deemed by the authors. A consensus threshold of 70% was chosen, with up to 5 rounds of blinded voting performed. Members were asked to ratify items into either a general comprehensive or focused/advanced curriculum. **Results:** Twenty-eight of 32 consultants (88%) responded and participated in voting rounds. Seventy-eight (72%) cognitive and 63 (75%) procedural competencies reached 70% consensus in the first round. This increased to 82 cognitive and 73 procedural items by round 4. Remaining unresolved were 14 of 24 pediatric, and group members ratified the addition of a separate pediatric curriculum. There were 6 cognitive and 7 procedural items that did not reach threshold after 4 rounds. All 13 remaining items were deemed important to include and were ratified to the respective curriculum based on a final fifth round majority vote. Final curriculum documents developed include a general comprehensive curriculum (91 cognitive and 53 procedural items), a focused/advanced curriculum (22 procedural items) and a pediatrics curriculum (22 cognitive and 9 procedural items). **Conclusion:** Through a consensus-building approach, the study authors have developed competency-based curricula anticipated to be of educational value to spine surgery fellowship educators and trainees. To our knowledge, this is the first nationally based effort of its kind.

17.2.1: Computer-assisted surgery is an effective educational tool for the training of orthopedic surgery residents in pedicle screw placement. ***Ahmed Aoude, Hamzah Alhamzah, Maryse Fortin, Peter Jarzem, Jean Ouellet, Michael Weber.*** **From McGill University, Montréal, Que.**

Background: The accurate placement of pedicle screws in vertebral pedicles is far from straightforward, and pedicle screw malposition can have significant complications. The training of orthopedic residents in adequate pedicle screw placement is therefore very important. **Methods:** A total of 24 residents from the McGill orthopedics program participated in this study. Each resident was randomly assigned to place a screw with a free hand technique (FH) and a computer-assisted surgery (CAS) technique on 1 of 3 cadavers (Cobb angles 5°, 15° and 67°), at randomly selected thoracolumbar vertebral levels. All residents were blinded to their colleagues' pedicle screw placements and were asked to fill out a short questionnaire after the session to evaluate CAS. Computed tomography images were obtained for each cadaver to assess pedicle screw placement accuracy and were classified as follows: A) screw completely in pedicle; B) screw outside of pedicle < 2 mm; C) screw outside of pedicle 2–4 mm; D) screw outside pedicle > 4 mm. **Results:** Five screws were classified as grade A or B (safe zone) and 19 as grade C or D (unsafe zone), using FH in comparison to 15 and 9, respectively, using CAS (p = 0.008). Severe spine deformity (Cobb angle 65°) was associated with lower accuracy using FH (p = 0.03). A greater number of screws were placed in the unsafe zone while using FH in the lumbar spine (p = 0.004). The self-reported survey showed that 65% of the residents still preferred using FH. **Conclusion:** Our results suggest that CAS improves screw placement accuracy and can be successfully used as an educational training tool for orthopedic surgery residents. However, CAS may need to be more user-friendly in order to improve residents' self-perception of its use.

18.2.1: Validation of the Calgary Spine Severity Score. ***Godefroy Hardy-St-Pierre,[*] Andrew Jack,[*] Ken C. Thomas,[†] Andrew Nataraj.[*]*** **From [*]University of Alberta, Edmonton, Alta., [†]University of Calgary, Calgary, Alta.**

Background: The Calgary Spine Severity Score (CSSS) is a published triage score reported in 2010. It separates spine referrals into 4 time-related categories of urgency. It stratifies patients according to clinical, radiological and pathological findings. However, the CSSS still requires external validation in another institution and in an unselected sample of patients. **Methods:** We applied the CSSS to an unselected sample of patients from the Royal Alexandra Hospital between April 2014 and September 2014. Variables collected were: elective/emergent procedure, redo procedure, deformity, time to OR, clinical CSSS, pathological CSSS and radiological CSSS. We compared the time to OR predicted by the CSSS in 1 of 4 categories (routine > 6 mo = CSSS 3–5; priority < 6 mo = CSSS 6–8; urgent < 1 mo = CSSS 9–11; and emergent < 1 wk = CSSS 12–15) with the actual time to OR. We used Kaplan–Meier survival analysis to assess the CSSS predictive ability. Cox proportional hazards models were built and compared via analysis of variance to determine whether the models differed in their ability to fit the data. **Results:** Of the 316 patients available to analyze, 289 had sufficient information and 118 were a mismatch with the actual time to OR, for an accuracy of 63%. The CSSS overestimated the urgency in 68 cases and underestimated it in 50 cases. Notably, 7 cauda equina syndrome cases were classified as priority (< 6 mo) instead of emergent. The concordance was 0.70 and the R^2 was 0.33. We proposed several adjustments to the CSSS to increase its accuracy. The modified CSSS had an accuracy of 96%, overestimating 9 cases and underestimating 1 case. The concordance was 0.77 and the R^2 was 0.70. **Conclusion:** The modified CSSS is an accurate and easy-to-use externally validated triage score.

19.2.2: Can triaging referrals with a simple 3-item pain questionnaire reduce wait times for consultations for patients who would benefit from lumbar spinal surgery? ***Darren Roffey,[*‡] Matt Coyle,[*†] Stephen Kingwell,[*§] Eugene Wai.[‡§]*** **From [*]University of Ottawa Spine Program, Ottawa Hospital, Ottawa, Ont., [†]Faculty of Medicine, University of Ottawa, Ottawa, Ont., [‡]Clinical Epidemiology Program, Ottawa Hospital Research Institute, Ottawa, Ont., [§]Division of Orthopedic Surgery, University of Ottawa, Ottawa, Ont.**

Background: We have developed a 3-item back-versus-leg pain questionnaire (3-Item-Q) that has previously identified optimal surgical candidates from nonspecific low back pain (LBP) referrals. However, questions remain over its capacity to reduce wait times for surgical patients and accurately quantify patient symptomology between referral and spinal surgery consultation. **Methods:** We performed a subanalysis of data collected via a prospective randomized controlled trial comparing a control group (triage via referral letter and radiology report) with a study group (triage via referral letter, radiology report and 3-Item-Q responses). Eligible adult lumbar spine patients were restricted to those triaged as P2 (routine) or P3 (nonurgent); P1 (urgent) patients were excluded. Study group patients had their wait-list position upgraded if they indicated consistent leg-dominant pain on the 3-Item-Q. Quality of life questionnaires were completed at referral and again at consultation. **Results:** Study group patients had a mean wait time of 122 ± 88 days, whereas control group patients waited 131 ± 60 days. Study group patients upgraded to P1 from P2 experienced the shortest wait times (78 ± 33 d); the largest percentage of surgical candidates was extracted from this cohort (21%). Upgraded study group patients (i.e., P2 to P1) also had an improved quality of life at consultation, as reported by responses to the EuroQol-5D. Overall, 39% of patients from both groups worsened from referral to consultation, as per responses from numerical pain scales and the Oswestry Disability Index. Contributing factors to worsening conditions were an unhealthy body mass index (≥ 25), low physical activity levels, depression/anxiety and back-dominant pain. **Conclusion:** This study highlights the real potential for patients to experience worsened symptoms while on the wait list for spinal surgery consultation. By using our 3-Item-Q and analyzing its responses, patients may experience shorter wait times, and surgeons can more effectively identify surgical candidates from the abundance of non-specific LBP referrals.

20.2.2: Strategies to improve the credibility of meta-analyses in spine surgery: a systematic survey. ***Nathan Evaniew, Leon van der Watt, Mohit Bhandari, Michelle Ghert, Ilyas Aleem, Brian Drew, Gordon Guyatt.*** **From McMaster University, Hamilton, Ont.**

Background: Meta-analyses are powerful tools that can synthesize existing research and support evidence-based care. They have

become increasingly popular in spine surgery, but the rigour with which they are being conducted has not been evaluated. Our objectives were to evaluate the methodological credibility of spine surgery meta-analyses and propose strategies to improve future research. **Methods:** We conducted a systematic survey of spine surgery meta-analyses published since 1990. Two reviewers independently evaluated credibility according to the Users' Guides to the Medical Literature and completeness of reporting according to the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) checklist. We used multivariable linear regression to evaluate potential associations. Inter-rater agreement was quantified using κ and intra-class correlation (ICC) coefficients. **Results:** We identified 132 eligible meta-analyses. The mean credibility score was 3 of 7 ± 1.4 (ICC 0.86). Clinical questions were judged as sensible in 125 (95%) studies, searches were exhaustive in 102 (77%), and risk of bias assessments were undertaken in 91 (69%). Seven (5%) meta-analyses addressed possible explanations for heterogeneity using a priori subgroup hypotheses, and 24 (18%) presented results that were immediately clinically applicable. Investigators undertook duplicate assessments of eligibility, risk of bias and data extraction in 46 (35%), and rated overall confidence in the evidence in 24 (18%). Later publication year, increasing journal impact factor, increasing number of databases, inclusion of RCTs and inclusion of non-English studies were associated with greater credibility ($p < 0.05$). The mean score for reporting was 18 of 27 ± 4.4 (ICC 0.94). **Conclusion:** The credibility of many current spine surgery meta-analyses is limited. Researchers can improve future meta-analyses by performing exhaustive literature searches, addressing possible explanations of heterogeneity, presenting results in a clinically useful manner, reproducibly selecting and assessing primary studies, addressing confidence in the pooled effect estimates and adhering to guidelines for complete reporting.

21.2.2: The societal cost of waiting to see a spine surgeon for lower back symptoms in Canada. ***Ghazal Fazli, Jeyagobi Jeyaratnam, Nadia Nandlall, Peter Coyte, Raja Rampersaud.*** **From University of Toronto, Toronto, Ont.**

Background: This study examines the societal costs associated with wait times from the point of referral to a spinal surgeon to the point of consultation (wait time 1 [WT1]) for patients with low back pain within a 1-year time horizon. **Methods:** We conducted a cost analysis of 308 patients from a prospective wait-time study who were prescreened as possible surgical candidates and wait listed for consultation. After consultation, patients were categorized as absolutely nonsurgical patients (NS; $n = 73$) and surgical candidates whose symptoms combined with correlative structural abnormalities would have been amenable to surgical intervention at some point before or after consultation (SC; $n = 235$). For this study, the SC group was further divided into those who had surgery (SC-S, $n = 102$) and those who were managed conservatively (SC-C, $n = 133$). The overall estimated cost (direct and indirect) during a 1-year period was determined based on self-reported cost diary data on healthcare utilization, as well as all societal cost (productivity, caregiver burden, transportation, out-of-pocket patient cost). Health utility scores were determined using the SF-6D taken at baseline, surgical consultation and 1 year from referral. **Results:** The overall WT1 was 6 (range 1–19) months. There was no significant change in the utility scores across all 3 time points for all groups, and thus a cost–utility comparison was not performed (mean SF-6D scores: SC-S 0.57, SC-C 0.61, NS 0.58). The total estimated societal costs (per patient) for the SC-S, SC-C and NS was $27 343, $39 385 and $31 401, respectively. Productivity loss was the major cost driver across all groups. **Conclusion:** The per-patient societal cost of waiting to see a spine surgeon is significant, particularly given that most patients do not ultimately require surgery. Alternate models of care, wherein appropriate care is delivered at the appropriate time, may significantly impact societal cost.

22.2.3: The cost of an adverse event depends on its definition and method of capture. ***Clifford Lin,*[*] *Christopher Witiw,*[†] *Kala Sundararajan,*[*] *Y. Raja Rampersaud.*[*] **From the [*]Division of Orthopaedic Surgery, University Health Network, Toronto, Ont., and the [†]Division of Neurosurgery, University Health Network, Toronto, Ont.**

Background: The incidence of adverse events (AE) demonstrates wide variability due to differences in case definition and method of capture. In an era of quality initiatives to improve value and drive health funding reform, the reliable determination of the health services impact of AEs carries significant consequences to the healthcare system and stakeholders. The primary objective of this study was to assess how 3 different methods of AE reporting affect the calculation of incremental cost and length of stay (LOS). **Methods:** We collected AE data using 1) voluntary reporting (SAVES; $n = 1815$), 2) prospective point-of-care collection with dedicated clinical staff (orthoSAVES; $n = 844$) and 3) data extraction from administrative ICD-10 coding (ICD-10) for the SAVES and orthoSAVES cohorts. Microcase costing data were also obtained for all patients. Incremental cost and LOS attributable to an AE was estimated using propensity matching based on the risk of AE (1 case to 2 controls). **Results:** The AE rates varied widely depending on the method of capture (SAVES: 17.4%; ICD-10-SAVES: 25.9%; orthoSAVES: 31.6%; and ICD-10-orthoSAVES: 30.8%). Results of the calculation of incremental cost in dollars (95%CI)/LOS in days (95% CI) were as follows: SAVES $21 236 (7808–34 664)/12.0 (5.8–18.2); ICD-10-SAVES $31 534 (23 247–39 821)/14.6 (10.6–18.6); orthoSAVES $13 506 (5449–21 563)/6.3 (3.8–8.8); and ICD-10-orthoSAVES $19 575 (11 727–27 423)/8.6 (6.2–11). Sensitivity analysis demonstrated that varying the case definition for ICD-10 data resulted in a 29% decrease in the incidence of AEs but a 27% increase in both incremental cost and LOS. **Conclusion:** Regardless of the method of capture and case definition, spine surgery AEs resulted in significant incremental cost and increased LOS. However, the gross variability in the estimated incremental cost or LOS is a cause for concern and requires further investigation. In an era of quality-based funding models, methods to ensure standardized collection protocols are paramount to enable fair and transparent AE-related funding allocation.

23.2.3: Economic evaluation of intraoperative cone beam CT-based navigation for the placement of spinal pedicle screws: a patient-level cost-effectiveness analysis. ***Nicolas Dea,*[*] *Charles Fisher,*[†] *Juliet Batke,*[†] *John Street.*[†] **From [*]Centre Hospitalier Universitaire de Sherbrooke, Sherbrooke, Que., [†]Vancouver General Hospital, Vancouver, BC.**

Background: Pedicle screws are routinely used in contemporary spinal surgery. Screw misplacement is, however, correlated with

potential adverse events. The goal of the present study was to perform an economic evaluation looking specifically at misplaced screws leading to reoperation, secondary to neurologic deficits or biomechanical concerns. **Methods:** A patient-level data cost-effectiveness analysis from the hospital perspective was conducted. Based on a single-centre observational study of prospectively collected data, we wanted to determine the value in adult spinal surgery of a navigation system coupled with intraoperative 3D imaging (O-Arm Imaging and the StealthStation S7 navigation Systems, Medtronic). The data source was a consecutive series of patients treated with the aid of computer-assisted surgery (treatment group) compared with a matched historical cohort of patients treated with conventional methods (control group). The primary effectiveness measure studied was the number of reoperations for misplaced screws. **Results:** A total of 5132 pedicle screws were inserted in 502 patients during the study period: 2682 screws in 253 patients in the treatment group and 2450 screws in 249 patients in the control group. Overall accuracy rates were 95.2% for the treatment group and 86.9% for the control group. Two patients (0.8%) required a revision surgery in the treatment group (both within the same admission) compared with 15 patients (6%) in the control group (9 within the same admission and 6 within 1 year during a subsequent admission). Costs of the different alternatives were assessed based on the annuitization of capital expenditures method. An incremental cost-effectiveness ratio of $15 961/reoperation avoided was calculated for the computer-assisted surgery group. Based on a reoperation cost of $12 618, this new technology becomes a cost saving for centres performing more than 254 instrumented spinal procedures per year. **Conclusion:** Computer-assisted spinal surgery has the potential to reduce reoperation rates and thus to have serious cost-effectiveness implications. High acquisition and maintenance costs of this technology can be offset by equally high reoperation costs. Our cost-effectiveness analysis showed that for high-volume centres this technology is economically justified.

