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Canadian Spine Society

17th Annual Scientific Conference
Le Westin Montréal
270 Saint-Antoine West
Montreal, Que.

Feb. 22–25, 2017

Abstracts

The Canadian Spine Society is a collaborative organization of spine surgeons advancing excellence in research, education and patient care.

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 combines the resources of the Canadian Spine Society and the Canadian Paediatric Spine Society to provide attendees with an in-depth review of current trends and innovative approaches to managing both childhood and adult spinal problems. The program spans a range of topics from care of the elderly spine to recent advances in pediatric spinal deformity. Presentations cover ongoing research involving the Canadian Spine Outcomes and Research Network as well as projects from individual investigators in centres across the country. Along with purely clinical subjects, this year's assembly will look at the medical–legal issues facing spine surgeons practising in Canada. The scope of the conference extends to nonoperative care, epidemiology of back pain and discoveries in basic science. The agenda offers a carefully constructed mix of lectures, updates and interactive symposia, which combine continuing medical education with engaging social interaction and professional networking. The 2017 Canadian Spine Society Scientific Conference is the best chance to become engaged with the Canadian spine scene.

Conflict of interest and disclosure information is available for all speakers presenting abstracts at the 17th Annual Scientific Conference of the Canadian Spine Society.

0107

Nationwide quality assessment of the Canadian Spine Outcomes Research Network (CSORN). ***James Fowler*[1,2,3], *Edward Abraham*[1,3,4], *Eden Daly*[1,3], *Erin Bigney*[1,3], *Kate Wagg*[1,3], *Neil Manson*[1,3,4]. From the [1]Canada East Spine Centre, Saint John, NB; the [2]Dalhousie School of Medicine, Research in Medicine Program, Saint John, NB; the [3]Dalhousie School of Medicine, Department of Surgery, Saint John, NB; and the [4]Saint John Regional Hospital, Horizon Health Network, Saint John, NB.**

Background: The Canadian Spine Outcomes and Research Network (CSORN) is an emergent, rapidly growing national spine registry. The utility of a medical database is dependent on the quality of the data. Our objective is to evaluate data quality of the CSORN database. **Methods:** A retrospective analysis of data from 17 CSORN sites across Canada, including 6233 patients, was conducted. Completeness of data, follow-up rates and percentage of patient enrolment were assessed via CSORN data quality reports and site interviews. Data quality was operationally defined as poor (< 60% complete), moderate (60%–80% complete) and good (> 80% complete). Descriptive statistics were used to ascertain data completeness and follow-up rates. Repeated-measures analysis of variance was used to investigate the effect of time. Significance was set at $\alpha < 0.05$. **Results:** Analyses revealed successful enrolment of 78% of potential patients. Follow-up rates significantly decreased across time ($F_{1,30} = 15.10$, $p = 0.001$). Follow-up rates declined significantly from 12 weeks (87.76%) to 12 months (59.25%) and 24 months (44.68%). At 12 weeks, 82.35% of sites had good follow-up, and 17.6% were moderate. At 12 and 24 months, 25% of sites had good follow-up rates, 25% had moderate and 50% had poor follow-up, as defined by this study. Overall data quality averaged 86.14%. The primary issue with data completeness can be narrowed down to specific problematic variables. The 24-month data quality is significantly lower, with thoracolumbar and cervical follow-up at moderate (72.65%) and poor (53.10%) quality, respectively. Mapping data from a previous database resulted in limited data quality. On average, 42.85% of CSORN variables were not included in previous databases, resulting in a 22.64% data quality drop. **Conclusion:** Overall data quality was classified as good. For new sites considering integration into CSORN, we do not recommend mapping over previously collected data. However, follow-up rates at 12 and 24 months were poor. This is common in medical databases, and CSORN has taken steps to improve data quality, including hiring a data quality coordinator and new training. Data quality is a critical component of databases and reanalysis is warranted following planned interventions.

0092

The impact of degenerative spinal disorders on the quality of life of patients undergoing spine surgery in Canada: a national comparison to healthy peers. ***Jean-Christophe Murray*[1,2], *Neil Manson*[3], *Greg McIntosh*[4], *Kenneth C. Thomas*[5], *Hamilton Hall*[2], *Charles Fisher*[6], *Y. Raja Rampersaud*[1,2]. From the [1]Toronto Western Hospital, University Health Network, Toronto, Ont.; the [2]Department of Surgery, University of Toronto, Toronto, Ont.; the [3]Canada East Spine Centre and Horizon Health Network, Saint John, NB; the [4]Canadian Spine Society, Toronto, Ont.; the [5]Department of Surgery, University of Calgary, Calgary, Alta.; and the [6]Division of Spine, Department of Orthopaedics, University of British Columbia, Vancouver, BC.**

Background: It is well known that access to elective surgical spine care is very limited in Canada. However, the national health burden of degenerative spinal disorders requiring surgery has not been assessed. Our primary objective was to assess the baseline health-related quality of life (HRQoL) in surgical spinal patients compared with their age- and sex-matched peers, and secondarily to patients living with other well-known debilitating chronic conditions. **Methods:** We performed a retrospective review from 19 Canadian Spine Outcomes and Research Network (CSORN) sites. Patients with a primary thoracolumbar degenerative diagnosis who have had or are awaiting elective surgery were included. Patients with incomplete HRQoL baseline data, nondegenerative diagnoses, or revision surgery were excluded. The primary outcome was the baseline physical component summary score (PCS) and mental component summary score (MCS) from the 12-item Short Form Survey (SF-12). Descriptive and comparative statistics were used to compare the overall and age- and sex-matched baseline HRQoL to published PCS/MCS data from healthy Canadians and to individuals with other well-known debilitating diseases. **Results:** Data from 3444 patients were analyzed. Diagnoses included stenosis ($n = 1190$), spondylolisthesis ($n = 1012$), disc herniation ($n = 840$), degenerative disc ($n = 200$) and deformity ($n = 202$). The mean overall MCS score was 47.9 ± 8.6 versus 51.7 ± 9.1 for normative data. The mean overall PCS

score was 32.3 ± 8.2, which is 2 standard deviations below the mean Canadian normative data (50.5 ± 9.0). Mean PCS scores were similar across each decade in the spine cohort (p = 0.317); however, PCS decreased with decade of age in the normative population. For those older than 75 years in the spine cohort, the mean PCS was only 1 standard deviation below the age-matched normative score. PCS scores were similar across all spinal diagnoses (p = 0.181). The mean reported PCS in patients with rheumatoid arthritis and heart failure was 36.5 and 35.7, respectively. **Conclusion:** Surgical degenerative spinal disorders lead to a profound reduction in patients' HRQoL that is worse or similar to other well-known debilitating diseases. These national data are critical to advocating the need for improved access to surgical care for patients with spinal disorders in Canada.

0106

Same day readmission following outpatient lumbar spine surgery. ***Lynn Symington[1,2,3], Edward Abraham[1,3,4], Erin Bigney[1,3], Kate Wagg[1,3], Neil Manson[1,3,4].* From the [1]Canada East Spine Centre, Saint John, NB; the [2]Dalhousie School of Medicine, Research in Medicine Program, Saint John, NB; the [3]Dalhousie School of Medicine; Department of Surgery, Saint John, NB; and the [4]Saint John Regional Hospital, Horizon Health Network, Saint John, NB.**

Background: Owing to the high demand for spine surgery and limited operating room (OR) time available, spine surgery patients undergoing low-risk procedures can receive outpatient surgery. Advantages include reduced wait times, increased access and decreased costs. However, unanticipated postoperative complications can result in readmittance of patients into hospital; thus, outpatient surgery–associated benefits may be lost. The present study seeks primarily to determine prevalence of same-day readmittance and reasons for readmittance. Additionally, we aim to elucidate if there are any significant demographic or surgical group differences between patients who are readmitted and those who are not. **Methods:** This retrospective analysis included patients receiving elective thoracolumbar outpatient surgery between June 2012 and June 2015 (n = 204) in a single centre. Data were retrieved from the Canadian Spine Outcomes Research Network database and electronic medical records. Variables of interest included patient demographics, initial patient assessment and intraoperative data. Readmission was defined as failure to discharge by 6 pm. Continuous variables were analyzed using 1-way analysis of variance, categorical variables with χ^2 tests and descriptive statistics for summarization of data. Significance was set at $\alpha < 0.05$. **Results:** Readmittance occurred in 18.6% of the sample. Urinary retention was the most prevalent reason for readmission (70%). Decompression alone (82.1%) was the most prevalent surgery. Significant differences in OR start time (χ^2_3 = 7.826, p = 0.025), chief complaint (χ^2_3 = 8.666, p = 0.017), number of levels ($F_{1,195}$ = 14.01, p = 0.001) and body mass index (BMI; $F_{1,195}$ = 7.75, p = 0.001) were observed. Readmittance increased by 61.02% for surgeries scheduled for after 12 pm. Patients with neurogenic claudication (30.43%) and back pain (25.92%) as their chief complaints were readmitted more often than those with radiculopathy (12.50%). Patients with a BMI of 35–39.9 were the most frequently readmitted (30.8%). Patients who had 1 level treated had a 12.75% readmittance rate compared with those with 2 levels (34.21%) and 3 levels (44.44%). **Conclusion:** Given the trends seen within this sample, patient selection and timing of surgeries at the time of surgical booking could alleviate readmittance. This may help decrease burden to both the patient and the health care system.