24.2.3: Predictors of inappropriate emergency department utilization following elective thoracolumbar spine surgery. ***Meghan Flood,*[†] *Edward Abraham,*[*†] *Alana Green,*[*†] *Neil Manson.*[*†] **From** [*]**Canada East Spine Centre, Horizon Health Network, Saint John, NB,** [†]**Dalhousie Medicine New Brunswick, Saint John, NB.**

Background: The incidence of spine surgery continues to rise, representing a significant patient population and a material percentage of healthcare expenditure. While spine surgeries yield a high success rate, recent research indicates that a large number of patients visit the emergency department (ED) postoperatively. This poses a burden to the patient and the healthcare system alike. This study aimed to identify and predict inappropriate ED visits within 6 months after elective thoracolumbar spine surgery. **Methods:** We identified 987 consecutive patients receiving surgery from 2008 to 2013. Patients with previous spine surgery, malignancy, worker's compensation or spine-related litigation (n = 388) were excluded. Through regional electronic medical record review, we identified 98 ED visits. Comprehensive chart reviews were then conducted for these visits, and 2 fellowship-trained orthopedic spine surgeons split patients into groups: those who engaged in an inappropriate surgery-related ED visit (n = 80) and those who did not (n = 519). Eighteen visits were determined to be appropriate and/or unrelated. These patients were included in the 519 "no inappropriate visit" group. Age, body mass index (BMI), SF-36 physican and mental summary scores, Oswestry Disability Index (ODI) scores, Numeric Rating Scale back pain and leg pain scores, Charlson Comorbidity Score, levels of intervention, sex, surgeon, marital status, living arrangement, education, work status, smoking, drug and alcohol use, exercise, primary pathology, primary symptom, surgery type (fusion/nonfusion), approach (open/MIS), perioperative adverse events, and family doctor status (yes/no) were measured. We performed t tests on continuous variables and χ^2 tests on categorical variables. A logistic regression model was then built based on these results and previous research. **Results:** During the exploratory phase, BMI (t_{589} = 2.487, p = 0.01) and marital status (χ^2_2 = 8.24, p = 0.02, n = 555) were the only 2 significant predictors of an inappropriate visit. The regression model was not statistically significant (p = 0.54). Upon further investigation, marital status was sex-mediated, with divorced/separated women significantly more likely to engage in an inappropriate visit than single or married/engaged/common-law women (χ^2_2 = 9.48, p < 0.01, n = 555); there was no effect for men (p = 0.76). **Conclusion:** While there were 2 significant factors in this model, the R^2 values were very low. This, in combination with the high frequency of inappropriate ED visits, indicates that a wide range of patients would benefit from further education surrounding postoperative complications.

25.2.4: Incidence, impact and risk factors of adverse events in thoracic and lumbar spine fractures. An ambispective cohort analysis of 390 patients. ***R. Andrew Glennie,*[*†] *Tamir Ailon,*[†] *Juliet Batke,*[†] *Nic Dea,*[†] *John Street*. **From** [*]**Dalhousie University, Halifax, NS,** [†]**University of British Columbia, Vancouver, BC.**

Background: Our objectives were to determine the incidence of adverse events (AE) in patients with thoracic or lumbar spine fractures treated both operatively and nonoperatively and to determine their impact on length of stay (LOS). Secondarily, we determined the difference in incidence of AEs in both neurologically intact and compromised patients. **Methods:** Data on intra-, pre- and postoperative AEs were prospectively collected using the SAVES data collection. Logistic regression was used to model the likelihood of experiencing at least 1 AE based on patient characteristics. The impact of the total number of AEs experienced by a patient and that of each of the most common AEs on LOS was determined using Poisson regression. **Results:** We included 390 patients in our final analysis; 276 (70.8%) were treated operatively. In all, 140 patients (36%) experienced neurologic deficit as a result of their initial injury. The AEs occurred in operatively treated patients 56% of the time compared with only 13% of the time in the nonoperative group. The presence of neurologic deficit increased the risk of AEs, especially in high thoracic (T1–T6) trauma, increasing the odds of having an adverse event by 12.1 (p < 0.001). The most common AEs were urinary tract infections (19.7%), neuropathic pain (12.3%), pneumonia (11.8%), delirium (10.5%) and ileus (6.2%). Patient LOS increased significantly with pneumonia (p < 0.001) and delirium (p < 0.001). **Conclusion:** The presence of neurologic injury and the need for operative fixation of thoracic or lumbar injuries leads to a greater risk of adverse events. Only pneumonia and delirium consistently increase LOS.

26.2.4: Factors associated with adverse events in major elective spine, knee, and hip in-patient orthopedic surgery. ***Dov B.***

Millstone,† Anthony V. Perruccio,*‡ Elizabeth M. Badley,†§ Y. Raja Rampersaud.* From *University Health Network, Toronto Western Hospital, Toronto, Ont., †University of Toronto, Dalla Lana School of Public Health, Toronto, Ont., ‡Institute of Health Policy, Management and Evaluation, University of Toronto, Toronto, Ont., §Division of Healthcare and Outcomes Research, Toronto Western Research Institute, Toronto, Ont.

Background: Hip and knee replacement and spinal fusion represent an increasing burden on the healthcare system. These procedures are also associated with significant adverse event (AE) rates and related cost. The objective of this study was to identify risk factors for AEs in these prevalent orthopedic surgeries based on a common clinical point-of-care AE capture system (Orthopaedic Surgical AdVerse Event Severity system — OrthoSAVES). **Methods:** Data on in-hospital AEs were collected over a 2-year period for elective inpatient knee, hip and spine orthopedic procedures for degenerative musculoskeletal conditions (predominantly osteoarthritis/spinal stenosis). Multivariable logistic regression was used to investigate the association between various factors (age, sex, surgical site, body mass index, surgical risk class, procedure time, medical comorbidities) and the likelihood of experiencing an AE. **Results:** The sample included 2146 patients. The overall AE rate was 27% (spine 29%, knee 27%, hip 25%). Factors independently associated with greater odds of an AE included increasing age (odds ratio [OR] 1.29, 95% CI 1.11–1.49, per 15-yr interval), male sex (OR 1.36, 95% CI 1.11–1.68), longer procedure time (OR 1.19, 95% CI 1.10–1.30, per 30-min increase), and undergoing revision surgery (OR 2.10, 95% CI 1.30–3.38). Decreased odds were associated with being overweight (OR 0.73, 95% CI 0.55–0.97) and for undergoing spine surgery (OR 0.49, 95% CI 0.32–0.77) once procedure time was taken in account. No significant effects relating to comorbidities were found. **Conclusion:** A point-of-care AE capture system revealed higher AE rates compared with estimates typically based on administrative data. We report increasing age, male sex, revision surgery and longer procedure times as common risk factors for an AE in this population. The conventional perception of higher adverse event rates in spine surgery appears to be related to longer surgical procedure times.

27.2.4: Prognostic factors for survival in surgical series of symptomatic metastatic epidural spinal cord compression: a prospective North American multicentre study in 142 patients. *Anick Nater,*† Michael Fehlings,*† Lindsay Tetreault,*† Branko Kopjar,‡ Charles Fisher,§ Alexander Vaccaro,¶ Paul Arnold,** James Schuster,†† Joel Finkelstein,‡‡ Laurence Rhines,§§ Mark Dekutoski,¶¶ Ziya Gokaslan,*** John France,††† Peter Rose.‡‡‡ From *University of Toronto, Toronto, Ont., †Toronto Western Hospital, Toronto, Ont., ‡University of Washington, Seattle, Wash., §Vancouver General Hospital, Vancouver, BC, ¶Rothman Institute/Thomas Jefferson University Hospital, Philadelphia, Pa., **Kansas University Medical Centre, Kansas City, Kan., ††Hospital of the University of Pennsylvania, Philadelphia, Pa., ‡‡Sunnybrook Health Sciences Centre, Toronto, Ont., §§University of Texas, Houston, Tex., ¶¶The Core Institute, Sun City West, Ariz., ***Johns Hopkins University, Baltimore, Md., †††West Virginia University, Morgantown, W.Va., ‡‡‡Mayo Clinic, Rochester, Minn.

Background: Symptomatic metastatic epidural spinal cord compression (MESCC) afflicts up to 10% of cancer patients. It is associated with shortened survival and worsened quality of life. This study aims to identify the key survival prognostic factors in surgically treated symptomatic MESCC patients. **Methods:** We enrolled 145 MESCC patients in a prospective North American multicentre study and followed them postoperatively for 12 months. Using univariate analyses, Kaplan–Meier methods and log-rank tests, the prognostic value of various clinical predictors were assessed. Predictors with $p < 0.2$ in univariate analyses were included in the final Cox proportional hazards model. **Results:** Overall median survival was 7.7 months; lung and breast cancer had the shortest and longest median survival, respectively (4.5 v. 12.1 mo). Nine patients (6%) whose primary cancers were lung ($n = 3$), kidney ($n = 3$), melanoma ($n = 1$), prostate ($n = 1$), and breast ($n = 1$) died within 30 days postoperatively; 46 (32%), 61 (42%), 74 (51%) and 86 (59%) died at 3, 6, 9 and 12 months, respectively. Significant predictors on the univariate analyses were site of primary tumour, number of vertebrae involved, metastases outside the spine, bladder dysfunction, ability to walk 4 steps, Oswestry Disability Index score, EQ-5D and ASIA scores. Only spinal metastasis involving ≥ 4 vertebral bodies was included in the final model (hazard ratio 2, $p = 0.002$). **Conclusion:** The extent of spinal metastasis, which is regarded as an indicator of the severity of metastasis burden, is an independent predictor of poor prognosis in patients with a single-level symptomatic MESCC lesion. It is essential to identify factors to optimize quality of life.

28.2.5: A comparison of 2 prospective adverse event recording tools with institutional ICD-10 coding for detecting perioperative adverse events in patients undergoing spinal surgery. *Christopher Witiw,* Clifford Lin,† Kala Sundararajan,† Y. Raja Rampersaud.† From the *Division of Neurosurgery, University of Toronto, Toronto, Ont., †Division of Orthopedic Surgery, Toronto Western Hospital, University of Toronto, Toronto, Ont.

Background: Recently, increasing attention has been focused on the validity of recording perioperative adverse events (AEs) with institutional administrative databases. Prospective tools for recording events have been shown to capture more individuals experiencing AEs and more AEs per individual; however, little is known about how these tools differ from one another. The aim of this investigation is to compare 2 methods of prospective perioperative AE detection. **Methods:** The previously validated Spine Adverse Events Severity System (SAVES) tool was used to record AEs by the surgical team via voluntary reporting at discharge for 1815 patients between August 2007 and December 2010. The orthoSAVES tool was administered by a dedicated clinical practitioner to prospectively record AEs on 844 patients between January 2011 and December 2012. In parallel, adverse events were extracted from administrative ICD-10 codes for all patients. Direct comparisons were made between ICD-10 capture and SAVES, as well as orthoSAVES using McNemar's test. Differences were considered significant at $p < 0.05$. **Results:** We found that orthoSAVES captured significantly more patients with any AE ($p < 0.01$), deep wound infection ($p = 0.01$), neurologic deterioration ($p < 0.05$), pulmonary embolism ($p < 0.05$), urinary retention ($p < 0.05$) and dural tear ($p < 0.05$) than ICD-10 codes. The SAVES tool captured significantly more urinary tract infections ($p < 0.05$) and postoperative pain ($p < 0.01$). However, it captured fewer patients with any AE ($p < 0.05$) and dural tear ($p < 0.02$) than

ICD-10 codes. **Conclusion:** Differences exist between prospective tools and ICD-10 databases in rates of overall AE and of specific types of AE. Interestingly, there also appear to be differences between prospective capture methods. Further study is needed to determine the optimal method for recording AEs in spinal surgery.

29.2.5: Assessment of impact of long-cassette standing radiographs on surgical planning for lumbar pathology: an international survey of spine surgeons. ***Dominic Maggio,*[*] *Tamir Ailon,*[*] *Justin Smith,*[*] *Christopher Shaffrey,*[*] *Virginie Lafage,*[†] *Frank Schwab,*[†] *Regis Haid,*[‡] *Themi Protopsaltis,*[†] *Eric Klineberg,*[§] *Justin Scheer,*[¶] *Shay Bess,*[**] *Paul Arnold,*[††] *Jens Chapman,*[‡‡] *Michael Fehlings,*[§§] *Christopher Ames.*[¶¶] **From [*]University of Virginia Medical Center, Charlottesville, Va., [†]NYU Hospital for Joint Diseases, New York, NY, [‡]Atlanta Brain and Spine Care, Atlanta, Ga., [§]University of California, Davis, Davis, Calif., [¶]Northwestern University Feinberg School of Medicine, Chicago, Ill., [**]Rocky Mountain Hospital for Children, Denver, Colo., [††]University of Kansas Medical Center, Kansas City, Kan., [‡‡]University of Washington, Seattle, Wash., [§§]University of Toronto, Toronto, Ont., [¶¶]University of California, San Francisco, San Francisco, Calif.**

Background: Associations between global spinal alignment, patient reported disability and surgical outcomes have increasingly gained attention. Assessment of spinal alignment requires standing full cassette radiographs; however, spine surgeons routinely rely on short-segment imaging only when evaluating seemingly isolated lumbar pathology. This may prevent adequate surgical planning and predispose to misrecognition of associated pathology in the thoracic spine and sagittal spinopelvic malalignment. We used a case-based survey questionnaire to evaluate whether routine performance of long cassette radiographs results in changes to respondents' operative plans compared with standard imaging of the involved lumbar spine. **Methods:** A case-based survey was distributed to AOSpine members with 15 cases of lumbar spine pathology and lumbar imaging only. These cases were then re-presented with additional long-cassette radiographs. Participants selected a single operative plan from 5 choices ranging from least to most extensive. Cases included 5 "control" cases with normal global alignment and 10 "test" cases with significant sagittal and/or coronal malalignment. Mean scores were determined for each question, with higher scores representing more extensive operative plans. **Results:** In all, 316 of 712 (44%) completed the survey, including 68% with spine fellowship training and representation from more than 40 countries. For test — but not control — cases, there were significantly higher surgical invasiveness scores for cases with long cassette films compared with those with lumbar imaging only (4.2 v. 3.4, $p = 0.002$). The addition of such radiographs resulted in 82.1% of respondents recommending instrumentation up to the thoracic spine, a 23.2% increase compared with the same cases presented with lumbar imaging only ($p = 0.008$). **Conclusion:** This study demonstrates the importance of maintaining a low threshold for obtaining long-cassette imaging when assessing seemingly isolated lumbar pathology. Deformity, particularly positive sagittal malalignment, may go undetected unless one maintains a high index of suspicion and obtains long-cassette radiographs. It is recommended that spine surgeons recognize the prevalence and importance of such deformity when contemplating operative intervention.

30.2.5: Long-term patient-reported outcome and surgical survivorship of MIS fusion for low-grade spondylolisthesis. ***Simon Harris, Raja Rampersaud*. From University Health Network, Toronto Western Hospital, University of Toronto, Toronto, Ont.**

Background: Little is known about the long-term benefits and survival of minimally invasive spine (MIS) lumbar fusions. The study's primary objective was to measure improvements in Oswestry Disability Index (ODI) 5 years following MIS fusion for lumbar spondylolisthesis and assess long-term survival. The secondary objective was to measure the 5-year change in health-related quality of life (HRQoL). **Methods:** A subset analysis of an ongoing prospective observational cohort study was performed. Consecutive patients undergoing MIS lumbar fusion for low-grade (Meyerding grade I-II) degenerative or isthmic lumbar spondylolisthesis were assessed. Procedures were performed from 2002 to 2008 by 1 academic surgeon using a single technique. The ODI and SF-36 scores were evaluated preoperatively and postoperatively at 6 weeks and 3, 6, 12, 24, 36 and 60 months. Kaplan–Meier survival curves assessed procedural survival at latest follow-up. **Results:** Fifty-nine patients were identified with completed 5-year follow-up. The mean age at surgery was 53 years, and 56% were women. Baseline ODI scores (42.48%) continued to improve until 1 year postoperative (17.64%) and were maintained to 5 years (18.25%). Kaplan–Meier survival curves for all fusions identified 88% survival at 4000 days. There was no difference in survival between isthmic versus degenerative etiologies. All SF-36 Norm-Based Score (NBS) domains improved with surgery. The SF-36 subcomponents most responsive to change were Role Physical (RP) and Bodily Pain (BP). Patients with isthmic spondylolisthesis had statistically higher scores for RP-NBS and BP-NBS than degenerative spondylolisthesis at intermediate and long-term follow-up. **Conclusion:** This paper presents the largest long-term cohort of MIS lumbar fusions for low-grade spondylolisthesis. Patient-reported outcomes were significant and maintained to at least 5 years. Overall procedure survival was high at long-term follow-up. Isthmic spondylolisthesis had greater improvement in SF-36 subcomponents (RP and BP) than degenerative spondylolisthesis.