0044

Repeat discectomy versus discectomy and fusion for recurrent lumbar disc herniations: a retrospective CSORN study. ***Jennifer Urquhart, Parham Rasoulinejad, Alyssa Fleming, Joanne St. John, Chris Bailey.* From the Division of Orthopaedics, Department of Surgery, Schulich School of Medicine and Dentistry, Western University, Lawson Health Research Institute, and London Health Sciences Centre, London, Ont.**

Background: Our objective was to determine whether repeat discectomy and fusion (DF) is superior to repeat discectomy (DA) in the treatment of recurrent lumbar disc herniation with respect to patient-rated outcome 1 year after surgery. **Methods:** Patients undergoing a same-level DA or DF were retrospectively identified from the Canadian Spine Outcomes and Research Network. Patients younger than 18 years; those who were lost to follow-up before 6 weeks; and those who had previous lumbar surgery, artificial disc replacement, dynamic stabilization or deformity correction were excluded. Analysis of covariance was used to assess the difference in leg pain between groups, adjusting for site, chief complaint and baseline score. The time-weighted average treatment effect was determined over all time periods. Missing data were replaced using multiple imputation or last value carried forward. **Results:** Eighteen patients had DA and 46 had DF. Demographics did not differ between cohorts except that the surgeon categorized the patient's chief complaint as back pain more often in the DF group (37% v. 0%, p = 0.003), even though patient-rated back pain intensity did not differ. The leg pain score 1 year after surgery was 4.2 ± 0.9 for the DF group and 4.4 ± 1.3 for the DA group (p = 0.882). No differences in time-weighted treatment effects were found for leg pain, back pain, Oswestry Disability Index score, or physical component summary or mental component summary scores on the 12-item Short-Form Survey. Hospital stay, duration of surgery and blood loss were greater for the DF group than the DA group ($p < 0.001$ for all comparisons). Adverse events, including dural tear (6.5% v. 11.1%, p = 0.583), wound infection (2.2% v. 5.6%, p = 0.485) and revision surgery (4.3% v. 11.1%, p = 0.315) did not differ between the DF and DA groups. A similar proportion of patients in the DF and DA groups were extremely or somewhat satisfied at 12 months after surgery (75.6% v. 72.2%, p = 0.784). **Conclusion:** Compared with patients treated with DF, those treated with DA have similar pain relief, functional recovery and satisfaction with treatment. Although surgeons select fusion to treat back pain, the back pain intensity was not significantly different between cohorts before or after surgery.

0097

Variation in the surgical treatment of lumbar spinal stenosis in Canada. ***Simon Manners[1], Greg McIntosh[2], Neil Manson[3], Raja Rampersaud[4], Hamilton Hall[2], Charles Fisher[5], Ken Thomas[1].* From the [1]University of Calgary, Calgary, Alta.; the [2]Canadian Spine Society, Toronto, Ont.; [3]Dalhousie University, New Brunswick, Saint John, NB;**

the [4]University of Toronto, Toronto, Ont.; and the [5]University British Columbia, Vancouver, BC.

Background: The primary objective of this study was to assess the variation in both the surgical management and patient-reported outcomes for patients with lumbar spinal stenosis (LSS) across Canadian centres. **Methods:** We conducted a study of prospectively collected data from the Canadian Spine Outcomes and Research Network (CSORN) registry. For inclusion, centres had to have performed surgery on at least 50 consecutive patients for LSS without instability (spondylolisthesis) or deformity. Data analyzed included preoperative (age, American Society of Anesthesiologists class, body mass index and preoperatove patient-reported outcomes [PROs]), intraoperative (procedure performed, duration of surgery, blood loss, adverse events [AEs]) and postoperative (AEs, PROs) factors. The PROs included the Oswestry Disability Index, 12-item Short-Form Survey and EuroQOL-5D scores preoperatively and at 3, 12 and 24 months postoperatively. Descriptive and comparative statistics were used to compare fusion rates and PROs across centres. **Results:** In total, 940 patients from 5 centres met our inclusion criteria. These patients did not differ significantly across centres with regards to baseline demographics or PROs. Of these, 584 (62%) underwent decompression and fusion compared with decompression alone. The fusion rate varied from 17% to 76% among centres. Previous surgery and presence of back pain as a dominant symptom did not account for these varied fusion rates. The overall AE incidence was 39% (49% for decompression and fusion v. 24% for decompression alone). The fusion procedures took longer (226 minutes v. 100 minutes) and had greater blood loss (536 mL v. 142 mL). All patients demonstrated clinically significant improvement in all PROs at all time points. There was no significant difference in PROs at any time point between those treated with a fusion and decompression versus decompression alone. **Conclusion:** There was significant variation among centres in the surgical management of LSS without deformity/instability. Most noticeable was the gross variation in rate of decompression and fusion compared with decompression alone without a significant difference in PROs. The CSORN registry has allowed the first objective look at surgical variation in the surgical management of LSS. These findings have important implications for value-based care pathways and appropriate resource allocation.

0116

Crafting the first spine surgery performance indicator — deriving a benchmark from CSORN. ***Jonathan Bourget-Murray*[1], *Michael Yang*[1], *Godefroy Hardy St-Pierre*[2]. From the [1]University of Calgary, Calgary, Alta.; and [2]Western University, London, Ont.**

Background: The concept of value in health care is gaining significant traction in the medical literature. Its main corollary is performance translated clinically in measurements given via performance indicators. No performance indicators in spine surgery have been published to date. We propose to lay the groundwork for the first set of spine surgery performance indicators using data from Canadian Spine Outcomes and Research Network (CSORN). **Methods:** We extracted data from the main CSORN database concerning 3 outcome metrics preoperatively and at 1 year postoperatively: visual analogue scale (VAS) for back pain, VAS for leg pain and Oswestry Disability Index (ODI) score. We stratified these metrics along 3 distinct procedures performed for lumbar stenosis: simple decompression, instrumented fusion and transforaminal lumbar interbody fusion (TLIF). Risk-adjustment was added for age, body mass index, prior spine operation and American Society of Anesthesiologists score via logistic regression. **Results:** We had 1221 patients across Canada with thoracolumbar surgery for stenosis. On 612 patients undergoing simple decompression, average improvements in VAS back, VAS leg and ODI at 12 months were 3.20, 3.65 and 18.33, respectively. On 207 patients undergoing instrumented fusion, average improvements in VAS back, VAS leg and ODI at 12 months were 3.43, 3.81 and 16.59, respectively. On 136 patients undergoing single-level TLIF, average improvements in VAS back, VAS leg and ODI at 12 months were 4.04, 4.72 and 20.94, respectively. Risk adjustment did not modify the metrics as the models failed to converge. The remaining patients underwent more complex procedures and were excluded from the analysis. **Conclusion:** Performance measurement of health outcomes is the cornerstone of assessing value. This work constitutes the first attempt at generating a set of spine surgery performance indicators in the scientific literature. The next step will be to compare future outcomes for the same procedures with the same diagnosis to this proposed benchmark: the resulting difference will be the first performance indicator. Despite using risk-adjustment factors shown in the literature to affect outcome, no significant difference was found. Alternate factors should be assessed.

0041

Predictors of failure to achieve minimal clinically important improvement following a stratified education and nonsurgical self-management program for low back pain (LBP). ***Jessica Wong*[1], *Raja Rampersaud*[2,3], *Elizabeth M. Badley*[1,4], *Anthony V. Perruccio*[1,4]. From the [1]Dalla Lana School of Public Health, University of Toronto, Toronto, Ont.; [2]Orthopaedic Surgery, University of Toronto, Toronto, Ont.; [3]Arthritis Program, Krembil Research Institute, University Health Network, Toronto, Ont.; and [4]Health Care & Outcomes Research and Arthritis Program, Krembil Research Institute, University Health Network, Toronto, Ont.**

Background: The objective of this study was to identify risk factors for failure 6 months following an assessment at the Interprofessional Spine Assessment and Education Clinics (ISAEC), a nonsurgical low back pain (LBP) stratified education and self-management program. **Methods:** A retrospective analysis of ISAEC patients was performed. Adjusted log-Poisson regression analysis was used to identify independent risk factors for failure. Failure was defined as a change in the Oswestry Disability Index (ODI) score of less than the minimal clinically important difference, 10 units. Baseline factors considered were age, sex, body mass index, number of comorbidities, pain intensity, pain duration, pain pattern, smoking, ODI score, STarT Back chronicity risk and self-efficacy. Analyses were stratified by pain pattern: back-dominant (BDP) and leg-dominant (LDP). The analytical sample was restricted to those who achieved a change of 10 or more units in ODI score and who completed the follow-up questionnaire. **Results:** A total of 435 patients were included (240 with BDP and 195 with LDP). Mean age was 51.8 years in the BDP group and 54.4 years in the LDP group. At baseline, the

LDP group reported greater disability and pain. A significantly higher proportion of women had BDP (62%) than LDP (52%). Overall failure rate was higher with BDP (58%) than LDP (44%). High chronicity risk was more prevalent in LDP (28%) than BDP (18%). In the adjusted analyses, younger age and worse baseline ODI scores were associated with a decreased risk of failure. Smoking in the LDP group was associated with a 2-fold increased risk of failure ($p < 0.01$). Women with LDP were nearly twice as likely to fail as men ($p < 0.01$); this was not the case in the BDP group ($p = 0.57$). Moderate and high chronicity risk (v. low chronicity risk) were associated with increased and similar risk of failure (risk ratio 1.7 and 1.9, respectively, $p < 0.01$) with LDP; no effect was observed with BDP ($p > 0.5$). **Conclusion:** Patients with BDP appear to have greater overall risk for failure, but the risk appears equally distributed across patients. In contrast, within the LDP group, women and those with moderate/high chronicity risk appear to have greater failure risk.