31.3.1: The effect of prolonged postoperative antibiotic administration on the rate of infection in patients undergoing posterior spine surgery requiring a Hemovac drain. ***Darryl Collings,*[*†] *Lori Nutt,*[*†] *Jennifer Urquhart,*[*†] *Linda Kuska,*[*†] *Fawaz Siddiqi,*[*†] *Kevin Gurr,*[*†] *Chris Bailey.*[*†] **From [*]London Health Sciences Centre, London, Ont., †Western University, London, Ont.**

Background: Postoperative prophylactic antibiotics for 24 hours following an elective procedure are routinely given to most orthopedic surgery patients as the standard of care. However, a spinal wound drain is often maintained for 48 hours following surgery to prevent compressive hematoma formation. It is hypothesized that maintaining the prophylactic antibiotics for 24 hours after drain removal may decrease infection rates. The purpose of this study is to compare the rate of deep infection in patients receiving prophylactic antibiotics for 24 or 72 hours and to provide more advanced practice guidelines on the management

of wound infections in postoperative spine surgery. **Methods:** All patients undergoing elective posterior spine surgery were screened. Five hundred patients met the inclusion criteria, with 450 patients computer-randomized to either 24 or 72 hours of antibiotics. A stratified block randomization design was used to ensure equal numbers of patients with diabetes in each group. For this interim analysis χ^2 tests were used to compare the rate of superficial and deep infection between the 2 groups. Secondary outcomes, such as length of stay (LOS) , were compared using simple 2-tailed *t* tests. **Results:** There were 17 superficial infections in the 24-hour group compared with 5 in the 72-hour group ($p = 0.008$). There were 7 deep infections in the 24-hour group compared with 8 in the 72-hour group ($p = 0.80$). The most commonly isolated organism was *Staphylococcus aureus*. The mean LOS was 4.0 ± 2.4 days in the 24-hour group and 4.3 ± 1.7 days in the 72-hour group ($p = 0.16$). **Conclusion:** These preliminary results suggest that a prolonged course of postoperative antibiotics may decrease the rate of superficial infection, but is not associated with a statistically significant difference in the rate of deep infection requiring irrigation and debridement.

32.3.1: Preliminary results of a Phase 1 trial on the use of photodynamic therapy in vertebral metastases. ***Albert Yee,*** [*] ***Shane Burch,*** [†] ***Arjun Sahgal,*** [*] ***Edward Chow,*** [*] ***Carolyn Niu,*** [‡] ***Carl Fisher,*** [‡] ***Cari Whyne,*** [*] ***Margarete Akens,*** [‡] ***Stuart Bisland,*** [§] ***Brian Wilson.*** [‡] **From** [*]**Sunnybrook Health Sciences Centre, Toronto, Ont.,** [†]**University of California, San Francisco, San Francisco, Calif.,** [‡]**University Health Network/Princess Margaret Hospital, Toronto, Ont.,** [§]**McMaster University, Hamilton, Ont.**

Background: The spine is a common site of cancer spread. Complications include pathologic fracture and spinal cord compression. Vertebroplasty (VP) and balloon kyphoplasty (KP) are minimally invasive stabilization procedures. Photodynamic therapy (PDT) is a tumour-ablative modality that may complement mechanical stability afforded by VP/KP. This first-in-human study evaluates PDT safety when applied in conjunction with VP/KP. **Methods:** Following institutional ethics and Health Canada approval, symptomatic patients eligible for VP/KP in treating pathologic fracture or at-risk lesions were recruited. Exclusion criteria were spinal canal compromise and/or neurologic impairment. Photodynamic therapy is a 2-step binary therapy of systemic drug (photosensitizer) followed by intravertebral activating light administration: Visudyne (6 mg/m^2),15-minute drug/light interval, 690 nm diode-laser light (150 mW/cm interstitial diffusing optical fibre), for escalating total light doses (50, 100, 150 and 200 J/cm delivered over 5.5–22.5 min). Light was applied through the VP/KP bone trochar before cementation. Six patients were treated as light-only (no drug) controls, followed by PDT (drug + light), with 6 patients planned for each light-dose increment. Drug/light safety, neurologic safety, generic (SF-36) and disease-specific outcomes (VAS, EORTC-QLQ-BM22) were recorded through 6 weeks. **Results:** To date, 15 patients have been treated (including 2 patients in drug + 100 J/cm cohort). Neurologic examination immediately following treatment was normal in all patients. There have been no adverse drug, light or neurologic events attributed to PDT. In general, patients experienced improvement in pain and functional scores by 6 weeks. Two patients (50 J/cm drug group) experienced further fracture despite VP/KP, resulting in lumbar radiculopathy by 5–6 weeks. Review by an independent data safety monitoring board determined that these 2 events were the result of cancer progression with failure of VP/KP mechanical support. Both patients were treated medically. **Conclusion:** To date, vertebral PDT using the drug and light regimen appears safe from a pharmaceutical and neurologic perspective. Ongoing study to determine safe dose range and subsequent efficacy studies will be required in clinical translation.

33.3.1: The minimal clinically important difference of the modified Japanese Orthopaedic Association score in patients with degenerative cervical myelopathy undergoing surgical intervention. ***Lindsay Tetreault,*** [*†] ***Aria Nouri,*** [*†] ***Pierre Cote,*** [‡] ***Michael Fehlings.*** [*] **From *University of Toronto, Toronto, Ont., †Toronto Western Hospital, Toronto, Ont., ‡University of Ontario Institute of Technology, Oshawa, Ont.**

Background: The modified Japanese Orthopaedic Association (mJOA) score is the most frequently used tool to assess functional status in patients with cervical spondylotic myelopathy (CSM). By defining the minimal clinically important difference (MCID) for this scale, clinicians can evaluate the impact of treatment interventions for CSM and better interpret results from previous therapeutic research studies. This study therefore aims to define the MCID of the mJOA in patients with CSM. A secondary objective is to define a cut-off point between an optimal and suboptimal surgical outcome. **Methods:** Three different methods were used to determine the MCID of the mJOA: 1) distribution-based, 2) anchor-based and 3) professional opinion. The first 2 were accomplished using data on 757 surgical CSM patients enrolled in either the prospective CSM-North America or International study. Distribution-based methods were used to estimate the MCID by computing the half standard deviation. In addition, using anchor-based methods, the change in mJOA (1-yr v. baseline) was compared between patients who achieved the MCID on the neck disability index (NDI) and SF-36 physical component score (PCS) and those who did not. The difference between the 2 groups was computed and taken to be the MCID. These results were confirmed by a survey distributed to members of AOSpine International that asked professionals to define the MCID of the mJOA. To determine an appropriate cut-off, the final mJOA at 1 year was compared between patients who achieved the MCID on the mJOA and those who did not. **Results:** In the combined CSM-North America and International data set, the average baseline mJOA of the total sample ($n = 757$) was 12.62 ± 2.81 and the mJOA at 1-year follow-up ($n = 627$) was 15.23 ± 2.65. The half standard deviation of the baseline mJOA was 1.40. The difference in DmJOA between patients who achieved the MCID on other scales was 1.50 with respect to the NDI and 1.33 based off the SF-36 PCS. The survey of 416 spine professionals confirmed these estimates; the mean response was 1.65 ± 0.66. From these 3 methods, we can approximate the MCID of the mJOA to be 1.5. In the group of patients who improved by 1.5 or more points on the mJOA, the final score at 1 year was 16.02 ± 2.10. Therefore, patients who reach a score of 16 on the mJOA likely demonstrated clinically significant gains, deeming this an appropriate cut-off point between optimal and suboptimal surgical outcomes. **Conclusion:** The MCID of the mJOA is 1.5. This knowledge will enable clinicians to identify meaningful functional improvements following surgical intervention in CSM patients.

34.3.1: Patient and surgeon radiation exposure during spinal instrumentation using intraoperative CT-based navigation. ***John Street, Daniel Mendelsohn, Jason Strelzow, Juliet Batke, Marcel Dvorak, Charles Fisher.*** **From Combined Neurosurgical and Orthopaedic Spine Program, Vancouver General Hospital, Vancouver, Departments of Orthopedics and Neurosurgery, University of British Columbia, Vancouver, BC.**

Background: Imaging modalities available to visualize spinal anatomy include plain X-rays, fluoroscopy and intraoperative CT scanning. All emit ionizing radiation, exposing the surgical team and patient to radiation. The radiation emitted to the patient and to the surgeon when performing surgeries using intraoperative CT-based spine navigation were compared. **Methods:** An ambispective review of surgical cases using intraoperative CT navigation over 1 year was performed. The number of intraoperative X-rays, fluororoscopy and CT dosages were recorded and standardized to effective doses. Fluoroscopy doses included scout images, guiding interbody devices and spine alignment verification. A literature review was performed to determine historical radiation exposure values for fluoroscopy-guided spine instrumentation. **Results:** Seventy-three surgical cases involving an average of 5.44 levels of instrumentation were reviewed. Thoracic and lumbar spine instrumentations had the highest radiation emission from all modalities (CT, X-ray, fluoroscopy) compared with cervical cases (TL: 6.40 mSv v. C: 2.33 mSv). Major deformity and degenerative cases involved more radiation exposure than trauma or oncology cases (6.68 mSv v. 4.18 mSv). On average, the patient was exposed to 8.7 times more radiation than the surgical team. Total radiation exposure to the patient was 1.85 times the values reported in the literature for thoracolumbar fusions performed with fluoroscopy. In comparison, radiation exposure to the surgeon was reduced by 89% compared with conventional fluoroscopically facilitated open thoracolumbar fusions. The average total radiation exposure to the patient was 5.69 mSv, less than a single routine lumbar CT scan (7.5 mSv). **Conclusion:** Intraoperative CT navigation increases the radiation exposure to the patient and reduces the radiation exposure to the surgeon. Intraoperative CT navigation improves the accuracy of spine instrumentation with acceptable patient radiation exposure and reduced surgical team exposure. Surgeons should be aware of the radiation exposure implications to both the patient and the surgical team when using intraoperative CT navigation.

35.3.2: Are postoperative pelvic parameters and sagittal balance predictive of further lumbar surgery in patients with spinal stenosis? ***Joel Phillips,[*†] Jennifer Urquhart,[*†] Corinne Tallon,[*†] Kevin Gurr,[*†] Fawaz Siddiqi,[*†] Stewart Bailey,[*†] Chris Bailey.[*†]*** **From [*]London Health Sciences Centre, London, Ont, [†]Western University, London, Ont.**

Background: Surgical treatment of spinal stenosis has been reported to have an early success rate of up to 85%. Despite this, recurrent surgical rates remain substantial in this population. Sagittal balance, pelvic incidence, pelvic tilt, sacral slope and lumbar lordosis (LL) are all measurements that could play a role in predicting success or failure of surgically treated lumbar spinal stenosis. This study examined whether postoperative pelvic parameters as well as sagittal balance were predictive of the need for further lumbar surgery in the spinal stenosis patient population. **Methods:** A retrospective review of 212 patients with surgically managed spinal stenosis at our institution between Feb. 1, 2006, and June 1, 2010, was performed. Postoperative upright radiographs were examined and measurements of pelvic parameters, lumbar lordosis and sagittal alignment were made. Modes of failure included instability or recurrent neural element compression at the operative level, adjacent-level or nonadjacent lumbar level. Secondary surgery for a wound infection was not included. **Results:** We included 199 patients with an average follow-up of 5.0 ± 1.5 years. Fourteen percent of patients failed surgical treatment and required revision surgery. The majority of patients' index procedures was a decompression and fusion (83% v. 17% decompression only). The second surgery rate was similar for those who underwent fusion versus decompression only ($p = 0.41$). The most common reasons for further surgery were adjacent level instability (30%) and/or adjacent level compression (54%). Sagittal vertical axis did not differ between patients who required further surgery and those who did not (66.9 ± 34.4° v. 59.3 ± 40.5°, $p = 0.55$). However, LL differed significantly between the 2 groups (41.9 ± 13.7° v. 49.3 ± 15.7°, $p = 0.022$, respectively). **Conclusion:** The results show that only decreased LL was associated with a second surgery. Other measurements of sagittal alignment as well as pelvic parameters did not predict need for revision. Postoperative measurement of LL may provide the highest yield in predicting future surgery in spinal stenosis.

36.3.2: Postoperative ambulation in patients undergoing total hip arthroplasty, total knee arthroplasty and elective lumbar spine surgery to treat arthritic pathologies. ***Michael Cochran,[*] Edward Abraham,[*†] Alana Green,[*†] Neil Manson.[*†]*** **From [*]Dalhousie Medicine New Brunswick, Saint John, NB, [†]Canada East Spine Centre, Horizon Health Network, Saint John, NB.**

Background: Degenerative osteoarthritis of the knee, hip and spine are an increasing concern as our population ages. Total knee arthroplasty (TKA) is generally considered the gold standard benchmark for orthopedic surgery recovery. The purpose of this study was to compare postsurgical walking performance and ambulatory capacity in patients undergoing lumbar fusion (LF) for lumbar spinal stenosis to those undergoing total hip arthroplasty (THA) and TKA. **Methods:** This is a single-centre prospective observational cohort study on patients who underwent THA ($n = 32$), TKA ($n = 33$) or 1–2 level LF ($n = 29$) between May 2013 and August 2014. An Orthocare Innovations StepWatch activity monitor was attached to each patient's ankle after incision closure. This measured patient ambulation for the duration of their postsurgical hospitalization. Preoperative measures included age, sex, body mass index (BMI), comorbidities, SF-36 PCS and MCS scores, and the Tampa Scale for Kinesiophobia. Ambulation measures included steps for each day, total steps, average steps, max steps per day, intensity for each day, average intensity and max intensity. Intensity is a measure of the number of steps per minute during activity. **Results**: Knee patients had significantly higher BMI than hip patients ($p < 0.05$), there was significantly lower mental health functioning in LF patients than hip patients ($p < 0.01$), and the LF group contained significantly more female patients than the THA and TKA groups ($p < 0.05$).

There were no other significant differences in baseline variables. The only significant group difference in activity was that knee patients displayed significantly higher average intensity than lumbar patients (mean 6.57 v. 5.17, $p < 0.05$); hip patients were not significantly different from either (mean 5.94). There were no other group differences in ambulation. However, both age ($p < 0.05$) and kinesiophobia ($p < 0.05$) were significantly correlated with postoperative activity. **Conclusion:** This study supports previous findings that postoperative recovery in spine patients is similar to that of hip and knee patients. It is interesting that a measure of kinesiophobia (fear of reinjury with movement/exercise) is the only significantly correlated variable other than age in this analysis. This may indicate the importance of educating patients about the importance and safety of postoperative ambulation during recovery.