0095

Self-efficacy predicts disability outcome in low back pain. ***Kala Sundararajan[1], Anthony Perruccio[1,2], Y. Raja Rampersaud[1,3]*. From the [1]Division of Orthopaedics, University Health Network, Toronto, Ont.; [2]Division of Healthcare and Outcomes Research, Krembil Research Institute, Toronto, Ont.; and [3]Spinal Program, Krembil Neuroscience Centre, Toronto Western Hospital, Toronto, Ont.**

Background: Self-efficacy is a potential driver of low back pain (LBP) disability outcomes. However, little is known about its predictors and how it affects disability. This study sought to identify patient factors predicting self-efficacy and mediators of its effects. **Methods:** Patients in an LBP self-management education program (the Inter-professional Spine Assessment and Education Clinics) completed questionnaires before and 6 months after assessment. At baseline, treatment expectations and the Chronic Pain Self-Efficacy Scale were collected. Oswestry Disability Index score was collected at both time points. Path analysis, a method for testing how well observed data fit a hypothesized causal model, was used to simultaneously identify self-efficacy predictors (age, sex, leg- v. back-dominant pain, baseline disability) and test treatment expectations as a potential mediator of self-efficacy's effect on 6-month disability. **Results:** In total, 605 patients assessed between 2012 and 2016 were included. The sample was 56% female, and mean age was 52 ± 16 years. Mean disability was 34 ± 18 at baseline and 24 ± 19 at 6 months (0–100 scale, lower is better). Mean self-efficacy was 6.7 ± 2.0 (1–10 scale, higher is better). Self-efficacy was found to be a strong independent predictor of 6-month disability outcome: adjusting for age, sex, leg- versus back-dominant pain and baseline disability, each unit increase in self-efficacy score predicted a 1.6-unit decrease in 6-month disability score (total effect, $p < 0.001$). Increased self-efficacy was predicted by better baseline disability and female sex; better treatment expectation was predicted by higher self-efficacy and baseline disability. In addition to self-efficacy, worse 6-month disability was predicted by worse expectations, older age and worse baseline disability. There was evidence that the effect of self-efficacy is partially mediated by treatment expectations, which accounted for 9% of the total effect of self-efficacy ($p = 0.06$). The direct effect of self-efficacy accounted for the remaining 91% ($p < 0.001$). **Conclusion:** Self-efficacy is a modifiable factor predictive of LBP disability outcome. Men and patients with worse baseline disability may particularly benefit from targeted approaches to modify self-efficacy. Furthermore, improving treatment expectations may increase the impact of self-efficacy on disability.

0109

Development of a minimum data set to enhance CSORN registry adverse event identification and reporting. ***Turker Dalkilic[1], Eden Daly[2], Y. Raja Rampersaud[2], John Street[1]*. From the [1]Vancouver Spine Program, Vancouver, BC; and the [2]Canadian Spine Outcomes and Research Network, Toronto, Ont.**

Background: Comprehensive adverse event (AE) identification is critical to the integrity of the Canadian Spine Outcomes and Research Network (CSORN) registry. Contributing sites have experienced varying success in data collection and reporting, potentially undermining the integrity of the data. The aims of this study were to 1) perform an environmental scan of AE reporting for all CSORN sites, 2) develop a minimum data set (MDS) of AEs to be collected and 3) test the inter- and intrarater reliability of this MDS. **Methods:** CSORN was examined for rates of event- and site-specific AE reporting. Using standardized methodology, success in data collection and reporting was examined for each CSORN site. CSORN and all previous Spinal Adverse Events Severity System (SAVES) publications were examined to identify the 10 most commonly reported AEs for use as the MDS. Ten representative patient cases were developed. The cases were analyzed by 5 raters (2 physicians, 1 nurse, 2 research coordinators), who identified and graded AEs using the MDS. Intra- and interrater reliability were calculated using κ statistics and intraclass correlation coefficients (ICC). **Results:** In total, 16% of 6217 enrolled patients had post-discharge to 12-weeks AE forms completed (site-specific range 0%–54%, 2 sites 0%), and 17.8% had greater than 12 weeks AE forms completed (site-specific range 0%–62%, 5 sites 0%). Many sites did not complete the AE form when the patient had no AE. The MDS contained 5 intraoperative and 5 postoperative AEs. Intrarater reliability for both identifying and grading AEs were high with all AEs ($\kappa > 0.75$), except for massive blood loss, postoperative neurologic deterioration and reoperation during the index admission. The interrater reliability measured with ICC was above 0.8 for identifying and grading intra-, pre- and postoperative AEs. **Conclusion:** Currently, CSORN AE recording is poor. An MDS with excellent inter- and intrarater reliability and ICC may allow sites to improve AE reporting. We propose to circulate this MDS to the Canadian Spine Society membership for external expert validation.

0037

Predictive factors for discharge destinations post-posterior lumbar spinal fusion. An analysis of the Canadian Spine Outcomes and Research Network Database. ***Fan Jiang[1], Mina Morocos[1], Alex Munteau[2], Greg McIntosh[3], Michael Weber[1]*. From [1]McGill University, Montreal, Que.; [2]Kansas City Univeristy, Kansas City, Mo.; and the [3]Canadian Spine Society, Toronto, Ont.**

Background: Spinal fusion is one of the more common and more expensive procedures currently being performed for a

variety of spine conditions. On average, patients spend 3–7 postoperative days hospitalized. However, certain patients who are unable to be discharged home may require prolonged hospital stay while awaiting a bed at a rehabilitation facility. With the aging population in North America, health care systems are faced with an increasing economic burden. An efficient system at providing quality of care while minimizing this unnecessary prolonged hospitalization could reduce expenditures and control costs. Currently, there are little data in the literature concerning the predictive factors of discharge destination in patients following posterior lumbar spinal fusion. The objective of this study was to identify predictors for discharge to home in these patients using the Canadian Spine Outcomes and Research Network (CSORN) database. **Methods:** Patients who underwent posterior lumbar spinal fusion between 2008 and 2015 were identified retrospectively using the CSORN database. Individual patient demographics, operative factors and discharge information were obtained. Multivariate analysis was performed to determine association between patient demographics, operative factors and discharge to home. **Results:** In total, 643 patients were identified from the database; 87.1% of the patients (n = 560) were discharged to home while 12.9% (n = 83) required discharge to other facilities. Using multivariate logistic regression analysis, the predictors for discharge to home were identified, including younger age, low body mass index, low Oswestry Disability Index score, not living alone preoperatively, reduced duration of surgery, reduced number of operated levels, and absence of blood transfusion during the hospital stay. **Conclusion:** Using the CSORN database, significant patient factors and operative factors were identified as predictors for discharge to home following lumbar spinal fusion. Understanding these factors allows the early identification of patients who may require short-term facility care following posterior lumbar fusion. This will grant us the ability to prompt the involvement of discharge planning and possibly expedite the discharge process, minimizing needless prolonged hospital stay.

0085

Adult cervical deformity: How does revision compare with primary surgery? A prospective multicentre study with 1-year follow-up. ***Alex Soroceanu*[1], *Justin Smith*[2], *Munish Gupta*[3], *Peter Passias*[4], *Themistocles Protopsaltis*[4], *Robert Hart*[5], *Virginie Lafage*[6], *Douglas Burton*[7], *Justib Scheer*[2], *Frank Schwab*[6], *Thomas Errico*[4], *Christopher Shaffrey*[2], *Christopher Ames*[8]. From the [1]University of Calgary, Calgary, Alta.; [2]University of Virginia, Charlottesville, Va.; [3]Washington University, St Louis, Mo.; [4]New York University, New York, NY; [5]Oregon Health & Science University, Portland, Ore.; [6]Hospital for Special Surgery, New York, NY; [7]Kansas City University, Kansas City, Mo.; and [8]University of California San Francisco, San Francisco, Calif.**

Background: There are little data in the current literature on the surgical treatment of adult cervical deformity (ACD), in particular revision surgery. This study assesses revision versus primary surgery in operative patients with ACD. **Methods:** We used a multicentre prospective database of surgically treated ACD patients. Patients who completed the 1-year follow-up visit were divided into 2 groups (primary v. revision). Baseline patient characteristics, surgical parameters, health-related quality of life (HRQoL) data, and complications were assessed using t tests and χ^2 tests, as appropriate. **Results:** Sixty-one patients met the inclusion criteria: 28 in the revision group and 33 in the primary group. The 2 groups were similar in terms of sex distribution (p = 0.9), smoking (p = 0.6), Charlson Comorbidity Index (p = 0.5), and body mass index (BMI; p = 0.6). With regard to surgical data, both groups had similar surgical times (p = 0.1), blood loss (p = 0.4434), use of traction (p = 0.13), and surgical approach (p = 0.14). Revision patients had a trend toward more 3-colum osteotomies (15.2% v. 35.7%, p = 0.06) and were more likely to require admission to the intensive care unit postsurgery (89.3% v. 66.7%, p = 0.036). At baseline, revision patients had worse Neck Disability Index (NDI) scores (54.49 v. 45.34, p = 0.0375) and similar Modified Japanese Orthopaedic Association (mJOA; 13.43 v. 13.37, p = 0.93) and numeric rating scale for neck pain (6.89 v. 6.78, p = 0.86). At 1 year, both groups had similar improvements on the NDI (p = 0.675) and mJOA (p = 0.2560). Revision patients had less neck pain improvement (1.69 v. 3.38, p = 0.036). Revision and primary patients had similar rates of overall (p = 0.12) and major complications (p = 0.19). **Conclusion:** Our results show that at baseline, revision ACD patients have more disability, as measured on the NDI score. Revision and primary patients achieved similar improvements at 1 year on the NDI, but revision patients experienced less improvement in neck pain. Revision patients showed a trend toward more 3-column osteotomies and were more likely to require admission to the intensive care unit. Complication rates were similar between the groups. These data may prove useful for treatment planning and patient counselling.

0020

Comparison of anterior and posterior surgery for degenerative cervical myelopathy — an MRI-based propensity score–matched analysis using data from the Prospective Multicentre AOSpine CSM North America and International studies. ***So Kato*, *Aria Nouri*, *Dongjin Wu*, *Satoshi Nori*, *Lindsay Tetreault*, *Michael Fehlings*. From Toronto Western Hospital, Toronto, Ont.**

Background: Two different approaches (anterior v. posterior) for degenerative cervical myelopathy (DCM) are often chosen by surgeons based on the imaging features of spinal cord compression, the number of levels affected and the spinal alignment; however, there is a lack of consensus on which approach is preferable. The objective of the present study is to compare postoperative outcomes between the anterior and posterior surgical approach for DCM using MRI-based propensity score–matched analysis. **Methods:** A total of 757 patients were enrolled in 2 prospective multicentre AOSpine studies, which involved 16 international sites. Preoperative MRIs were investigated to characterize cord compression (single-level disc pathology, multilevel disc pathology, ossification of the posterior longitudinal ligament, enlargement of the ligamentum flavum, subluxation/listhesis, congenital fusion, number of compression levels and kyphosis). Propensity to receive anterior decompression was calculated using demographic data, preoperative MRI findings and modified Japanese Orthopaedic Association (mJOA) scores, and one-to-one matching was performed to compare outcomes between the anterior and posterior groups after adjustment for background characteristics. **Results:** A total of 435 cases were included in the propensity score calculation, and

one-to-one matching resulted in 77 pairs of anterior and posterior surgical cases. Postoperative mJOA (15.5 v. 15.6, $p = 0.92$), recovery rate of mJOA (46.0% v. 48.1%, $p = 0.77$), Neck Disability Index (24.5 v. 20.4, $p = 0.89$) and Short Form-36 physical component summary score (41.7 v. 42.2, $p = 0.75$) were not significantly different between the 2 groups. Overall, rates of perioperative complications were similar in both groups (10% v. 10%, $p > 0.99$); however, dysphagia/dysphonia (4%) and epidural hematoma (4%) were reported only in the anterior group. **Conclusion:** Anterior and posterior decompression for DCM showed similar postoperative outcomes and rates of complications.

0117

The first clinical use of quantitative spinal cord MRI: serial monitoring to identify disease progression in patients with degenerative cervical myelopathy managed nonoperatively. ***Allan R. Martin[1], Benjamin De Leener[2], Julien Cohen-Adad[2], David W. Cadotte[3], Sukhvinder Kalsi-Ryan[1], Jefferson R. Wilson[1], Lindsay Tetreault[1,4], Aria Nouri[1], Adrian Crawley[1], David J. Mikulis[1], Howard Ginsberg[1], Michael G. Fehlings[1].***

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Background: The natural history of degenerative cervical myelopathy (DCM) is variable, ranging from long-term clinical stability to rapid decline. Clinical progression may be masked by neuroplasticity, behavioural adaption and the subjective and transient nature of symptoms, such as fine motor dysfunction, numbness and gait impairment. Quantitative MRI (qMRI) techniques can directly measure tissue injury in terms of axonal loss, demyelination and atrophy. This longitudinal prospective study assesses the utility of serial qMRI at 1-year follow-up to detect disease progression in patients with DCM managed nonoperatively. **Methods:** Twelve patients with DCM with 1-year follow-up data were included. Clinical data included modified Japanese Orthopaedic Association (mJOA), Nurick, QuickDASH, cervical spondylotic myelopathy–Graded Redefined Assessment of Strength, Sensibility and Prehension (CSM-GRASSP), grip strength, monofilament sensation, Berg balance and GaitRITE scores. 3T MRI data included spinal canal (SC) cross-sectional area (CSA), diffusion fractional anisotropy (FA), magnetization transfer ratio (MTR), and T_2*-weighted white to grey matter signal intensity ratio (T_2*w WM/GM), extracted from maximally compressed level (MCL) and rostral (C1-C3) and caudal (C6-C7) levels. Disease progression was defined clinically by a 1-point decrease in mJOA score or 3 other measures worsening by 5%. Quantitative MRI progression was defined as any of 10 univariate measures or a composite score worsening by 2.65 standard deviations of previously established test–retest variability ($p = 0.004$, single-tailed, corrected for multiple comparisons). **Results:** Four of 14 patients (28.6%) showed clinical worsening at 1 year, including 2 patients with a decline in mJOA score and 2 patients with decreases in other scores (grip strength, sensation, gait). Six of 14 patients showed qMRI progression, including all 4 patients with clinical progression. Quantitative MRI progression was most commonly seen with changes in MCL CSA (4 patients) and MCL T_2*w WM/GM ratio (3 patients). **Conclusion:** Quantitative multiparametric SC MRI appears to detect progression of SC tissue injury with greater sensitivity than clinical assessments, including mJOA score. These follow-up results have been made available to the treating surgeons for consideration during surgical decision-making. To our knowledge, this represents the first clinical use of SC qMRI and an important step toward clinical translation of these techniques.

0068

Combinatorial surgical and neuroprotective therapy for cervical spondylotic myelopathy results in improved neurological function: from preclinical proof of concept to a phase iii randomized controlled trial. ***Michael Fehlings[1], Branko Kopjar[2], Spyridon Karadimas[1], Paul Arnold[3].***

From the [1]University of Toronto, Toronto, Ont.; [2]University of Washington, Seattle, Wash.; and [3]Kansas University Medical Center, Kansas City, Kans.

Background: Surgical decompression is an effective treatment for cervical spondylotic myelopathy (CSM). However, a number of patients continue to experience substantial neurologic impairment postsurgery. Riluzole has neuroprotective effects in injuries of the central nervous system. To determine the efficacy of riluzole for promoting neurologic improvement in CSM following decompression, we performed a preclinical proof of concept experiment and then we translated our work and established a Phase III multicentre randomized controlled clinical trial (CSM-Protect). **Methods:** Surgical decompression was performed in a rat CSM model, and riluzole or control was administered. Spinal cord blood flow (SCBF) was evaluated in all CSM rats in vivo before and after decompression using FAIR MRI. The long-term outcomes of decompression with or without riluzole treatment were determined using neurobehavioural and neuroanatomical assessments. Our multicentre double-blind randomized CSM-Protect trial includes a total of 300 CSM patients undergoing decompression surgery and randomized 1:1 to receive riluzole (2 × 50 mg daily for 14 days before and 28 days postsurgery) or placebo treatment. The modified Japanese Orthopaedic Association (mJOA) score will determine the effectiveness of the combinatorial treatment at 6 months following surgery. Statistical analysis will be performed as a sequential adaptive trial with interim analysis. **Results:** Rats receiving combinatorial treatment displayed long-term significant neurologic improvements associated with preservation of motor neurons and corticospinal tracts compared with rats treated with decompression alone. Riluzole also dramatically reduced the extent of ischemia-reperfusion injury postsurgical decompression in our animal model. At present, 274 participants have been enrolled into the CSM-Protect trial. A planned interim analysis using this sample has commenced. **Conclusion:** The proposed combinatorial therapy promotes neurologic recovery in CSM rats. Confirmation of this proof of concept has been translated from the bench to the bedside, and we are currently running the CSM-Protect trial to determine the efficacy of this combinatorial treatment option for use in CSM patients.