37.3.2 Pain on the brain: Is the SF-36 mental component summary enough? ***Erin Bigney,*[*] *Neil A. Manson,*[*†] *Alana J. Green,*[*] *Edward P. Abraham.*[*†] **From** [*]**Canada East Spine Centre, Horizon Health Network, N.B.,** [†]**Dalhousie Medicine New Brunswick, Saint John, NB.**

Background: Patient ability to cope with pain is gaining increasing attention in spine surgery research. However, most databases do not include psychological measures beyond the SF-36 mental component summary (MCS). This study aimed to correlate MCS scores with thoracolumbar spine surgery outcomes to determine the strength of this association. We believe this offers a preliminary indication as to whether the MCS is sufficient for measuring psychological factors that contribute to spine patient outcomes. **Methods:** We performed an ambispective cohort analysis of 462 consecutive patients from a prospective spine surgery outcomes database. Minimum follow-up was 1 year. Exclusions were previous spinal fusion, spine-related litigation or malignancy. Primary measures were pre- versus postoperative change in SF-36 physical component summary (PCS), Oswestry Disability Index (ODI), back and leg pain numerical rating scales (NRS-B; NRS-L) and patient satisfaction. Secondary measures were demographics (age, sex, body mass index [BMI], primary diagnosis, primary symptom), length of hospital stay (LOS), adverse events (perioperative, postoperative, postdischarge, reoperation). Preoperative MCS values were linearly regressed against each continuous dependent variable. Categorical variables were analyzed using χ^2 tests by dividing preoperative MCS scores by quartiles. **Results:** The average preoperative MCS score was 43.48 ± 11.91 (range11–70). The MCS score was a significant predictor of SF-36 PCS change (b = 0.22, $t_{445} = 4.82$, $p < 0.001$; $R^2 = 0.05$, $F_{1,445} = 23.21$, $p < 0.001$) and ODI change (b = 0.15, $t_{460} = 3.23$, $p = 0.001$; $R^2 = 0.22$, $F_{1,460} = 10.45$, $p = 0.001$). The MCS scores also predicted patient satisfaction (b = 0.17, $t_{448} = 3.62$, $p < 0.001$; $R^2 = 0.03$, $F_{1,448} = 13.11$, $p < 0.001$). However, preoperative MCS scores did not significantly predict change in NRS-B or NRS-L, LOS or BMI. There were no differences in sex or adverse events by MCS quartiles. Interestingly, MCS scores did predict age at surgery (b = 0.22, $t_{459} = 4.83$, $p < 0.001$; $R^2 = 0.03$, $F_{1,459} = 23.36$, $p < 0.001$). **Conclusion:** While MCS scores are correlated with many outcome measures, the correlations are not as strong as those yielded by other past measures of pain coping and social support. Regression slopes are weak and the percent variance accounted for is negligible. Future research should compare MCS to other common psychological measures. This may highlight the importance of integrating different psychological measures into large-scale spine surgery databases.

38.3.2: Accurate and safe cervical osteotomy for kyphotic deformity in ankylosing spondylitis. ***Jacques Bouchard, John Hurlbert, Ken Mogadham, Ganesh Swamy, Antonio Tsahtsarlis*. From University of Calgary, Calgary, Alta.**

Background: The purpose of this paper is to describe a safer and more accurate technique for the surgical correction of cervical thoracic kyphotic deformity in association with ankylosing spondylitis. **Methods:** Traditional surgery for the correction of deformity in the cervical spine has been with the patient sitting and awake, with local anesthesia. The osteotomy is performed, then the surgeon manually manipulates the head and neck into position before fixing the spine with a halo and internal fixation. The principle risks are over/undercorrection and paralysis from spinal cord damage. The modification in techniques discussed here are 1) awake intubation and general anesthesia throughout procedure, 2) intraoperative spinal cord monitoring, 3) gradual multiplanar correction using distraction external fixator (Ilizarov distraction bars from circular fixators, Orthofix external fixator or special design turnbuckle fixator) attached to the halo, and 4) internal fixation of the spine. **Results:** Twenty-seven patients have undergone gradual multiplanar correction. Follow-up is 1–5 years. The chin brow angles have improved from 42.5° preoperative (range 32–55°) to 8.1° postoperative (range 0–20°). In 5 patients with coronal tilt the correction was from 17.4° preoperative (range 7–35°) to 4.4° postoperative (range 0–12°). Four patients had complications, 2 of which were transient and minor. All patients were very satisfied with the procedure and results. **Conclusion:** The basic osteotomy technique remains unchanged, but since the correction is assisted with distraction devices more precise alignment of the spine can be obtained while maintaining its stability. At no time during the procedure is the head not stabilized by the halo. Use of the external devices permits a variation of distraction moment and direction. Having the procedure done under general anesthesia has improved patient acceptance. Excellent multiplanar correction of cervical deformity in ankylosing spondylitis can be accomplished safely and accurately with the described technique.

39.3.3: Adjacent segment pathology in the lumbar spine: progressive disease or a consequence of iatrogenic fusion? ***Andrew Jack, Mashfiqul Siddiqui, Godefroy Hardy-St. Pierre, Andrew Nataraj*. From University of Alberta, Edmonton, Alta.**

Background: Clinical adjacent segment pathology (CASP) following surgery in the lumbar spine has a literature-reported range of 5.2%–18.5%. However, it is unclear whether CASP occurs due to increased mechanical stress created by a fusion segment or represents a progression of lumbar degenerative change in patients predisposed to spondylosis. We aimed to address this question by comparing prevalence of CASP in traumatic and spondylotic patient cohorts. **Methods:** We performed a retrospective cohort study comparing the prevalence of adjacent segment surgery for CASP in patients who underwent lumbar spinal fusion for trauma versus for degenerative disease in a single centre between 2002 and 2008. Outcome measures were

the incidence of subsequent surgery for CASP and radiological evidence of CASP. Several clinical factors were also compared between groups. **Results:** There were significant baseline differences in mean age (trauma: 38.6 yr v. spondylotic: 49.7 yr, $p < 0.01$, t test), sex (trauma: 78% males v. spondylotic: 50% males, $p < 0.01$, Fisher test), median follow-up (trauma: 8 yr v. spondylotic: 6 yr, $p < 0.01$, Wilcoxon test), and median number of levels fused (trauma: 3 v. spondylotic: 1, $p < 0.01$, Wilcoxon test). Univariate analysis revealed a significant difference in the proportion of patients experiencing CASP between groups (trauma: 0/40 v. spondylotic: 15/100, $p < 0.01$, Fisher test). Stratified analysis controlling for sex and age still revealed a significant difference in CASP between groups ($p < 0.05$, Fisher test). Logistic regression analysis could not be performed since there were no cases of CASP in the trauma cohort. Due to a longer follow-up in the trauma group (biasing toward CASP development), it was not adjusted for. **Conclusion:** We found a higher rate of repeat surgery for CASP in patients with degenerative lumbar disease. This finding suggests that the cause of CASP is patient factors predisposing to progressive degenerative disease, not mechanical factors induced by surgical intervention.

40.3.3: The association of cervical spine alignment with neurological recovery in a prospective cohort of surgical myelopathy patients: analysis of a series of 124 cases. ***Mohammed Shamji,*[*†] *Chandan Mohanty,*[*†] *Eric Massicotte,*[*†] *Michael Fehlings.*[*†] **From [*]Toronto Western Hospital, Toronto, Ont., [†]University of Toronto, Toronto, Ont.**

Background: There is evidence that both cervical sagittal alignment and spinal cord MRI hyperintensity correlate with disease severity in cervical spondylotic myelopathy (CSM) patients. The impact of spinal alignment on neurological recovery in patients has not been thoroughly investigated. The goal of this study was to evaluate the impact of sagittal alignment and magnetic resonance imaging (MRI) abnormalities on neurological recovery in a prospective surgical series of myelopathy patients. **Methods:** An ambispective analysis of prospectively collected data was performed of surgical patients with CSM at a single tertiary-care neurosurgical centre. Demographic data and clinical preoperative and postoperative measures of neurological disability (mJOA, Nurick, NDI scores) were collected and analyzed for dependency on cervical spine imaging parameters including alignment (kyphotic v. lordotic) and spinal cord signal abnormality (quantitative hyperintensity). Multiple logistic regression analysis was utilized at the 0.05 level of significance with correction for multiple comparisons. **Results:** Among 124 CSM patients, kyphotic alignment was seen in 34% of patients. Surgical intervention was more frequently anterior or combined anterior/posterior in this group than in those with preserved lordosis. Most patients exhibited postoperative neurological improvement for myelopathy severity; however, the extent of improvement was dichotomous based on preoperative sagittal alignment. Improvement was noted to a greater extent among patients with preoperative lordosis (DmJOA of 3.1) than among patients with preoperative kyphosis (DmJOA of 1.4, $p = 0.02$). Surgical correction of spinal malalignment did not improve neurological recovery, although it is unclear whether it protects against symptomatic adjacent segment disease. **Conclusion:** Most CSM patients showed postoperative neurological improvement. Patients with preoperative lordotic alignment exhibited greater improvement than those with preoperative kyphotic alignment. Neither correction of spinal alignment nor choice of surgical approach in this series specifically affected the extent of neurological recovery.

41.3.3: Use of neuropathic pain questionnaires in predicting the development of failed back surgery syndrome following lumbar discectomy for radiculopathy. ***Mohammed Shamji,*[*†] *Alina Shcharinsky.*[*†] **From [*]Toronto Western Hospital, Toronto, Ont., [†]University of Toronto, Toronto, Ont.**

Background: Failed back surgery syndrome (FBSS) describes neuropathic pain that occurs when extremity symptoms in lumbar disease persist despite structurally corrective spinal surgery. It is unclear whether specific preoperative pain characteristics predict which patients are prone to this postoperative persistence of their disabling symptoms. **Methods:** This prospective study analyzed surgical patients with painful radiculopathy secondary to lumbar degenerative disease. Clinical parameters included general demographic information, preoperative and postoperative clinical examination, self-reported pain and disability scores, and neuropathic pain scoring. The neuropathic pain screening tests used were the Douleur Neuropathique 4 (DN4) and Leeds Assessment of Neuropathic Symptoms and Signs (LANSS), with correlation tested for ordinal score and screen positivity. Multiple logistic regression analysis was used to define predictors of postoperative symptomatology. **Results:** Among 250 surgical radiculopathy patients, 12% were classified with FBSS with only modest relief of leg pain. The condition was highly associated with abnormal preoperative screens for neuropathic pain but not sex, smoking status or preoperative pain severity (multiple logistic regression, $\alpha = 0.05$). Good correlation was seen between the 2 screening tests used in this study for both absolute ordinal score (Spearman $r = 0.84$, $p < 0.001$) and thresholding for determining the patient as having neuropathic pain features (Spearman $r = 0.48$, $p < 0.001$). **Conclusion:** While FBSS was more common among younger and female patients, it occurred with low overall frequency in this population. Higher neuropathic pain screening scores correlated strongly with likelihood of significant postoperative leg pain. Further work is required to develop more accurate prognostication tools for radiculopathy patients undergoing structural spinal surgery.

42.3.3: Quality of life and neurological outcomes after surgical decompression in patients with cervical ossification of the posterior longitudinal ligament: prospective, multicentre AOSpine International study of 479 patients. ***Hiroaki Nakashima,*[*†] *Lindsay Tetreault,*[*‡] *Narihito Nagoshi,*[*†] *Nouri Aria,*[*‡] *Michael Fehlings.*[*‡] **From [*]University of Toronto, Toronto, Ont., [†]Nagoya University Graduate School of Medicine, Nagoya, Japan, [‡]Toronto Western Hospital, Toronto, Ont.**

Background: Degenerative cervical myelopathy (DCM) is an all-encompassing term that includes cervical spondylotic myelopathy (CSM), ossification of the posterior longitudinal ligament (OPLL) and other degenerative changes to the cervical spine. It is unclear whether surgery is equally effective and safe in patients with OPLL as it is in other forms of DCM. If outcomes are comparable between disease causations, there will be further justification to unify the terminology in this field and adopt the term

"DCM." The aim of this study is to compare the impact of surgical decompression on functional status and quality of life outcomes between patients with OPLL and those with other forms of DCM. **Methods:** A total of 479 patients with symptomatic DCM undergoing surgery were prospectively enrolled in the Cervical Spondylotic Myelopathy-International study at 16 global sites (6 in Asia Pacific, 5 in Europe, 3 in South America and 2 in North America). Patients' functional and neurologic statuses were quantified using the modified Japanese Orthopaedic Assessment scale (mJOA). The Nurick score and patients' quality of life (QOL) were assessed using self-reported outcome measures, such as the neck disability index (NDI), and the SF-36 health survey. Functional status and QOL were compared between baseline and 1 year postoperative in patients with OPLL and those with other forms of DCM. **Results:** Of 479 patients, 135 (28.2%) exhibited imaging evidence of OPLL while 344 (71.8%) displayed other forms of degenerative changes. There were no significant differences in demographics, surgical approach or most baseline severity sores between patients with OPLL and those with other forms of DCM. Patients with OPLL achieved similar functional outcomes at 1 year following surgery when compared with patients with other forms of DCM. With respect to QOL scores, the NDI and most of the subscales of the SF-36 did not differ between the 2 groups. However, the SF-36 role limitation physical subscale (p = 0.009) and the SF-36 social functioning subscale (p = 0.01) were significantly lower in OPLL patients. Finally, there were more perioperative complications in the OPLL group, but more than half of these were superficial infections. **Conclusion:** Surgical decompression for the treatment of cervical OPLL results in significant improvements in QOL and neurologic status, comparable to gains seen in other forms of DCM. The majority of perioperative complications in OPLL were transient and without long-term functional consequences. These results provide another basis for unifying nomenclature and using the standard term "DCM."

43.3.4: Minimally invasive decompression in focal lumbar spinal stenosis with or without stable spondylolisthesis — comparative outcomes and reoperation rates at a minimum of 2 years. *B. Roy Chaudhary, Rohit Amritanand, Y. Raja Rampersaud*. From University Health Network, Toronto Western Hospital, Toronto, Ont.

Background: The objective of the study was to assess surgical and patient-reported outcomes following decompression alone in selected patients with degenerative lumbar spondylolisthesis (DLS) compared to those with no DLS. **Methods:** A single-surgeon consecutive series of patients undergoing surgery for lumbar spinal stenosis with a minimum 2-year follow-up were assessed as part of an ongoing prospective observational study. Primary outcome measures were Oswestry Disability Index (ODI) scores and reoperation rates. Decompression alone was chosen for patients with neurogenic claudication/radiculopathy or no tolerable mechanical back pain and no dynamic instability (< 5 mm of motion). All patients underwent bilateral decompression via a unilateral minimally invasive approach. **Results:** A total of 157 lumbar spinal stenosis (LSS) patients had surgery between January 2007 and June 2011: 62 with DLS and 95 without. The cohorts were comparable for age (p = 0.51) and preoperative ODI score (p = 0.74). The DLS cohort had a greater proportion of women (p = 0.02). There was significant ODI improvement in both cohorts (DLS mean baseline ODI improved from 40 to 23 at 2 years [$p < 0.01$] and in no DLS from 39 to 26 [$p < 0.01$]). The change in ODI was comparable in the 2 cohorts (p = 0.18). The VAS leg and back scores similarly improved between cohorts (p = 0.50 and 0.22, respectively). Satisfaction was also similar in the 2 groups (88% of DLS patients rated their postsurgical satisfaction scores as favourable, while for no DLS patients this was 82%, p= 0.56). In the DLS cohort, the reoperation rate was 11.3% at a mean follow-up of 3.06 (range 2–4) years. For those without DLS the reoperation rate was 11.6% at a mean follow-up of 4.49 (range 2–6) years. **Conclusion:** Using the aforementioned selection criteria, DLS patients undergoing decompression alone have excellent intermediate term results comparable to LSS patients without DLS. For highly selected DLS patients, successful outcomes without a fusion are achievable.

44.3.4: Impact of nonoperative care utilization on postthoracolumbar spine surgery outcomes: a national perspective using the CSORN registry. *Michael Johnson,[*] Steven Passmore,[*] Greg McIntosh.[†]* From [*]University of Manitoba, Winnipeg, Man., [†]Canadian Spine Outcomes and Research Network.