0050

A clinical practice guideline for the management of patients with degenerative cervical myelopathy: recommendations for patients with mild, moderate and severe disease and nonmyelopathic patients with evidence of cord compression. ***Lindsay Tetreault[1], James Harrop[2], Brian Kwon[3], Allan Martin[1], James Middleton[4], John Rhee[5],***

K. Daniel Riew[6], *Jeffrey Wang*[7], *Jefferson Wilson*[1], *Michael Feblings*[1]. **From the [1]University of Toronto, Toronto, Ont.; [2]Thomas Jefferson University, Philadelphia, Pa.; [3]University of British Columbia, Vancouver, BC; [4]University of Syndey, Sydney, Australia; [5]Emory University, Atlanta, Ga.; [6]Columbia University, New York, NY; and [7]University of California Los Angeles, Los Angeles, Calif.**

Background: This study aims to develop guidelines that outline how to best manage patients with mild, moderate and severe myelopathy and nonmyelopathic patients with evidence of cord compression with or without clinical symptoms of radiculopathy. **Methods:** Five systematic reviews were conducted to synthesize evidence on disease natural history; risk factors of disease progression; the efficacy, effectiveness and safety of nonoperative and surgical management; the impact of preoperative duration of symptoms and myelopathy severity on outcomes; and the frequency, timing and predictors of symptom development. A multidisciplinary group used this information in combination with their clinical expertise to develop recommendations for the management of degenerative cervical myelopathy (DCM). **Results:** Our recommendations were as follows: 1) We recommend surgical intervention for patients with moderate and severe DCM. 2) We suggest offering surgical intervention or a supervised trial of structured rehabilitation for patients with mild DCM. If initial nonoperative management is pursued, we recommend operative intervention if there is neurological deterioration and suggest operative intervention if the patient fails to improve. 3) We suggest not offering prophylactic surgery for nonmyelopathic patients with evidence of cervical cord compression without signs or symptoms of radiculopathy. We suggest that these patients be counselled as to potential risks of progression, educated about relevant signs and symptoms of myelopathy, and followed clinically. 4) Nonmyelopathic patients with cord compression and clinical evidence of radiculopathy with or without electrophysiological confirmation are at a higher risk of myelopathy and should be counselled about this risk. We suggest offering either surgical intervention or nonoperative treatment consisting of close serial follow-up or a supervised trial of structured rehabilitation. In the event of myelopathic development, the patient should be managed according to the recommendations above. **Conclusion:** These guidelines should be implemented into clinical practice to improve outcomes and reduce morbidity in patients with DCM.

0105

The impact of spinal cord signal intensity changes on the clinical presentation and surgical outcome of patients with degenerative cervical myelopathy: an ambispective analysis of a global cohort of patients. *Aria Nouri*[1,2], *Allan Martin*[1,2], *So Kato*[1,2], *Hamed Reihani-Kermani*[1,2], *Lauren Riehm*[1], *Michael Feblings*[1,2]. **From the [1]University of Toronto, Toronto, Ont.; and [2]Toronto Western Hospital, Toronto, Ont.**

Background: Degenerative cervical myelopathy (DCM) encompasses a group of conditions that typically result in progressive cervical spinal cord injury. This injury frequently coincides with T_2-weighted (T2WI) and T_1-weighted (T1WI) image signal intensity changes. However, the associations between MRI signal intensity changes, neurologic status and surgical outcome remain subjects of controversy. **Methods:** MRI data derived from a global cohort of 757 patients from 2 prospective and multicentre studies were retrospectively reviewed. T2WIs and T1WIs were assessed for the presence, extent and location of signal intensity changes, compared with the presence of clinical signs and symptoms and correlated with functional status measures, including the Modified Japanese Orthopaedic Association (mJOA), Nurick, Neck Disability Index and the 36-Item Short Form Survey (SF-36). Additionally, signal change characteristics were evaluated for their ability to predict surgical outcome. Intrarater reliabilities of signal changes characteristics were computed for a subset of patients. **Results:** T1WI and T2WI MRIs were available for 419 patients. Patients without signal changes [T2WI(–)/T1(–)], with T_2 hyperintensity [T2WI(+)/T1(–)], and with both T2WI hyperintensity and T1WI hypointensity [T2WI(+)/T1WI(+)] accounted for 28.9%, 51.8% and 19.3%, respectively. The prevalence of clinical signs and symptoms were consistently lower in patients without signal changes and more common in patients with both T1WI and T2WI signal changes and those with multilevel T_2 hyperintensity changes. On univariate analysis, signal groups T2WI(–)/T1WI(–), T2WI(+)/T1WI(+) and the number of signal levels were associated with surgical outcome ($p < 0.01$). Multivariate logistic analysis resulted in a final model comprising T2WI(+)/T1WI(+) and baseline mJOA, with an area under the curve of 0.774. **Conclusion:** The absence of signal changes and the presence of T1WI hypointensity associate most consistently with the baseline clinical findings. T2WI hyperintensity in isolation appears to be nonspecific in its association with baseline neurologic status and does not predict surgical outcome; however, when taking into consideration the number of hyperintensity levels, greater impairment at presentation and worse surgical outcomes are expected with multilevel involvement. Multivariate analysis indicates that spinal cord T1WI hypointensity at baseline translates to a lower likelihood for a good postoperative outcome at 2 years.

0128

Error propagation in spinal intraoperative navigation from nonsegmental registration: a prospective cadaveric and clinical study. *Daipayan Guha*[1], *Raphael Jakubovic*[2], *Shaurya Gupta*[1], *Albert Yee*[1,3], *Victor Yang*[1,3]. **From the [1]University of Toronto, Toronto, Ont.; [2]Ryerson University, Toronto, Ont.; and [3]Sunnybrook Health Sciences Centre, Toronto, Ont.**

Background: Computer-assisted navigation may guide spinal instrumentation. Current systems rely on a dynamic reference frame (DRF) for image-to-patient registration and tool tracking. Displacement of levels distant to the DRF may generate inaccuracy from intersegmental mobility. We quantify intraoperative vertebral motion from patient respiration and surgical manipulation. **Methods:** Respiration-induced vertebral motion was quantified from 13 clinical cases of open posterior instrumented fusion. Patients were positioned prone on a Wilson frame, with a head clamp for cervical fusions. The absolute position of a spinous-process clamp was tracked by an optical navigation system over about 12 respiratory cycles. Vertebral motion during screw tract formation was quantified in 4 human cadavers. Following an open posterior exposure, the position of a tracked awl was quantified before and after exertion of force to create pilot holes for pedicle screw tracts. **Results:** Peak-to-peak respiration-induced vertebral motion was maximal in the anteroposterior (0.57 mm ± 0.38 mm)

and craniocaudal axes (0.65 mm ± 0.45 mm). Anteroposterior displacement was greater in the lower thoracic spine (0.65 mm ± 0.31 mm) than in the cervical (0.51 mm ± 0.50 mm) or lumbar spine (0.38 mm ± 0.08 mm). In multivariate regression, both tidal volume and end-expiratory pressure were positively correlated with anteroposterior and 3D displacement. Manipulation during screw tract formation caused displacement predominantly in the mediolateral (0.71 mm ± 0.84 mm) and craniocaudal planes (1.02 mm ± 0.92 mm). Mediolateral displacement was greater in the thoracic and lumbar spines than in the cervical spine (mean 0.96 mm, 0.73 mm and 0.45 mm, respectively), while craniocaudal displacement was greater in the lumbar than the cervical and thoracic spines (mean 1.38 mm, 0.92 mm and 0.82 mm, respectively). **Conclusion:** Vertebral motion is unaccounted for during image-guided surgery when performed at levels distant from the DRF. Respiration and manipulation-induced vertebral motion are greater than 2 mm in 6%–15% of cases, varying with spinal region and ventilator parameters. Respiration-induced motion is significantly underestimated in this study. These errors should be compensated for in image-guidance systems to minimize navigation inaccuracy.