Background: A standard justification for scheduling elective spine surgery for degenerative pathology is that nonoperative care options have been exhausted. There are no standardized definitions of either "nonoperative" or "exhausted." Our objective was to assess the impact of nonoperative care in the 6 months preceding spine surgery on postsurgical outcomes across Canada. **Methods:** Participants (n = 456) had degenerative spinal pathology or deformity of the thoracolumbar region, with no evidence of trauma, infection or neoplasm. They consented to the Canadian Spine Outcomes and Research Network (CSORN), then proceeded to spine surgery between January 2012 and August 2014. Outcomes assessed were change in pain, disability and VAS-EuroQuol for health-related quality of life. **Results:** Prior to surgery, nonoperative treatment was not routinely provided; 51% (n = 233) attended no therapy, 34% (n = 156) attended some, while only 15% (n = 67) had more than 30 visits within 6 months. Those attending nonoperative therapy 1–30 times within 6 months presurgery had a statistically significant improvement in health-related quality of life score from baseline (52.3 ± 22.5) to follow-up (70.5 ± 17.5) compared with those who did not attend any presurgical care (baseline: 51.7 ± 20.4; follow-up: 64.9 ± 20.7, $F_{2,372}$ = 3.44, p = 0.033). For Oswestry Disability Index score, there was a trend approaching statistical significance toward improvement for those attending nonoperative therapy more than 30 times (baseline: 52.9 ± 16.4; follow-up: 33.5 ± 20.2) compared with those who did not attend any presurgical care (baseline: 51.1 ± 16.0; follow-up: 38.5 ± 19.0, $F_{2,317}$ = 2,855, p = 0.059). No other significant differences were found. **Conclusion:** Failure of nonoperative care does not appear be a common prerequisite for elective thoracolumbar surgery. Presurgical nonoperative care was underutilized; approximately half the patients did not attend any therapy at all. Presurgical nonoperative intervention improved postsurgical health-related quality of life, with an additional trend toward decreasing disability. Only after consistent referral to structured and exhaustive nonoperative therapy can the role of nonoperative treatment in complimenting surgical outcomes be validly determined.

45.3.4: Presurgical imaging, testing and injection utilization in elective thoracolumbar spine surgery candidates: a nationwide analysis from the CSORN database. *Neil Manson,[*†] Edward Abraham,[*†] Alana Green,[*†] Greg McIntosh.*[‡] **From [*]Canada East Spine Centre, Horizon Health Network, Saint John, NB, [†]Dalhousie Medicine New Brunswick, Saint John, NB, [‡]Canadian Spine Outcomes and Research Network.**

Background: The objective was to assess the utilization of imaging, tests and injections in spine surgery candidates in the 6 months before surgical booking. **Methods:** We conducted a retrospective analysis of prospectively collected data from the Canadian Spine Outcomes and Research Network (CSORN). Twelve spine surgery sites across Canada contributed patient data for possible spine surgery cases between October 2008 and September 2014. Patients (n = 527) had degenerative spinal pathology or deformity of the thoracolumbar region. Frequencies were tabulated to estimate some of the imaging, testing and spinal injection utilization by spine surgery candidates before surgeon consultation. **Results:** Patients reported 836 counts of 1 use, 274 counts of 2 uses, 126 of 3 and 236 counts of more than 3 uses. This equals a conservative estimate (if > 3 = 4) of 1471 imaging, tests and/or injections. The EMG/nerve conduction tests and bone scans were used the least. Magnetic resonance imaging had the highest prevalence of use, followed by X-rays. There was no statistically significant difference in the frequency of X-ray utilization in those with deformity, fracture or spondylolisthesis compared with those with infection, tumour, disc herniation, degenerative disc disease or stenosis. There was a significant difference in pain ratings by imaging frequency. Those with no X-ray had significantly higher leg pain ratings than those with more than 3 X-rays (p < 0.05). Patients with no CT imaging had the highest leg pain ratings; patients with more than 3 CT scans had the lowest leg pain ratings (p < 0.05). Those with 1 MRI had significantly higher leg pain ratings than those with more than 3 X-rays (p < 0.05). **Conclusion:** There is an inverse association between the amount of pain and the frequency of the imaging test. Despite numerous guidelines and published reports that suggest the limited value of X-raying patients with uncomplicated back pain, this imaging technique remains a popular choice. Patients requiring spine surgery demonstrate a high utilization of healthcare resources, including diagnostic imaging, on their pathway to the surgeon. Defining a Canadian strategy to manage and optimize the care and resource utilization for these patients is required.

46.3.5: A clinical prediction rule for clinical outcomes in patients undergoing surgery for degenerative cervical myelopathy: analysis of an international AOSpine prospective multicentre dataset of 743 patients. *Lindsay Tetreault,[*†] Branko Kopjar,[‡] Pierre Cote,[§] Michael Fehlings,[*†] Paul Arnold.*[¶] **From [*]University of Toronto, Toronto, Ont., [†]Toronto Western Hospital, Toronto, Ont., [‡]University of Washington, Seattle, Wash., [§]University of Ontario Institute of Technology, Toronto, Ont., [¶]Kansas University Medical Center, Kansas City, Kan.**

Background: Cervical spondylotic myelopathy (CSM) is a degenerative spine disease that is often treated surgically. International differences in patient demographics and disease presentation, along with biases in surgical practice, may contribute to regional differences in patient prognosis. This study aims to determine the most important global clinical predictors of surgical outcome in patients undergoing surgery for CSM, based on data from 2 multicentre prospective studies. **Methods:** A total of 743 surgical CSM patients participated in either the CSM-North America or CSM-International study. The model was developed to distinguish between patients with mild myelopathy at 1 year postoperatively (mJOA ≥ 16) and those with substantial residual neurologic impairment (mJOA < 16). Univariate analyses were performed to evaluate the association between outcome and various clinical predictors. Multivariate logistic regression was used to formulate the final prediction model. **Results:** Univariate analyses demonstrated that the odds of a achieving a score ≥ 16 decreased with the presence of certain symptoms, including impaired gait; the presence of certain signs, such as lower limb spasticity; positive smoking status; a higher comorbidity score; more severe preoperative myelopathy; and older age. The final prediction model included age (odds ratio [OR] 0.97 p = 0.0017), duration of symptoms (OR 0.88, p = 0.049), smoking status (OR 0.51, p = 0.0018), impairment of gait (OR 1.94, p = 0.0168), broad-based unstable gait (OR 1.75, p = 0.0133), baseline severity (OR 1.23, p < 0.0001) and comorbidity score (OR 0.84, p = 0.0030). **Conclusion:** Patients are more likely to achieve a score ≥ 16 if they are younger, have a shorter duration of symptoms, are less severe preoperatively, do not smoke and do not have comorbidities or evidence of gait dysfunction.

47.3.5: A comparison of health-related quality of life outcomes in spinal cord injury patients residing in rural and urban areas. *R. Andrew Glennie,[*] Juliet Batke,[†] Nicolas Dea,[†] Marcel Dvorak,[†‡] Vanessa Noonan,[†‡] John Street.*[†] **From [*]Dalhousie University, Halifax, NS, [†]Combined Neurosurgical and Orthopaedic Spine Program, University of British Columbia, Vancouver, BC, [‡]Rick Hansen Institute, Vancouver, BC.**

Background: Our objectives were to 1) describe the differences in health-related quality of life (HRQOL) outcomes in those patients residing in rural versus urban areas after spinal cord injury (SCI) at 1 and 5 years; 2) determine whether patients originally residing in a rural area are able to maintain their place of residence after SCI; and 3) describe some potential interventions early in acute hospital and rehabilitation phases of stay that may help patients maintain their place of residence. **Methods:** Patients admitted to Vancouver General Hospital or GF Strong Rehabilitation Centre with a traumatic SCI between 2004 and 2012 were identified using the Rick Hansen Spinal Cord Injury Registry (RHSCIR). Health-related quality of life was determined with SF-36 physical and mental scores. Functional and health outcomes were determined using the functional independence measures (FIM), Craig Hospital Inventory of Environmental Factors–Short Form (CHIEF-SF) and the spinal cord injury patient health questionnaire (PHQ-9). **Results:** We identified 867 RHSCIR participants. Prior to injury, 41.7% of participants lived in a rural setting. Of the rural participants with 5-year follow-up data, only 44.8% were able to maintain their rural place of residence. Admission demographic data comparing the urban and rural groups was similar except for age at injury, which was greater for urban participants (p < 0.001). Urban patients had a significantly higher incidence of depression at 1 year on PHQ-9 (p = 0.01). There was no significant difference in SF-36, FIM,

CHIEF-SF and PHQ-9 scores for each group at 1 and 5 years. **Conclusion:** A significant proportion of rural patients move to larger urban centres after SCI at 1 year. The HRQOL outcomes were similar between urban and rural patients at 1 and 5 years.

48.3.5: Minimally invasive versus open discectomy: a systematic review and meta-analysis. ***Nathan Evaniew, Moin Khan, Brian Drew, Desmond Kwok, Mohit Bhandari, Michelle Ghert*. From McMaster University, Hamilton, Ont.**

Background: Minimally invasive surgical (MIS) techniques may accelerate recovery and reduce pain, but they also require technical expertise and involve increased risks. This meta-analysis was performed to determine the effects of MIS techniques on function, pain, complications and reoperations for cervical and lumbar discectomies. **Methods:** MEDLINE, EMBASE and Cochrane Library were systematically searched up to Jan. 12, 2014. Two reviewers assessed eligibility and risk of bias. Functional outcomes were pooled using standardized mean differences (SMDs) and complications were pooled dichotomously. Minimal important differences (MIDs) were incorporated to aid interpretation. Quality of evidence was summarized using the Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach. **Results:** Ten trials reported on lumbar discectomies (n = 1159) and 4 reported on cervical discectomies (n = 431). The MIS techniques did not improve function (cervical SMD 0.11, 95% CI –0.09 to 0.31; lumbar SMD 0.04, 95% CI –0.11 to 0.20) or reduce pain (cervical SMD –0.21, 95% CI –0.52 to 0.10; lumbar SMD 0.08, 95% CI –0.16 to 0.32). Evidence suggested overall higher rates of nerve root injuries (relative risk [RR] 1.62, 95% CI 0.45–5.84), incidental durotomies (RR 1.56, 95% CI 0.80–3.05) and reoperations (RR 1.48, 95% CI 0.97–2.26) with MIS techniques. Infections trended toward being more common with open procedures (RR 0.24, 95% CI 0.04–1.38). Evidence overall was low to moderate quality. **Conclusion:** Current evidence does not support the routine use of MIS cervical and lumbar discectomies. Further high-quality trials are warranted given the lack of high-quality evidence.

49.1.1: Validity of transcranial motor evoked potentials as early indicators of neural compromise in rat model of spinal cord compression. ***Susan Morris,*[*†] *Jason Howard,*[‡] *Douglas Rasmusson,*[†] *Ron El-Hawary.*[*†] **From [*]IWK Health Centre, Halifax, NS, [†]Dalhousie University, Halifax, NS, [‡]Sidra Medical and Research Center, Doha, Qatar.**

Background: We sought to determine the temporal threshold at which complete (100%) loss of intraoperative transcranial motor evoked potentials (TcMEPs) will result in significant postoperative functional deficits. **Methods:** We divided 24 adult male Wistar rats into 3 experimental groups according to the length of time that 100% TcMEP signal loss was maintained. All animals had preoperative functional testing. Following surgical placement of a balloon catheter in the thoracic sublaminar space, TcMEPs were recorded while the spinal cord was compressed by balloon inflation. The recordings were terminated after maintaining a 100% TcMEP loss for different time periods (0, 5 or 15 min). Functional behavioural testing was repeated after 24 hours. **Results:** Only the group where the catheter was left inflated for 5 or 15 minutes after a complete (100%) loss of TcMEP amplitude showed a significant deterioration in functional testing as compared with preoperative baseline values. Functional testing remained normal for the control group and for the group in which termination of spinal cord compression occurred immediately after a decrease of TcMEP amplitude to 100%. There was a strong correlation between TcMEP amplitude recovery post-intervention and functional ability at 24 hours postsurgery. **Conclusion:** If 100% loss of TcMEP signals is immediately recognized and reversed by rapid removal of the compressive force on the spinal cord, normal postoperative function was observed in this rat model. However, delaying intervention for even 5 minutes can result in significant postoperative functional deficits.

50.1.2: Validation of true spine length radiographic measurements. ***Alan Spurway,*[*†] *Waleed Kishta,*[*] *Chukwudi Chukwunyerenwa,*[*] *Ron El-Hawary.*[*†] **From [*]IWK Health Centre, Halifax, NS, [†]Dalhousie University, Halifax, NS.**

Background: A diminishing returns effect for vertical growth of coronal T1–S1 height has been suggested during treatment for early onset scoliosis (EOS). It has been theorized that the increased length from treatment surgeries translates into increased thoracic kyphosis. Out-of-plane growth is not captured with the standard coronal height measurement. A new technique using custom software has been produced to measure the sagittal plane true spine length (TSL). **Methods:** Accuracy and inter-rater reliability (IRR) in superoptimal conditions was tested using phantom models. Six kyphotic curve configurations were created. The T1–T12 TSL and geometric chord distances were measured physically and electronically. Four reviewers used the software to measure the TSL, height and chord lengths of the thoracic sections on 23 consecutive preoperative EOS patient posterioranterior (PA) and lateral radiographs. The reviewers then measured the PA height, sagittal height and chord, Cobb and kyphosis angles of the same patients using commercial software. To assess intrarater reliability, measures were repeated 2 weeks or more after initial collection. **Results:** The IRR for the phantom models was excellent with an average intraclass correlation coefficient (ICC) of 0.999 (0.994–1.000) and an average absolute error of 0.27 mm (0.00–0.55). Clinical testing showed excellent IRR for the PA view with an average ICC of 0.980 (0.959–0.991). The IRR for sagittal views had an average of 0.818 (0.604–0.923). Errors between reviewers ranged from an average 9.44 mm PA to 19.33 mm sagittal. **Conclusion:** The TSLs are accurate and consistent measurements during superoptimal and optimal conditions. The crowded thoracic anatomy on lateral images causes measurement IRR decreases in both the custom and commercial software. Higher-quality lateral images will increase usability and accuracy of the software. Sagittal TSL and chord lengths are reliable measures that can add information to the assessment of growth during EOS treatment.

51.1.3: Closure of the intervertebral disc annulus fibrosus using a novel suture application device — in vivo porcine and ex vivo biomechanical evaluation. ***Antony Bateman,*[*†] *Christian Balkovec,*[‡] *Margarete Akens,*[*] *Robert Harrison,*[§] *Stuart McGill,*[‡] *Albert Yee.*[*†] **From [*]University of Toronto, Toronto, Ont., [†]Sunnybrook Health Sciences Centre, Toronto, Ont., [‡]University of Waterloo, Waterloo, Ont., [§]Anchor Orthopedics XT Inc., Mississauga, Ont.**

Background: Defects in the annulus fibrosus (AF) remain a challenge in the surgical treatment of lumbar disc herniations, with

persistent defects allowing potential reherniation of nucleus pulposus (NP) tissue. We performed an in vivo feasibility study of a minimally invasive Kerrison-shaped suture device designed to achieve closure of AF defects in the intervertebral disc. A cervical porcine model was chosen to simulate human lumbar discs. **Methods:** Three pigs (53–57 kg) were anesthetised and underwent a ventral surgical approach to the cervical spine (C2/3–C5/6). The AF of 2 discs was incised with a scalpel in a vertical fashion and a simulated partial NP discectomy performed. The resultant defect was closed at 1 randomly selected level using the ANCHORKNOT device to apply a 2–0 nonabsorbable UHMWPE suture with a Dines knot and 4 half-hitches. This was the optimal configuration based on preliminary ex vivo biomechanical tests. The pigs were then observed for 4 weeks before euthanasia. The excised cervical spine underwent 7 T MRI followed by histological hematoxylin-eosin evaluation. **Results:** A Dines knot with 4 half hitches resulted in no knot slippage after motion segments were subjected to 4000 cycles of flexion and extension with 1500 N of axial load. Clinically, the neurologic examination in treated pigs was normal following surgery. Histological and MRI assessment confirmed sustained defect closure at 4 weeks. There was no significant reaction to the suture material and no NP extrusion at any of the sutured levels. **Conclusion:** Our in vivo porcine study demonstrates that it is technically feasible to perform a suture repair of an AF defect using this novel device, with sustained defect closure through 4 weeks. This technique may reduce the incidence of early disc reherniation following discectomy through closure of the AF defect, although further study is required to assess this potential application.