0021

After-hours emergent spine surgery: Perhaps we should think twice? ***Raphaële Charest-Morin[1], Alana Flexman[2], Michael Bond[2], Tamir Ailon[2], Charles G. Fisher[2], Marcel F. Dvorak[2], Michael C. Boyd[2], Brian K. Kwon[2], Nicolas Dea[3], Scott J. Paquette[2], John T. Street[2]*** **From [1]Laval University, Québec, Que.; [2]University of British Columbia, Vancouver, BC; and [3]University of Sherbrooke, Sherbrooke, Que.**

Background: After-hours emergent spinal surgeries are frequent, and often performed under suboptimal conditions. The consequences of performing these surgeries under such conditions on outcomes are unknown. The objective was to compare emergent spine surgery performed after hours to those performed in regular operating hours with respect to mortality, length of stay (LOS) and perioperative adverse events (AEs). **Methods:** In total, 1440 patients underwent emergent spinal surgery at a single institution between 2009 and 2013. Surgery was defined as "in hours" if completed between 7 am and 4 pm and defined as "after hours" if more than 50% of the operation was between 4:01 pm and 6:59 am or if it was performed over the weekend. Data on demographics, diagnosis, comorbid disease, surgical intervention, Spine Surgical Invasiveness Index (SSII), duration of surgery, intraoperative blood loss (IOBL) and postoperative outcome measures (AEs, mortality, LOS) were prospectively collected. **Results:** In total 664 (46.1%) procedures were performed after hours. Duration of surgery and IOBL were similar between groups ($p > 0.05$). Of the patients operated after hours, 63% experienced more than 1 AE compared with 57% in the in-hours group ($p = 0.016$). The number of intraoperative AEs per patient was higher in the after-hours group (median 1, interquartile range [IQR] 0–4 v. 1, IQR 0–3, $p = 0.0096$). After-hours designation was an independent predictor of AE on multivariate analysis (adjusted odds ratio [OR] 1.3, 95% CI 1.02–1.66, $p = 0.034$). Mortality doubled in patients who had surgery after hours (4.4% v. 2.1%, $p = 0.013$). On multivariate analysis, after-hours surgery showed a borderline association with in-hospital death (adjusted OR 1.99, 95% CI 0.98–4.06, $p = 0.056$). LOS was longer in the after-hours group (median 14, IQR 7–28 v. 13, IQR 7–24, $p = 0.014$). However, on multivariate analysis, association between LOS and after-hours surgery was not significant (adjusted OR 1.63, 95% CI –0.83 to 4.10, $p = 0.194$). **Conclusion:** Emergent spine surgery performed after hours is associated with an increase in perioperative AEs. Further research is needed to determine the specific contributors to poorer outcomes after hours. System changes to facilitate in-hours surgery could mitigate the adverse outcomes associated with after-hours surgery.

0080

Factors associated with an increased risk of postoperative infection following spine surgery. ***Mina Aziz[1], Michael Johnson[1], Steve Passmore[1], Neil Berrington[1], Greg McIntosh[2], Michael Goytan[1]*** **From the [1]University of Manitoba, Winnipeg, Man.; and the [2]Canadian Spine Outcomes and Research Network, Toronto, Ont.**

Background: Postoperative infection is a serious complication of spine surgery and can contribute to the strain on the health care system's resources, because some studies have estimated the cost of such an infection to be $200 000 per patient. The purpose of this study is to determine what factors affect the risk of postoperative infection. We hypothesize that female sex, smoking, diabetes, having thoracolumbar procedures, having a neurologic deficit, older age, body mass index (BMI), medical comorbidities and number of operative levels increase the patients' risk of postoperative infection. **Methods:** We conducted a retrospective review of prospectively collected data within the Canadian Spine Outcomes and Research Network (CSORN) registry of all patients who underwent a spinal operation. Data were analyzed using the SAS university edition statistical software. Analysis of variance was used to analyze continuous variables, and odds ratios and Fisher exact tests were used to analyze categorical variables, with results considered significant at $p < 0.05$. **Results:** Out of 4888 patients identified from the registry, 3152 patients had complete data and were included in the analysis. There were 88 infections recorded, representing a 2.8% risk of infection. There were no statistically significant differences in sex, age, smoking status, number of comorbidities or number of operative levels between infected and noninfected groups. Having a neurologic deficit did not appear to increase the risk of having an infection. Patients who were diabetic were 1.89 times more likely to have an infection (95% CI 1.13–3.15, $p < 0.02$), and those undergoing thoracolumbar procedures were 2.65 times more likely to have an infection (95% CI 1.27–5.51, $p < 0.01$). Those with an infection had significantly higher BMI (30.12 ± 6.29 v. 28.68 ± 6.15, $p < 0.03$). **Conclusion:** There is a 2.8% overall rate of postoperative spine infection in 20 Canadian centres. The factors that were associated with patient risk of infection were diabetes, thoracolumbar procedures and increased BMI. In the future, multivariate analysis of these data should be conducted to determine the interactions between the various risk factors.

0111

Health-related quality of life changes after minimally invasive surgery for degenerative lumbar spondylolisthesis compared with total hip and knee arthroplasty for osteoarthritis: a matched-cohort study. ***Eric Crawford[1,2], Robert Ravinsky[1], Y. Raja Rampersaud[1,3]*** **From the [1]Division of**

Orthopaedic Surgery, University of Toronto, Toronto, Ont.; [2]Institute of Health Policy Management and Evaluation, University of Toronto, Toronto, Ont.; and [3]Division of Orthopaedic Surgery, Toronto Western Hospital, University Health Network, Toronto, Ont.

Background: The objective of this study is to determine the comparative health-related quality of life (HRQoL) changes associated with minimally invasive surgery (MIS) for degenerative lumbar spondylolisthesis (DLS) to matched cohorts of total hip and knee arthroplasty patients with osteoarthritis. This evaluation of surgical procedures for degenerative musculoskeletal conditions is warranted, given the evolving care pathways for total joint replacement (TJR) patients, with resultant decreases in health care utilization and costs and the increasing demand for surgery in patients with DLS. **Methods:** A cohort of patients with DLS undergoing 1- or 2-level decompression or decompression and instrumented fusion MIS procedures between 2008 and 2014 was created. Matched cohorts of patients with hip osteoarthritis (H-OA) and knee osteoarthritis (K-OA) undergoing TJR were formed based on age, sex and date of surgery. Prospectively collected patient-reported changes in 36-Item Short Form Survey (SF-36) physical component summary (PCS) score were the main outcome measure. **Results:** Seventy-three patients met all inclusion criteria for the DLS cohort (n = 38 for decompression alone), with a minimum follow-up time of 1 year (mean 1.76 ± 0.42 years). The mean age of patients in the DLS cohort was 65.37 years (range 48–80 years), and 51 patients (69.9%) were women. There were no differences in baseline demographic characteristics between the cohorts. PCS scores improved significantly from baseline to follow-up for all groups: DLS ($p < 0.001$), H-OA ($p < 0.001$) and K-OA ($p < 0.001$). There were no significant differences ($p = 0.253$) in the magnitude of change between the groups for PCS scores (DLS: mean 9.50, 95% CI 7.23–11.78; H-OA: mean 12.49, 95% CI 9.65–15.32; K-OA: mean 10.82, 95% CI 8.38–13.26). Subgroup analysis revealed that DLS patients undergoing decompression or decompression and instrumented fusion MIS procedures had equivocal changes in PCS scores compared with matched H-OA and K-OA patients undergoing TJR. **Conclusion:** MIS procedures for DLS result in equivocal gains in physical HRQoL compared with TJR for H-OA and K-OA. Cost-utility evaluations in this area are needed to demonstrate the relative value of MIS procedures for DLS and to advocate for health policy that acknowledges the benefit of surgical care for this population.

0010

Atlas instrumentation guided by the medial edge of the posterior arch: an anatomic and radiologic study ***Amro Alhabib[1], Abdulkarim Al Rabie[1], Sami Aleissa[2], Abdulrahman Albakr[1], Abdulaziz Abobotain[1,3]*. From [1]King Saud University, Riyadh, Saudi Arabia; [2]King Saud Bin Abdulaziz University for Health Sciences, Riyadh, Saudi Arabia; and [3]McGill University, Montreal, Que.**

Background: Atlas instrumentation is frequently done in fusion procedures involving the craniocervical junction. Identification of the entry point at the centre of the Atlas lateral mass (ALM) could be a challenge given its rounded posterior surface and the surrounding rich venous plexus. This report examines using the medial edge of the Atlas posterior arch (MEC1) as a fixed and reliable anatomic reference to guide the entry point of ALM screws. **Methods:** Fifty normal cervical spine computed tomography studies were reviewed, including 3D reconstruction of C1 vertebra. Quantification was done for ALM transverse diameter and midpoint. ALM screw trajectory was planned along MEC1 and another point 2 mm lateral to MEC1. Proximity to the midpoint of ALM was determined for both. ALM instrumentation was then performed in 10 fresh human cadavers. O-arm (Medtronic) 3D imaging was performed for anatomic verification. Freehand instrumentation of ALM was performed (Multiaxial vertex screws, Medtronic) using an entry point 2 mm lateral to MEC1 with a sagittal trajectory parallel to the Atlas inferior arch (IAC1). O-arm 3D imaging was performed afterwards to confirm instrumentation accuracy. **Results:** Based on radiologic assessment, the average lateral mass diameter was 12.35 mm. Inserting a lateral mass screw using a point 2 mm lateral to MEC1 was closer to the midpoint of ALM than inserting it along the MEC1 ($p < 0.0001$). Twenty screws were successfully inserted within the ALM in the 10 cadavers based on using an entry point 2 mm lateral to MEC1. No encroachment into the spinal canal or foramen transversarium was found. Two screws were superiorly directed and violated the occipitocervical joint; they were found not to be parallel to IAC1. **Conclusion:** The MEC1 provides a fixed and reliable landmark for ALM instrumentation. The 2-mm point lateral to MEC1 is closer to the midpoint of ALM. IAC1 also provides a guide for the sagittal trajectory. Attention to anatomic landmarks may help reduce complications of Atlas instrumentation and needs to be verified in future clinical studies.

0039

Revision rates following minimally invasive decompression for lumbar spinal stenosis in patients with and without preoperative degenerative lumbar spondylolisthesis with a minimum of 5-year follow-up. ***Nizar Moayeri[1,2], Markian Pabuta[1,3], Raja Rampersaud[4,5]*. From the [1]Department of Neurology and Neurosurgery, University Health Network, Toronto, Ont.; [2]Department of Neurology and Neurosurgery, University Medical Center Utrecht, Utrecht, The Netherlands; [3]University of Ottawa, Ottawa, Ont.; [4]Orthopaedic Surgery, University of Toronto, Toronto, Ont.; and [5]Arthritis Program, Krembil Research Institute, University Health Network, Toronto, Ont.**

Background: Long-term follow-up reoperation data for minimally invasive decompression (MID) lumbar spinal stenosis (LSS) is lacking. The objective of this study was to evaluate reoperation rates in patients with LSS who underwent an MID, stratified for degenerative lumbar spondylolisthesis (DLS). **Methods:** All patients with LSS with and without grade 1 DLS who underwent MID between 2002 and 2011 were included. The same technique was used by the senior author for all patients with neurogenic claudication/mechanical radiculopathy, no (or tolerable) mechanical back pain, and those with up to a 25% (grade I) spondylolisthesis, and no obvious dynamic instability on imaging. Reoperation rates, defined as any operation on the same or adjacent level, were assessed. Revision decompression alone was considered if the aforementioned criteria were met, otherwise patients underwent a minimally invasive posterior fusion at revision.

Clinical outcome was evaluated using the Oswestry Disability Index (ODI) and pain scores. **Results:** In total, 247 patients (mean age 66 years, range 20–88 years) were included. Of these, 68.7% underwent 1-level decompression. The most common decompressed level was L4–5 (47.2%). Preoperative spondylolisthesis at the level of spinal stenosis was present in 56.9%. Mean follow-up was 8.2 years (range 5.0–14.9 years). The overall reoperation rate was 15.8%. No significant differences were observed between those with and without DLS. The mean time to reoperation in patients with and without spondylolisthesis was 3.9 years and 2.8 years, respectively, for decompression only, and 3.1 years and 3.1 years, respectively, for fusion. At the 5-year follow-up point, no difference was observed between the mean improvement of ODI and visual analogue scale score (leg/back) compared with the preoperative baseline in patients with and without spondylolisthesis. **Conclusion:** MID is an effective and durable procedure for the treatment of LSS with or without stable DLS. Patients with leg-dominant symptoms and stable grade 1 DLS do not require a fusion.

0056

The effect of surgical wait time on patients with degenerative lumbar spondylolisthesis: a Canadian Spine Outcomes and Research Network (CSORN) study. ***Jin Tee*[1], *Y. Raja Rampersaud*[2], *Neil Manson*[3], *Hamilton Hall*[4], *Ken Thomas*[5], *Greg McIntosh*[4], *Charles Fisher*[1]. From the [1]Vancouver General Hospital, Vancouver, BC; [2]Toronto Western Hospital, Toronto, Ont.; [3]Saint John Regional Hospital, Saint John, NB; [4]CBI Health Group, Toronto, Ont.; and [5]University of Calgary, Calgary, Alta.**

Background: The objectives of this study were to investigate the effect of surgical wait time (SWT) on the baseline and postoperative patient-reported outcome (PRO) metrics in surgical patients with degenerative spondylolisthesis (DS) and to identify independent predictors of PRO in DS patients treated surgically. **Methods:** Surgical DS patients treated between 2013 and 2015 were identified in the Canadian Spine Outcomes and Research Network (CSORN) registry. SWT was defined as the period from surgical wait listing to day of surgery, with study population dichotomy to 1) SWT less than 3 months and 2) SWT of 3 or more months. Baseline and postoperative (3 months, 1 year) demographic and PRO metrics were analyzed using bivariate and multivariate modelling. **Results:** The SWT less than 3 months cohort had 158 patients, whereas the SWT of 3 months or more cohort had 146 patients. Both SWT groups were similar in age, sex, symptom duration and smoking status. The SWT less than 3 months cohort, however, had more patients receiving Worker's Compensation ($p < 0.01$). Both groups were similar in terms of baseline PROs and spine-specific metrics, except for the SWT of 3 months or more cohort, who were more depressed ($p < 0.01$). At 3 months, the SWT of 3 months or more cohort showed greater satisfaction (96.2% v. 86.2%, $p < 0.01$). This effect was not maintained at 1 year. All other PRO metrics were similar at 3 months and 1 year. Multivariate modelling showed that both surgical wait times and symptom duration were not independent predictors of outcome in surgical DS patients. **Conclusion:** Prolonged surgical wait time was not detrimental to the postoperative outcome in surgical patients with DS.

0115

Pain catastrophizing behaviour can be associated with poorer clinical outcomes. ***Edward Abraham*[1,2], *Kate Wagg*[1], *Erin Bigney*[1], *Eden Daly*[1], *Neil Manson*[1,2]. From the [1]Canada East Spine Centre, Saint John, NB; [2]Saint John Regional Hospital, Horizon Health Network, Saint John, NB; and [3]Dalhousie School of Medicine; Department of Surgery, Saint John, NB.**

Background: The aim of the current study was to examine the effect of clinically relevant presurgical pain catastrophizing behaviour on postsurgical pain, disability and return to work outcomes. **Methods:** A prospective cohort analysis of 213 consecutive spine surgery candidates was conducted. Patients having undergone previous spine surgery were excluded. Participants were given the Pain Catastrophizing Scale (PCS) at baseline, along with functional measures, including the Oswestry Disability Index (ODI) and Numeric Rating Scales for Back and Leg Pain (NRS-B/L). Functional measures were issued again 1 year postoperatively. Return to work (RTW) status was also measured. A 1-way analysis of variance was conducted to analyze the effect of PCS scores on functional outcome measures and RTW status. Outcome measures were collapsed into binary groups: patients who failed to significantly improve on all 3 measures and those who did significantly improve. We conducted a χ^2 analysis to determine the effect of PCS on overall failure to improve. **Results:** Pain catastrophizing at a clinically relevant (score > 30) level resulted in significantly higher pain for both NRS-B ($F_{1,192} = 6.58$, $p = 0.011$) and NRS-L ($F_{1,193} = 12.13$, $p = 0.001$) at 1 year postoperatively as well as a statistically and clinically relevant increase in ODI scores ($F_{1,193} = 5.937$, $p = 0.016$). Patients with clinically relevant levels of pain catastrophizing had significantly delayed return to work as well ($F_{1,70} = 4.009$, $p = 0.049$). Indeed, 50% of patients with clinically relevant levels of pain catastrophizing preoperatively failed to clinically improve on all 3 outcome measures of interest, resulting in a significant level of failed surgery ($p = 0.035$). **Conclusion:** Clinically relevant levels of pain catastrophization predispose the surgical spine patient to worse functional outcomes, decrease in return to work and a higher rate of overall surgical failure at 1 year postoperatively. Management of this psychological risk factor preoperatively may help contribute to better clinical outcomes. Indeed it is becoming more evident that the biopsychosocial approach to medicine is imperative for this spine patient population.