52.1.4: Vertebroplasty versus kyphoplasty in osteoporotic vertebral compression fracture model: What is safer? ***Fahad Abduljabbar,*[*†] *Abdulaziz Al-Jurayyan,*[*] *Saad Alqahtani,*[*] *Zeeshan Sardar,*[*] *Rajeet Singh Saluja,*[*] *Jean Ouellet,*[*] *Michael Weber,*[*] *Thomas Steffen,*[*] *Lorne Beckman,*[*] *Peter Jarzem.*[*] **From [*]McGill University Health Centre, Montréal, Que., [†]King Abdulaziz University, Jeddah, Saudi Arabia.**

Background: Kyphoplasty and vertebroplasty are widely used techniques to alleviate pain in fractures secondary to osteoporosis. However, cement leakage toward vital structures like the spinal cord can be a major source of morbidity and even mortality. We define safe cement injection as the volume of cement injected into a vertebra before cement leakage occurs. Our objective is to compare the amount of cement that can be safely injected into an osteoporotic vertebra with simulated compression fracture using either vertebroplasty or balloon kyphoplasty. **Methods:** Forty artificial vertebral analogues made of polyurethane with osteoporotic cancellous matrix representing the L3 vertebrae were used for this study that were divided into 4 groups of 10 vertebrae each. The 4 groups tested were low viscosity cement injected using vertebroplasty, high viscosity cement injected using vertebroplasty, low viscosity cement injected using balloon kyphoplasty, and high viscosity cement injected using balloon kyphoplasty. The procedures were carried out under fluoroscopic guidance. Injection was stopped when the cement started protruding from the created vascular channel in the osteoporotic vertebral fracture model. The main outcome measured was the volume of cement injected safely into a vertebra before leakage through the posterior vascular channel. **Results:** The highest volume of cement injected was in the vertebroplasty group using high viscosity cement, which was almost twice the injected volume in the other 3 groups. One-way analysis of variance comparing all groups showed a statistically significant difference ($p < 0.005$). **Conclusion:** High viscosity cement injected using vertebroplasty delivers more cement volume before cement leakage and fills the vertebral body more uniformly when compared with balloon kyphoplasty in osteoporotic vertebrae with compression fractures.

53.1.5: Brain-derived neurotrophic factor promotes intraneural macrophage migration and allodynia in experimental disc-herniation neuropathy. ***Mohammed Shamji,*[*†] *YuShan Tu,*[‡] *Michael Salter.*[‡] **From [*]Toronto Western Hospital, Toronto, Ont., [†]University of Toronto, Toronto, Ont., [‡]SickKids Research Institute, Toronto, Ont.**

Background: Disc herniation–induced radiculopathy arises from both mechanical compression and biochemical inflammation of apposed neural elements. This study demonstrated the need for intraneural macrophage migration after placement of heterotopic disc tissue to generate the painful neuropathy phenotype. **Methods:** C57BL/6 mice underwent a surgical procedure with mid-thigh exposure of the sciatic nerve. Control animals underwent exposure only, whereas experimental animals underwent placement of littermate tail nucleus pulposus (NP). Animals were evaluated throughout 1 week for mechanical allodynia by Von Frey testing, thermal hyperalgesia by heat withdrawal latency, cold allodynia by acetone testing and gait stability by RotaRod testing. At sacrifice, immunohistochemistry was performed to identify perineural and intraneural macrophage and lymphocyte presence. Necessity of an inflammatory response in developing the positive findings was tested by inducing macrophage apoptosis using bisphosphonate liposomes and by limiting macrophage migration using a tamoxifen-induced CreER brain-derived neurotrophic factor (BDNF) knockout system, as well as local anti-BDNF therapy. **Results:** Mice exposed to heterotopic NP stimulation demonstrated substantial mechanical allodynia, thermal hyperalgesia and cold allodynia compared with controls. Intraneural macrophage infiltration was observed in this group, alongside associated autoreactive lymphocytes at the disc-nerve interface. Selective deletion of macrophage BDNF activity or perineural delivery of BDNF antagonists blocked both macrophage infiltration and the painful phenotype. Taken together, these suggest an important role for BDNF-mediated macrophage migration in the development of experimental radiculopathy, beyond simply macrophage-mediated inflammation. **Conclusion:** Noncompressive disc herniation leads to altered behaviour in this animal disease model, with demonstrated need for intraneural macrophage migration. Strategies to decrease perineural inflammation or maintain integrity of the blood/nerve barrier may be effective in treating painful disc-herniation radiculopathy.

54.1.6: Development and evaluation of an open-source 3D virtual simulator with integrated motion-tracking as a teaching tool for pedicle screw insertion. ***Stewart McLachlin, Brendan Polley, Mirza Beig, Jeremie Larouche, Cari Whyne*. From Sunnybrook Research Institute, Toronto, Ont.**

Background: Simulation is an effective adjunct to the traditional surgical curriculum, though access to these technologies is often limited and costly. The objectives of this work were to develop a

freely accessible virtual pedicle screw simulator and to improve the clinical authenticity of the simulator through integration of low-cost motion tracking. **Methods:** The open-source medical imaging and visualization software 3D Slicer was used as the development platform for the virtual simulation. 3D Slicer contains many features for quickly rendering and transforming 3D models of the bony spine anatomy from patient-specific CT scans. A step-wise pedicle screw insertion workflow module was developed that emulated typical preoperative planning steps. This included taking anatomic measurements, identifying insertion landmarks, and choosing appropriate screw sizes. Virtual monitoring of the surgeon's simulated tool was assessed with a low-cost motion tracking sensor in real-time (about $80, Leap Motion). This allowed a screw surrogate (i.e., pencil) to be tracked as the surgeon defined the virtual screw's insertion point and trajectory on a 3D spine model. The final step graded screw insertion based on bone density contact and cortical breaches. **Results:** Using a combination of existing and custom-written 3D Slicer modules, a robust and accessible virtual simulator was created. Initial surgeon feedback of the virtual simulator with integrated motion tracking was positive, with no noticeable lag and high accuracy between real-world and virtual environments. The software yields high-fidelity 3D visualization of the complex geometry and the tracking enabled coordination of motion to small changes in both translational and angular positioning. **Conclusion:** Free software and low-cost tracking can facilitate widespread adoption of simulation technology for pedicle screw insertion (and other implants). Future work will evaluate the benefit of this simulation platform with use over the course of resident spine rotations to improve planning and surgical competency, and in quantitatively evaluating performance.

55.2.7: Preoperative "amber flag" psychological measure scores and patient expectations: a nationwide analysis from the CSORN database. ***Neil Manson,*[*†] *Alana Green,*[*] *Greg McIntosh,*[‡] *Edward Abraham.*[*†] **From** [*]**Canada East Spine Centre, Horizon Health Network, Saint John, NB,** [†]**Dalhousie Medicine New Brunswick, Saint John, NB,** [†]**Canadian Spine Outcomes and Research Network.**

Background: Previous research has revealed a disconnect between patient and surgeon expectations for postoperative outcomes. There is a consensus among most Canadian spine surgeons that the primary objective of elective thoracolumbar surgery is to correct radicular symptoms — a reduction in back pain is desired but supplementary. Nonetheless, many patients still perceive back pain to be the primary indication for surgery. Patient expectations have been shown to have a strong impact on recovery. The purpose of this study was to determine whether there is a correlation between "amber flag" scores on preoperative psychological measures and patient expectations. **Methods:** This was a retrospective analysis of prospectively collected Canadian Spine Outcomes and Research Network (CSORN) data (n = 568). Twelve spine surgery sites across Canada contributed data for possible spine surgery cases between October 2008 and September 2014. Two patient types were investigated: those without amber flags (MCS12 > 42 and PHQ9 < 15 and EQ5D-AD = none or moderate, n = 424) and those with amber flags (MCS12 = 42+ or PHQ9 = 15+ or EQ5D-AD = extreme, n = 144). Prior to surgery, patients are asked to choose the single most important change that they expect to occur as a result of their operation; there were 7 choices. **Results:** A Spearman Rho analysis showed a weak correlation between patient expectations and psychological amber flags. Those without amber flags listed a reduction in leg pain as their number one reason most often (37.3%) and those with amber flags listed a reduction in back pain significantly most often (41.7%, rs_{568} = 0.13, p = 0.013); however, the effect size was very small. Pain was significantly more important than function to both groups (p < 0.05). **Conclusion:** Surgeons should be especially careful to address expectations with patients who demonstrate psychiatric symptoms on preoperative questionnaires. Further investigations are needed to assess patient expectations and amber flags vs. postoperative outcomes. Databases should also consider employing more sensitive pain perception scales preoperatively. These might be more sensitive in identifying patients at risk of poor surgical outcomes due to misaligned expectations.

56.2.8: Assessment of frailty in elderly spinal surgery patients. ***Rachelle Palkovsky,*[*] *Fred Nicholls,*[†] *Shane Burch.*[*] **From** [*]**University of California San Francisco, San Francisco, Calif.,** [†]**University of Calgary, Calgary, Alta.**

Background: The primary objective of this initial study was to determine the incidence of frail elderly patients referred to a subspecialty clinic electing surgical treatment of spinal disorders. The secondary objective was to determine the utility of the frailty index (FI) for predicting surgical outcomes in the elderly patient with spinal pathology. **Methods:** For this prospective cohort study, 65 presenting patients aged 65 years and older, who were scheduled to undergo elective spine surgery were consented and enrolled. The methods used were consistent with those already established for determining frailty in elderly patients. Patients were required to complete the Godin–Shephard Leisure-Time Physical Activity Questionnaire, ambulate along a 15-foot walking course while wearing a dual access accelerometer and have grip strength measured using a dynamometer. Exhaustion and unintentional weight loss (> 10 lbs) were self-reported. The final score (0–5) was calculated according to patients' respective sex and body mass index using the validated FI scoring system. Follow-up for enrolled patients was conducted through the collection of the EQ5D, SF-36 and visual analogue scale validated outcome questionnaires during postoperative follow-up examinations. **Results:** Of the 64 patients enrolled, 4 (12.5%) qualified as frail, 27 (42.29%) qualified as prefrail and 33 (51.56%) were nonfrail. Subgroup analysis revealed 13.11% of patients reported unintentional weight loss, 49.18% reported routine exhaustion and 37.70% reported diminished activity levels. Walking speed in the bottom 20th percentile was observed in 9.84% of the patients. Dynamometer data demonstrated 45.31% of all patients scored in the bottom 20th percentile for grip strength. **Conclusion:** Assessment of the FI in a clinical setting proved simple and undisruptive. The patient sample of this study suggests that a significant proportion of presenting elderly spinal surgical patients qualify as frail, and an even larger proportion present as prefrail, indicating the need for presurgical evaluation of this patient group. Classifying patients as nonfrail, prefrail or frail may prove to be of significant value in the evaluation of elderly spinal surgical candidates and for prognostication of surgical outcomes.

57.2.9: Predicting adverse events and their impact on hospital length of stay in a prospective Spine AdVerse Events Severity (SAVES) database. ***Tamir Ailon,*[*†] *Peter Wagner,*[‡] *Hanbing Zhou,*[‡] *Natalie Egge,*[‡] *Maribeth Harrigan,*[‡] *Anthony Lapinsky,*[‡] *Patrick*

Connoly,[‡] John Street,[*] Christian DiPaola. **From [*]Vancouver General Hospital, University of British Columbia, Vancouver, BC, [†]University of Virginia Medical Center, University of Virginia, Charlottesville, Va., [‡]UMass Memorial Health Care, University of Massachussetts Medical School, Worcester, Ma.**

Background: Adverse event (AE) reporting in spine surgery has historically been retrospective, using administrative data. Prospective recording using the Spine AdVerse Events Severity system (SAVES) identifies a higher rate of postoperative complications. Our objective was to determine the incidence, severity, risk factors and effect on hospital length of stay (LOS) for AEs in spine surgery. **Methods:** The AEs for spine patients were prospectively collected for 18 months and linked with retrospective data from operative reports. Patient and surgical characteristics were correlated with incidence and severity of AEs to identify important risk factors and impact on hospital LOS. **Results:** At least 1 AE occurred in 75% of patients, with an average of 1.2 AEs per patient. The most common AEs were pain control (31%), urinary retention (9.7%) and wound infection (6.3%). For patients experiencing at least 1 AE, 30% had no effect on LOS, 48% increased 1–2 days, 15% increased 3–7 days and 7% greater than 8 days. Our system captured 25.4% more AEs than hospital administrative data. Univariate analysis revealed patient age, emergent surgery, diagnostic and surgical categories, and spine region to be predictors of both AEs and LOS. Instrumentation was predictive of increased LOS but not AEs. Logistic regression model of AE likelihood demonstrated emergent surgery, Charlson Comorbidity Index and extent of surgery to be independent predictors with odds ratios of 8.0, 1.1 and 3.7, respectively. Poisson regression modelling of hospital LOS demonstrated a strong influence of surgical invasiveness with a risk of 2.1 for circumferential fusion. Surgery for trauma, infection and deformity has the largest impact on LOS compared with degenerative disease. **Conclusion:** Spine surgery is associated with a high incidence of AEs, which often prolong LOS. Better characterization of adverse events and their predictors could lead to improved management strategies that reduce patient morbidity and mortality.

58.2.10: Clinical and surgical predictors of perioperative complications in patients with degenerative cervical myelopathy: results from the multicentre, prospective AOSpine International study on 479 patients. ***Lindsay Tetreault,[*†] Branko Kopjar,[‡] Gamaliel Tan,[§] Pierre Cote,[¶] Michael Fehlings.*[*†] From [*]University of Toronto, Toronto, Ont., [†]Toronto Western Hospital, Toronto, Ont., [‡]University of Washington, Seattle, Wash., [§]Tan Tock Seng Hospital, Singapore, [¶]University of Ontario Institute of Technology, Toronto, Ont.**

Background: Surgery for the treatment of cervical spondylotic myelopathy (CSM) is not without associated morbidity and is typically accompanied by complication rates between 11% and 38%. By identifying important clinical and surgical predictors of complication development, clinicians can recognize their high-risk patients and institute appropriate prevention plans. This study aims to identify important clinical and surgical predictors of perioperative complications in patients with CSM. **Methods:** We enrolled 479 surgical CSM patients were enrolled in the prospective CSM-International study at 16 global sites. A panel of physicians reviewed all adverse events and classified each as related or unrelated to surgery. Univariate analyses were performed to determine demographic and surgical differences between patients who suffered a perioperative complication and those who did not. A complication clinical prediction rule was developed using multiple logistic regression. **Results:** Eighty patients experienced 92 perioperative complications (16.7%). Univariately, the major clinical risk factors were OPLL ($p = 0.022$), the number of comorbidities ($p = 0.020$), diabetes ($p = 0.004$) and coexisting gastrointestinal disorders ($p = 0.045$). Patients undergoing a 2-stage surgery and those with a longer operative duration were also at a greater risk of perioperative complications. A final model consisted of diabetes (OR 2.35, $p = 0.039$), age (OR 1.02, $p = 0.25$), operative duration (OR 1.003, $p = 0.17$), 2-stage surgery (OR 20.37, $p = 0.012$), OPLL (OR 1.82, $p = 0.064$), gastrointestinal comorbidities (OR 2.53, $p = 0.020$) and body mass index (BMI) (OR 1.06, $p = 0.10$). **Conclusion:** Patients are at higher risk of perioperative complications if they are older, have OPLL, a higher BMI, diabetes or gastrointestinal disorders, and if they undergo a 2-stage surgery and a long operation.

59.2.11: Longitudinal analysis of the incidence of adverse events in tertiary spine referral centres: a national perspective from the Canadian Spine Outcomes and Research Network (CSORN) registry. ***Michael Johnson,[*] Steven Passmore,[*] John Street,[†] Charles Fisher,[†] Greg McIntosh.*[‡] **From [*]University of Manitoba, Winnipeg, Man., [†]Vancouver Coastal Health, Vancouver, BC, [‡]Canadian Spine Outcomes and Research Network.**

Background: Published reports of adverse events (AE) typically explore a single occasion at a single institution, which is characterized by large variances in reported incidences. Our objective was to use a multicentre national database to record AE incidence at points along the recovery spectrum in an attempt to better understand an often-reported tenfold difference in AE incidence. **Methods:** This was a retrospective examination of prospectively consented patients to the CSORN registry. Data obtained between October 2008 and September 2014 in 12 hospital sites across Canada were used to determine longitudinal AE incidence rates across 4 time points: intraoperative, perioperative and post-discharge (≤ 12, > 12 wk). Poisson regression for count data was used for statistical analysis. **Results:** Of the 1733 documented spine surgeries, AE occurrence was as follows: intraoperative = 128 (incidence = 7.4%), perioperative = 253 (incidence = 14.6%), discharge to 12 weeks postoperative = 75 (incidence = 4.3%), post-12 weeks = 31 (incidence = 1.8%). Surgeons are directly involved in AE documentation personally or as part of rounds at all CSORN sites except 2 (1 site uses a resident and the other has indirect surgeon involvement via chart abstraction by a research coordinator). AE incidence over time by principal pathology is shown in the Table.

Table: AE indicence over time, by principal pathology

Pathology	*n*	Intra	Peri	≤ 12 wk post	> 12 wk post
Disc herniation	210	13 (6.2%)	13 (6.2%)	5 (2.4%)	5 (2.4%)
Spondylolisthesis	203	15 (7.4%)	47 (23.2%)	19 (9.4%)	1 (0.5%)
Stenosis	450	38 (8.4%)	74 (16.4%)	28 (6.2%)	8 (1.8%)
Deformity	55	8 (14.5%)	20 (36.4%)	3 (5.5%)	2 (3.6%)
Fracture	37	3 (8.1%)	4 (10.8%)	2 (5.4%)	0
Infection	12	3 (25%)	1 (8.3%)	0	0
Tumour	12	1 (8.1%)	1 (8.3%)	0	0

Conclusion: Longitudinal collection of AEs revealed that the perioperative period had the highest rate of AEs, especially with surgery for spondylolisthesis. Deformity surgery represents the highest incidence of complications across the 4 time intervals. Methods of AE recording were similar between sites.

60.2.12: The use of validated clinical outcome measures in spinal surgery: an analysis of recent annual meeting abstracts. ***John Street,*[*†] *Isaac Ryan Perlus,*[‡] *Jim Kennedy,*[‡] *Brian Lenehan.*[‡§] **From** [*]**University of British Columbia, Vancouver, BC,** [†]**Blusson Spinal Cord Centre, Vancouver, BC,** [‡]**University of Limerick, Limerick, Ireland,** [§]**University Hospital Limerick, Limerick, Ireland.**

Background: Our objective was to analyze the use of clinical outcome measures in abstracts accepted to the CSS and NASS annual meetings from 2010 to 2013 inclusively. **Methods:** Abstracts accepted to CSS and NASS annual meetings (2010–2013) were read. The frequency of abstracts containing clinical outcome measures and of validated versus nonvalidated outcome measures were analyzed. A literature search was performed using the NASS Evidence-Based Clinical Guidelines for Multidisciplinary Spine Care, Cochrane Library database, PubMed and Google Scholar. The concepts contained in the items of the 10 most commonly used outcome measures were selected and linked to the most specific International Classification of Functioning, Disability and Health (ICF) categories. **Results:** A total of 1663 abstracts were analyzed. Of the abstracts accepted to CSS and NASS, 71% and 53%, respectively, contained validated outcome measures. The 10 most commonly used outcome measures were the Oswestry Disability Index, visual analogue scale, SF-36, Neck Disability Index, Scoliosis Research Society, SF-12, EQ5D, modified Japanese Orthopedic Association score, Abbreviated Injury Scale and Roland Morris Disability Questionnaire. The NASS Evidence-Based Clinical Guidelines for Multidisciplinary Spine Care provided limited validity recommendations covering 3 spinal conditions. The Cochrane Library database published reviews for disc arthroplasty, degenerative disease, vertebral and burst fractures, spinal fusion, back pain and cervical spondylotic myelopathy. All concepts for each outcome measure were linkable to the ICF. **Conclusion:** According to the present study, all of the 10 most commonly used outcome measures in abstracts to CSS and NASS (2010–2013) were validated in the field of spinal surgery. There is still a need for a universal database to determine which outcome measures would be most useful for a given spinal condition or surgical approach. The 10 most commonly used outcome measures were linked to the ICF. This provides evidence that recently, researchers and clinicians in spinal surgery have identified the importance of using validated health-related quality of life outcome measures as their health predictors.

61.1.13: The efficacy and accuracy of cone beam CT (O-Arm) navigation (StealthStation) on screw position in primary cases of adult major deformity surgery. ***John Street,*[*] *Jason Strelzow,*[*] *Danny Mendelsohn,*[*] *Nicolas Dea,*[†] *Marcel Dvorak,*[*] *Charles Fisher.*[*] **From** [*]**University of British Columbia, Vancouver, BC,** [†]**Université de Sherbrooke, Sherbrooke, Que.**

Background: Intraoperative computed tomography (CT) and navigation systems may provide an opportunity to improve precision and accuracy of pedicle screw placement. Adult spinal deformity provides unique anatomic challenges potentially amenable to spinal navigation. Our study examines the efficacy and safety of intraoperative cone beam CT navigation for pedicle screw placement in complex spinal deformity cases. **Methods:** We identified patients treated at our institution with spinal fusion for the primary diagnosis of major adult deformity between January 2008 and December 2012 in whom O-Arm and StealthStation navigation was used (NAV). A historic control cohort (nonNAV) was matched based on age, number of levels, curve type and size and previous fusion. The number and timing of screw malposition, the need for revision screw placement was recorded, along with direction and anatomic level of misplaced screws. All patients had a minimum of 1 year follow-up. Quantitative statistical analysis compared screw placement between cohorts. **Results:** Fifty-six patients met inclusion criteria in each cohort. The mean number of screws placed in each group was not significantly different ($p = 0.75$). Thirty-eight (34%) patients in the nonNAV group had misplaced screws compared with 21 (19%) in the NAV group ($p = 0.002$). The need for intraoperative screw revision favoured navigation ($p < 0.03$). The number of adverse events and length of stay were not significantly different. The mean number of postoperative CT scans was significantly fewer in the NAV group ($p = 0.004$) while mean OR time was statistically different between groups (492 min in NAV group v. 408 min, $p = 0.002$). **Conclusion:** Our results demonstrate that intraoperative CT-guided navigation provides an equally safe and more accurate tool for pedicle screw placement than traditional techniques in adult spinal deformity surgery. There were more intraoperative screws adjusted and fewer postoperative screws revised with navigation.

62.1.14: Does early surgical decompression improve neurological recovery of complete spinal cord injury? A prospective cohort study. ***Etienne Bourassa-Moreau,*[*†] *Jean-Marc Mac-Thiong,*[*‡] *Stefan Parent,*[*‡] *Ang Li,*[*†] *Cynthia Thompson.*[*] **From** [*]**Hôpital du Sacré Coeur, Montréal, Que.,** [†]**Université de Montréal, Montréal, Que.,** [‡]**Centre hospitalier universitaire Ste-Justine, Montréal, Que.**

Background: The objectives of this study were 1) to compare the effect of early and late surgical decompression on neurologic recovery in complete traumatic spinal cord injury (SCI) and 2) to assess if surgical timing impacts differently on cervical or thoracolumbar SCI. **Methods:** A prospective cohort study was performed in a single Level 1 trauma centre specializing in SCI care. All consecutive cases of traumatic SCI referred between 2010 and 2013 were screened for eligibility. Neurological status was assessed systematically using the American Spinal Injury Association (ASIA) grading system at first arrival to the trauma centre; the neurologic recovery was assessed at rehabilitation discharge. Patients operated within 24 hours of the trauma were compared with patients operated later than 24 hours after the trauma. Potential confounders were recorded such as the age, ISS, smoking, body mass index, the Glasgow Coma Scale score and duration of follow-up. **Results:** Fifty-three complete SCIs were included in the study with 33 thoracic SCI and 20 cervical SCI. The 38 patients operated < 24 hours after trauma were generally younger than the 15 patients operated 24 hours or more after trauma, although no other potential confounder was statistically different. Overall, 28% (15 of 53) of

complete SCI had some neurologic recovery with 34% (13 of 38) of patients operated < 24 hours and 13%(2 of 15) of patients operated 24 hours or more (p = 0.182). Sixty-four percent (9 of 14) of cervical complete SCI operated < 24 hours after trauma had some neurologic recovery whereas none of the 6 complete cervical SCI operated 24 hours or more after trauma improved (p = 0.008). **Conclusion:** This study suggests that surgical decompression earlier than 24 hours after trauma in complete SCI may promote improvement in neurologic status, especially at the cervical level.

63.1.15: The role of MRI in predicting surgical outcome in patients with degenerative cervical myelopathy. ***Aria Nouri,*[*†] *Lindsay Tetreault,*[*†] *Juan Zamorano,*[†] *Kristian Dalzell,*[†] *Aileen Davis,*[*‡] *David Mikulis,*[*§] *Albert Yee,*[*¶] *Michael Fehlings.*[*†] **From [*]Institute of Medical Science, University of Toronto, Toronto, Ont., [†]Division of Neurosurgery, Toronto Western Hospital, Toronto, Ont., [‡]Division of Healthcare and Outcomes Research, Toronto Western Hospital, Toronto, Ont., [§]Division of Neuroradiology, Toronto Western Hospital, Toronto, Ont., [¶]Division of Orthopaedic Surgery, Sunnybrook Health Sciences Centre, Toronto, Ont.**

Background: Cervical spondylotic myelopathy (CSM) is the most common cause of spinal cord impairment in the elderly population worldwide. While MRI is the primary imaging modality for confirming the diagnosis, its role in predicting surgical outcome remains unclear. Using prospective and multicentre study data, this study aims to assess the role of MRI in predicting the surgical outcome of patients treated for CSM. **Methods:** We enrolled 278 patients with ≥ 1 clinical signs of myelopathy to undergo decompression surgery. Complete baseline clinical and MRI data were available for 102 patients. MRI parameters measured included presence/absence of signal change on T1 and T2, T2 signal quantitative factors and anatomic measurements. A dichotomized postoperative modified Japanese Orthopedic Association (mJOA) score at 6 months was used to characterize patients with mild myelopathy (≥ 16) and those with substantial residual neurologic impairment (< 16). Univariate analysis assessed the association between baseline parameters and outcome. Multivariate logistic regression was conducted following a conceptual division of variables into 3 groups: T1 signal analysis, T2 signal analysis and anatomic measurements. **Results:** Baseline mJOA (p < 0.001; OR 1.644, 95% CI 1.326–2.037), maximum canal compromise (MCC; p = 0.0322, OR 0.965, 95% CI 0.934–0.997), T2 hyperintensity ROI (p = 0.0422, OR 0.67, 95% CI 0.456–0.986) and sagittal extent (p = 0.026, OR 0.673, 95% CI 0.475–0.954) were significantly associated with outcome univariately. The final model comprised T1 hypointensity (p = 0.029, OR 0.242, 95% CI 0.068–0.866), MCC (p = 0.005, OR 0.940, 95% CI 0.90–0.982) and baseline mJOA (p < 0.001, OR 1.743, 95% CI 1.353–2.245), yielding an area under the receiver operating curve (AUC) of 0.845. **Conclusion:** Baseline mJOA is a strong predictor of postsurgical outcome in CSM at 6 months. However, a model inclusive of MCC and T1 hypointensity assessment provides superior predictive capacity. This suggests that MRI analysis has a distinct and significant role in predicting surgical outcome. It is therefore recommended that a thorough MRI analysis be conducted in all CSM patients considered for surgical treatment.

64.1.16: Postsurgical patients can have similar functional improvements and return to work rates following rehabilitation as those treated nonsurgically. ***Greg McIntosh,*[*] *Hamilton Hall,*[*] *Tom Carter,*[*] *Chris Gregg.*[†] **From [*]CBI Health Group, Toronto, Ont., [†]The Back Institute, Wellington, New Zealand.**

Background: The purpose of this study was to compare the clinical outcomes of 2 distinct groups of low back pain (LBP) patients commencing rehabilitation: those with a history of spine surgery (n = 1097) and those without surgical intervention (n = 2092). **Methods:** This prospective study of LBP cases was a collaborative effort of spine care rehabilitation clinics in New Zealand and Canada. Patient enrollment occurred between January 2008 and October 2012. All patients had mechanical LBP as determined by the Saskatchewan Spine Pathway triage methodology. **Results:** There were 929 cases from New Zealand and 2260 from Canada. At assessment, the postsurgical group had lower pain levels (mean 5.24 v. 5.57, p < 0.001), but poorer baseline function (p < 0.001), and were more likely to be off work (p < 0.001) than the nonsurgical group. At the conclusion of rehabilitation, the postsurgical group had significantly less functional improvement (p < 0.001) but this difference was no longer significant at 3-month follow-up. The postsurgical group had significantly less reduction in pain (p < 0.001) at discharge and follow-up (p < 0.001). Return to work rates at follow-up were not significantly different between groups (postsurgery: 60.1% v. nonsurgical: 64.9%, p < 0.001). **Conclusion:** Initially, postsurgical patients had less pain but showed less reduction in pain over time and had poorer baseline function; both groups achieved similar functional improvements and return to work rates.

65.1.17: Intraoperative cone beam CT (O-Arm) and stereotactic navigation (StealthStation) system in complex adult spine surgery — early experience and learning curve. ***Ana Contreras, Juliet Batke, Nicolas Dea, Marcel F.S. Dvorak, Charles G. Fisher, John Street.* **From the University of British Columbia, Vancouver, BC.**

Background: There is limited data evaluating the clinical learning curve for surgeons and its relationship to patient outcomes when using intraoperative navigation and imaging systems. We examined the clinical learning curve and patient outcomes of using O-Arm and StealthStation for 6 fellowship-trained spine surgeons at our institution, a single quaternary referral centre, from 2009–2013. **Methods:** This ambispective study examined 231 surgical cases where O-Arm and StealthStation were used to facilitate pedicle instrumentation. The learning curve was determined by examining total operative time and blood loss, operative time and blood loss per surgical level and the incidence of surgery-related adverse events (AEs) by year. The AEs were prospectively collected using the Spine AdVerse Events Severity System (SAVES). **Results:** At our institution, all spine surgeons were using O-Arm and StealthStation by the beginning of 2009. A total of 231 patients had screws placed using the O-Arm and StealthStation between Jan.1, 2009, and Dec. 31, 2012. The number of screws placed increased significantly from 430 screws placed in 27 cases in 2009 to 758 screws in 75 cases in 2012 (p < 0.05). The average estimated blood loss (EBL) decreased from 1229 mL in 2009 to 907 mL in 2012 (p < 0.05). The EBL per case per number of levels instrumented decreased from 5.72 mL

in 2008 to 2.39 mL in 2012 ($p < 0.05$). Mean operating time decreased from 407 to 378 minutes ($p < 0.05$). The number of misplaced screws per case decreased from 0.78 to 0.54 from 2009 to 2012 ($p < 0.05$). There were no significant differences in incidences of dural tear, surgical site infection or other surgical AEs over the study period. **Conclusion:** Our results demonstrate that there is a learning curve to the use of intraoperative CT-based navigation, as measured by OR time, intraoperative blood loss and screw malposition. There were no significant differences in surgical AEs during this learning period.

66.1.18: A pilot randomized controlled trial of iodine-impregnated plastic adhesive drape usage in spine surgery and the effect on wound bacterial load. ***Philippe Phan,*[*†] *Vu (Brian) Le,*[†‡] *Darren Roffey*[*§], *Stephen Kingwell,*[*†] *Paul MacPherson,*[§¶] *Marc Desjardins,*[**††] *Eugene Wai.*[*†] **From the [*]University of Ottawa Spine Program, Ottawa, Ont., [†]Ottawa Hospital, Ottawa, Ont., [‡]Division of Orthopaedic Surgery, Department of Surgery, University of Ottawa, Ottawa, Ont., [§]Ottawa Hospital Research Institute, Ottawa, Ont., [¶]Division of Infectious Diseases, Department of Medicine, University of Ottawa, Ottawa, Ont., [**]Division of Microbiology, Department of Pathology and Laboratory Medicine, University of Ottawa, Ottawa, Ont., [††]Eastern Ontario Regional Laboratory Association, Ottawa, Ont.**

Background: Little evidence exists supporting the use of plastic adhesive drapes (PAD) to prevent surgical site infection, despite their widespread utilization for decades. Through a double-blinded, randomized controlled trial, we investigated the effect of PADs on bacterial colony-forming units (CFU) during elective spinal surgery with a novel, inexpensive, low-risk methodology to investigate the microbiological effects. **Methods:** Over 3 months, 15 blinded elective spine patients were randomly assigned to PAD (3M Ioban2) versus no PAD usage. A blinded observer collected surface specimens using flocked swabs (Copan ESwab) on wounds immediately postoperation (POD-0) and on postoperation day 3 (POD-3) using a standardized technique. Specimens were plated for bacterial CFUs on both blood and chocolate blood agar in triplicate in serial dilutions. The CFUs were manually counted. Median CFU/cm of wound swabbed and % positive cultures were calculated, and statistical significance was assessed with the Mann–Whitney *U* test and Fisher exact test, respectively. **Results:** There were no significant differences between groups in baseline characteristics. POD-0, blood agar, median CFU/cm: no PAD = 0 (range 0–7.69) versus PAD = 0.04 (range 0–4.18, $p > 0.2$); % positive cultures: no PAD = 42.9% versus PAD = 50% ($p > 0.99$). POD-0, chocolate blood agar, median CFU/cm: no PAD = 0.06 (range 0–7.51) versus PAD = 0.09 (range 0–4.8, $p > 0.2$); % positive cultures: no PAD = 57.1% versus PAD = 62.5% ($p > 0.99$). POD-3, blood agar, median CFU/cm: no PAD = 0.08 (range 0–1.87) versus PAD = 0.22 (range 0–4.53, $p > 0.2$); % positive cultures: no PAD = 57.1% versus PAD = 50% ($p > 0.99$). POD-3, chocolate blood agar, median CFU/cm: no PAD = 0.04 (range 0–2.22) versus PAD = 0.04 (range 0–4.56, $p > 0.2$); % positive cultures: no PAD = 71.4% versus PAD = 75% ($p > 0.99$). **Conclusion:** Our study demonstrated similar bacterial contamination whether a PAD was used or not. With the numbers available, we did not detect a significant difference between groups. As this is a pilot study, we acknowledge that it is underpowered — but note that this methodology is feasible for ongoing study.

67.2.19: Dynesys long-term outcome study. ***Godefroy Hardy-St-Pierre, Mashfiqul Siddiqui, Ronald L. Henderson, Andrew Nataraj*. From University of Alberta, Edmonton, Alta.**

Background: Dynesys (Zimmer) is a dynamic stabilization spinal instrumentation system. It endeavours to provide spinal stability without fusion with the goal of preventing adjacent segment disease (ASD). Dynesys was introduced in 1993 and is mostly used in Europe. There are no published data for long-term follow-up at 5 years or more. **Methods:** We retrospectively reviewed prospectively collected data on patients undergoing surgery with implantation of the Dynesys system from 2006–2009. We analyzed data regarding 18 variables: neurologic deficit, claudication, multilevel degeneration, prior ASD, OR segments, associated procedure, age, sex, medical and psychiatric comorbidities, prior spine OR, smoking, body mass index > 35, revision OR, scoliosis, spondylolisthesis, early complications and hospital stay. We analyzed 2 primary end points: solid fusion on X-ray and clinical ASD, both at 5 years. Secondary end points were time to fusion, time to ASD and reoperation. We conducted a multivariate analysis via the random forest method. Mann–Whitney *U* test and Fisher exact test were used to qualify the association between variables. **Results:** There were 52 patients. Three died of unrelated causes during follow-up. Fifteen had ASD (29%) at a mean 45 months. Nine had a solid fusion (17%), 2 of whom also had ASD. Mean time to fusion was 65 months. The multivariate analysis revealed 3 variables significantly associated with ASD: prior ASD (OR 11.3, $p = 0.005$), neurologic deficit (OR 8.5, $p = 0.018$) and multilevel degeneration (OR 0.18, $p = 0.026$). No variable was associated with fusion. **Conclusion:** Dynesys is associated with a much higher rate of ASD then previously reported in short-term follow-up studies despite maintaining a low fusion rate. This may relate to the use of Dynesys in selected patients deemed to be at the highest risk for ASD. The natural history of ASD seems to overcome the treatment at 5 years.

68.2.20: Maverick total disc replacement in a real-world patient population: a prospective, multicentre observational study. ***Peter Jarzem,*[*] *Leonardo Simoes,*[*] *Richard Assaker,*[†] *Karsten Ritter-Lang,*[‡] *Dominique Vardon,*[§] *Stephane Litrico,*[¶] *Stephane Fuentes,*[**] *Michael Putzier,*[††] *Jorg Frank,*[‡] *Pierre Guigui,*[‡‡] *Gerard Nakach,*[§§] *Jean-Charles Le Huec.*[¶¶] **From *Montreal General Hospital, Montréal, Que., [†]Hôpital Roger Salengro, Lille, France, [‡]Orthopädische Universitätklinikum Magdeburg, Magdeburg, Germany, [§]Clinique du Cours Dillon, Toulouse, France, [¶]Hôpital Pasteur, Nice, France, [**]Hôpital de la Timone, Marseille, France, [††]Charité Universitätsmedizin Berlin, Berlin, Germany, [‡‡]Hôpital Beaujon, Clichy, France, [§§]Centre Hospitalier Intercommunal de Meulan, Meulan, France, [¶¶]Hôpital Pellegrin, Bordeaux, France.**

Background: Controlled trials have shown that total disc replacement (TDR) can provide pain and disability relief to patients with degenerative disc disease. However, whether these outcomes can be achieved for patients treated in normal surgical practice has not been well documented. **Methods:** This prospective international study observed changes in disability and back pain in 134 patients who were implanted with Maverick TDR within the framework of routine clinical practice and followed for 2 years postsurgery. Primary and secondary outcomes were the differences from baseline

to 6 months postsurgery using the Oswestry Disability Index and the change in back pain intensity assessed on a 10-cm visual analogue scale, respectively. Mean patient age at surgery was 43 years but ranged up to 65 years. **Results:** Respectively, 123 patients had an implant at 1 level, 10 patients at 2 levels and 1 patient at 3 levels. Statistically significant improvements in mean disability (–25.4) and low back pain intensity (–4.0) scores were observed at 6 months postoperatively ($p < 0.0001$ for both). During the study, 56 patients (42%) experienced a complication or adverse event. **Conclusion:** This is the first international observational study to report outcomes of TDR in real-world clinical settings. We showed statistically significant improvements in disability and pain scores at 6 months following Maverick TDR, which were maintained for 2 years alongside an acceptable rate of perioperative complications. The safety and tolerability shown in this observational study were comparable to those from controlled trials.

69.2.21: Pedicle screw malposition in revision spinal surgery: efficacy of intraoperative CT-based navigation. ***Harvey Wu, Andrew Pennington, Juliet Batke, Kaiyun Yang, Charles G. Fisher, Marcel F.S. Dvorak, John Street*****. From University of British Columbia, Vancouver, BC.**

Background: Revision surgery poses unique technical challenges for pedicle screw instrumentation. Use of intraoperative 3D imaging with navigation has been under-reported in spine revision surgery. The aim of this study was to examine pedicle screw malposition rates and patient outcomes in revision surgeries comparing O-Arm and StealthStation navigated cases to traditional freehand techniques. **Methods:** This ambispective study compared 2 matched cohorts of patients undergoing revision thoracolumbar surgery. The study group comprised 56 consecutive patients who underwent O-Arm and StealthStation navigation assisted pedicle screw instrumentation (NAV) between Jan. 1, 2008, and Dec. 31, 2012. The control group comprised 34 historical matched cases with surgery between Jan.1, 2006, and Dec. 31, 2008, using traditional (freehand or with fluoroscopy), non-navigated techniques (nonNAV). Cases were matched on age, sex, surgical location, number of surgical levels and primary diagnosis. **Results:** A significant difference existed in the number of misplaced screws between NAV and nonNAV groups (31 v. 54, $p < 0.001$). Mean number of misplaced screws per case was 0.57 ± 0.92 with navigation and 1.86 ± 2.49 without ($p = 0.01$). No difference existed in the number of screws revised intraoperatively (10 v. 7, $p = 0.54$). One NAV patient and 2 nonNAV patients required early postoperative screw revision during the same admission ($p = 0.33$). No screws in the NAV group required revision during subsequent admissions. No difference was observed in grade of screw malposition ($p = 0.11$), anatomic location of malposition ($p = 0.26$), duration of surgery ($p = 0.11$), incidence of intraoperative dural tear ($p = 1.00$), wound infection ($p > 0.99$) or length of stay ($p = 0.78$). A significant difference in intraoperative massive (> 2L in 3 h) blood loss existed; 3.3% of NAV cases compared with 7.8% of nonNAV cases. **Conclusion:** This early analysis of revision surgery demonstrates an increased accuracy of pedicle screw placement using O-Arm and StealthStation, without an increase in OR time. Clinical outcomes between NAV and nonNAV cases were similar.

70.2.22: Intraoperative skull-femoral traction in posterior spinal arthrodesis for adolescent idiopathic scoliosis: the impact on perioperative outcomes and health resource utilization. ***David Parsons, Rachael Da Cunha, Samir Al Sayegh, Jeremy LaMothe, Michael Letal, Herman Johal, Fabio Ferri-de-Barros*****. From University of Calgary, Calgary, Alta.**

Background: To study how the systematic use of intraoperative skull-femoral traction (IOSFT) in posterior arthrodesis for adolescent idiopathic scoliosis (AIS) impacts perioperative outcomes and health resource utilization. **Methods:** Retrospective, single-centre cohort study. Seventy-three consecutive patients with AIS who underwent single stage posterior spinal arthrodesis between 2008 and 2012 at a tertiary children's hospital were identified. Forty-five patients were operated with IOSFT (traction group) and 28 patients were operated without IOSFT (nontraction group). Outcome measures included operative time, calculated blood loss, blood transfusion requirement, traction-related complications and cost comparisons. **Results:** Operative time was 375.6 minutes for the traction group ($p = 0.0001$) and 447.6 minutes for the nontraction group. Calculated blood loss was significantly less in the traction group ($p = 0.027$). Thirty-three percent of patients in the traction group required blood transfusion compared with 64% of patients in the nontraction group ($p = 0.01$, absolute risk reduction of 31%). There was no significant difference in curve magnitude correction ($p = 0.49$). There were no significant complications with the use of traction. There was a significant reduction in cost per surgical procedure in the traction group ($p = 0.0003$). **Conclusion:** The systematic use of IOSFT in posterior arthrodesis for AIS contributed to significant reductions in operative time, calculated blood loss and blood transfusion requirement, thus resulting in lower perioperative costs and improved health resource utilization. There were no significant complications or added morbidities associated with the use of IOSFT, thus supporting its use as an adjunct to posterior arthrodesis in AIS. Improved health resource utilization resulted in improved access to surgical care for children. Further research is required to investigate the generalizability of our findings and to study the effect of IOSFT on patient-based outcomes.

71.2.23: The effect of growth-friendly surgery on coronal and sagittal plane spine growth in idiopathic scoliosis. ***Chukwudi Chukwunyerenwa,[*] Ron El-Hawary,[*] Luke Gauthier,[*] Alan Spurway,[*] Charlie Johnston,[†] Anna McClung*****.[†] From [*]IWK Health Centre, Halifax, NS, [†]Texas Scottish Rite Hospital for Children, Dallas, Tex.**

Background: Our objective was to evaluate the effect of lengthening procedures on coronal, sagittal and true spine length in children with idiopathic scoliosis. **Methods:** We performed a retrospective, multicentre review of 18 patients with minimum 5-year follow-up after growth-friendly surgery. Radiographs were analyzed at implantation and at each lengthening procedure. Primary outcomes were changes in coronal, sagittal and true (along the sagittal arc of vertebrae) T1–T12 length per lengthening. **Results:** With minimum 5-year follow-up, 18 patients with a mean age of 4.1 years were treated with rib-based ($n = 9$) or spine-based ($n = 9$) distraction. Three groups were compared: First lengthening (L1), second through fifth lengthening (L2–L5), and sixth through tenth lengthening (L6–L10). Cobb angle stayed constant (45.0°, 44.7°, 48.6°), maximum kyphosis increased (32.1°, 45.3°, 47.5°),* coronal thoracic height increased (16.4 cm, 17.6 cm, 17.8 cm)*, true

thoracic length increased (18.4 cm, 19.5 cm, 20.8 cm)*, change in coronal T1–T12/lengthening decreased (5.7 mm, 4.0 mm, 1.7 mm), change in sagittal T1–T12/lengthening decreased (4.0 mm, 3.3 mm, 3.1 mm) and change in true T1–T12/lengthening remained constant (2.8 mm, 4.4 mm, 4.4 mm). *$p < 0.05$. **Conclusion:** Although there is the appearance of a law of diminishing returns when measured in the coronal plane, these changes were not as apparent when measured in the sagittal plane and were nullified with measurement of true spine length. These findings support the hypothesis that, when measured in the plane of distraction, a law of diminishing returns may not be apparent.

72.2.24: A qualitative web-based expert opinion analysis on the adoption of intraoperative CT and navigation systems in spine surgery. ***Melissa Nadeau,*[*†] *Juliet Batke,*[*] *Helen Novak Lauscher,*[†] *Charles Fischer,*[*†] *John Street.*[*] **From** [*]**Vancouver General Hospital, Vancouver, BC,** [†]**University of British Columbia, Vancouver, BC.**

Background: Intraoperative computed tomography and navigation systems have numerous potential uses in instrumented spine surgery and may decrease patient morbidity, leading to cost-effectiveness implications. Despite this, its adoption is not ubiquitous. The goal of this study is to identify facilitators and barriers to the adoption of this technology by spine surgeons. **Methods:** A web-based survey was designed to explore spine surgeons' impressions of intraoperative computed tomography and navigation systems. The survey was distributed to surgeon members of the Canadian, New Zealand and Australian spine societies. Participants were stratified into user and nonuser groups, with a slight variability in questions to both groups based on applicability. **Results:** Fifty-three surgeons completed the survey. The main differences between users ($n = 24$) and nonusers ($n = 29$) of this technology were their baseline expectations, the size of their spine practice group and the proportion of spine surgery in their practice. The main reasons for adopting this technology were its clinical safety, accuracy and technical utility in complex cases (15 of 24 respondents). Nonusers mostly identified the prohibitive cost and lack of availability in their institution as the primary deterrent to adopting it (21 of 25 respondents), as well as the limited need and benefit associated with its use (6 of 26 respondents). Evidence gaps identified were cost–benefit analysis (8 of 19 respondents) and clinical outcomes studies (6 of 19 respondents). Both users and nonusers identified the top advantages as being more accurate and safer screw placement. Top disadvantages cited were cost and increased radiation exposure to the patient. Recommendations for training requirements and device improvements were made by surgeons and reported. **Conclusion:** Spine surgeons recognize the improved screw placement accuracy and safety of intraoperative computed tomography and navigation systems. The cost is the biggest deterrent to their widespread adoption. Cost–benefit analysis and outcome studies related to their use are warranted. Suggestions for improvements in this technology and training for its use are discussed.