0075

Radiographic and demographic factors predicting slip progression in nonoperatively treated degenerative lumbar spondylolisthesis. ***Duncan Cushnie*[1,2], *Jennifer Urquhart*[1,2], *Kevin Gurr*[1,2], *Chris Bailey*[1,2]. From [1]Western University, London, Ont.; and [2]London Health Sciences Centre, London, Ont.**

Background: Degenerative lumbar spondylolisthesis (DS) is a common radiographic finding that may lead to spinal stenosis and is associated with chronic back and leg pain. However, there is little evidence to guide clinical decision-making as to which slipped vertebrae will progress without operative stabilization. This study seeks to determine which commonly available radiological and demographic metrics predict slip progression in

patients with nonoperatively treated DS. **Methods:** Patients presenting with DS with spinal stenosis and neurologic leg symptoms were recruited into a progressively followed cohort. Radiographs and MRI metrics of sagittal balance, pelvic obliquity, facet joint morphology and biometric demographics were analyzed using univariate and logistic regression to identify predictors of spondylolisthesis progression identified on radiographs obtained at least 5 years later. **Results:** Sixty-six patients completed a minimum of 5 years of follow-up and provided the required imaging and questionnaire assessments. Those who progressed were younger, with significantly more progressing participants younger than 65 years (64.4% v. 28.6%, $p < 0.01$), more frequently obese (61.9% v. 26.8%, $p = 0.012$), with greater mean disc height (9.72 mm, 95% CI 8.35–11.09 mm v. 7.61 mm, 95% CI 6.55–8.66 mm, $p = 0.015$) and segmental angles (20.6°, 95% CI 17.6–23.6° v. 15.0°, 95% CI 13.6–18.2°, $p < 0.014$). Stepwise logistic regression confirmed younger age, obesity, male sex, smaller initial slip, and greater segmental angle as significant risk factors ($p < 0.05$). **Conclusion:** Obesity, younger age, male sex, greater segmental angle and smaller initial slip predicted slip progression in patients with DS. Initial mean disc height was higher in progressing cases, likely through its correlation with male sex and age, but was not independently predictive of progression in multivariate regression analysis.

0119

Screw-related violation of the superior facet joint in lumbar fusion: influence of surgical technique and anatomic features. ***Alisson Teles, Michael Paci, Gabriel Gutman, Fahad Abduljabbar, Michael Weber, Jeff Golan.* From the McGill Scoliosis & Spine Group, Montreal, Que.**

Background: The objective of this study was to evaluate the anatomic and surgical risk factors for screw-related facet joint violation at the superior level in lumbar fusion. **Methods:** We retrospectively reviewed consecutive series of lumbar fusion performed by a single surgeon. The inclusion criterion was primary lumbar fusion of 1 or 2 levels for degenerative disorders. We compared the incidence of superior facet joint screw violation in patients who underwent minimally invasive (MIS) versus open surgery. The postoperative computed tomography scan was evaluated by 2 independent reviewers who were unaware to which group the patients belonged. Axial, sagittal and coronal views were reviewed, and pedicle screws were graded as intra-articular if they clearly interposed between the superior and inferior facet joints of the superior level. **Results:** A total of 131 patients were included. Interobserver reliability for facet joint violation assessment was high ($\kappa = 0.789$). The incidence of superior facet joint violation was 11.45% per top level screw (n = 30 of 262). The rate of facet violation was 29.09% in the MIS group (n = 16 of 55) and 10.52% in the open group (n = 8 of 76) (odds ratio [OR] 3.33, 95% CI 1.35–8.19, $p = 0.007$). In logistic regression analysis, independent predictors of facet violation were percutaneous screw placement (adjusted OR 3.06, 95% CI 1.22–7.69, $p = 0.017$), right side pedicle screw (adjusted OR 3.14, 95% CI 1.23–7.97, $p = 0.016$) and facet angle greater than 45° (adjusted OR 14.57, 95% CI 5.74–36.98, $p < 0.0001$). **Conclusion:** The incidence of screw-related superior facet joint violation was 11.45%. Percutaneous screw placement and facet angle higher than 45° are associated with higher risk of joint violation.

0015

Intrathecal morphine following lumbar fusion: a placebo-controlled trial. ***Daniel Yavin[1,2], Perry Dhaliwal[3], Tara Whittaker[1], Geoffrey S. Hawboldt[4], Gordon A.E. Jewett[5], Steven Casha[1,6], Stephan du Plessis[1].* From the [1]Division of Neurosurgery, Department of Clinical Neurosciences, University of Calgary Cumming School of Medicine, Calgary, Alta.; [2]Department of Community Health Sciences, University of Calgary Cumming School of Medicine, Calgary, Alta.; [3]Division of Neurosurgery, Department of Surgery, University of Manitoba, Winnipeg, Man.; [4]Department of Anesthesia, University of Calgary Cumming School of Medicine, Calgary, Alta.; [5]Division of Neurology, Department of Clinical Neurosciences, University of Calgary Cumming School of Medicine, Calgary, Alta.; and [6]The Hotchkiss Brain Institute, University of Calgary Cumming School of Medicine, Calgary, Alta.**

Background: The objective of this sutdy was to evaluate the safety and efficacy of intrathecal morphine following lumbar fusion. **Methods:** We randomly assigned 150 patients undergoing instrumented lumbar fusion for degenerative indications to receive a single intrathecal injection of morphine (0.2 mg) or placebo (normal saline) immediately before wound closure. An oblique injection technique was used to mitigate the risk of precipitating a cerebrospinal fluid leak. The primary outcome was pain on the visual analogue scale during the first 24 hours after surgery. Secondary outcomes included respiratory depression, treatment-related side effects, postoperative opioid requirements, and length of hospital stay. An intention-to-treat, repeated-measures analysis was used to estimate outcomes according to treatment. **Results:** The baseline characteristics of the 2 groups were similar. Intrathecal morphine reduced pain both at rest (32% area under the curves [AUCs] difference, $p < 0.002$) and with movement (22% AUCs difference, $p < 0.02$) during the initial 24 hours after surgery. The risk of respiratory depression was not increased by intrathecal morphine (hazard ratio 0.86, 95% CI 0.44–1.68, $p = 0.66$). Although postoperative opioid requirements were reduced with intrathecal morphine ($p < 0.03$), lengths of hospital stay were similar ($p = 0.32$). Other than a trend toward increased intermittent catheterization among patients assigned to intrathecal morphine ($p = 0.09$), treatment-related side effects did not significantly differ between the 2 groups. The early benefits of intrathecal morphine on postoperative pain were no longer apparent from 48 hours onwards. **Conclusion:** A single intrathecal injection of 0.2 mg of morphine safely reduces postoperative pain following lumbar fusion. Funded by the Alberta Spine Foundation; ClinicalTrials.gov number, NCT01053039.

0074

Anterior cervical discectomy and fusion versus posterior cervical foraminotomy for cervical radiculopathy: utilization, costs and adverse events. ***Christopher Witiw[1], Fabrice Smieliauskas[2], John O'Toole[3], Michael Fehlings[1], Richard Fessler[3].* From the [1]Division of Neurosurgery, University of Toronto, Toronto, Ont.; [2]Department of Public Health Sciences, The University of Chicago, Chicago, Ill.; and [3]Department of Neurological Surgery, Rush University Medical Center, Chicago, Ill.**

Background: Cervical radiculopathy is a common and debilitating condition. When symptoms fail to resolve with nonoperative

management, surgery is generally indicated. This is typically accomplished by either anterior cervical discectomy and fusion (ACDF) or posterior cervical foraminotomy (PCF). ACDF is more common; however, recent single-centre studies suggest comparable efficacy and significant cost savings with PCF in appropriately selected patients. The objective of this investigation is to compare the 2 approaches in terms of utilization, morbidity and cost from a national perspective. **Methods:** A sequential algorithm was used to identify those undergoing single-level ACDF or PCF for cervical radiculopathy from the American insurance claims research database Truven Health MarketScan. The study period spanned 2003 to 2014. Outcomes consisted of mortality, adverse events (AEs) and readmission to hospital over a 30-day postintervention horizon. Hospital length of stay and total payments to the health provider by the individual, a third party payer or Medicare were assessed. Propensity score matching was used to balance groups on baseline covariates. **Results:** The PCF cohort comprised 4851 patients and the ACDF cohort included 46 147. Time in hospital was 0.28 days (95% CI 0.25–0.31, $p < 0.001$) shorter for the PCF cohort. A significantly greater proportion of PCF cases were discharged on the same day (70.6% v. 46.1%, $p < 0.001$). Mortality (0.1/1000, $p = 0.012$), vascular injury (0.2/1000, $p = 0.001$), postoperative dysphagia/dysphonia (14.5/1000, $p < 0.001$), cutaneous cerebrospinal fluid leak (0.2/1000, $p = 0.002$) and deep venous thrombosis (0.9/1000, $p = 0.013$) occurred more frequently in the ACDF cohort. Conversely, wound infections (14.6/1000, $p < 0.001$) and 30-day readmissions to hospital (9.8/1000, $p < 0.001$) were significantly more frequent in the PCF cohort. Unadjusted total payments for PCF were $15 281 ± $12 225 and $26 849 ± $16 309 for ACDF. The matched difference was –$11 726 (95% CI –$12 221 to –$11 232, $p < 0.001$ over a 30-day horizon, favouring PCF. **Conclusion:** These findings suggest a potential for substantial cost savings with PCF and opportunity for value improvement in the operative management of cervical radiculopathy. The data suggest a need for a large-scale prospective comparative study.

0079

Does exceeding the surgical booking priority target time predict adverse events in emergency spine surgery? ***Michael Bond*[1], *Raphaële Charest-Morin*[1], *Alana Flexman*[2], *Tamir Ailon*[1], *Michael Boyd*[1], *Marcel Dvorak*[1], *Charles Fisher*[1], *Brian Kwon*[1], *Scott Paquette*[1], *John Street*[1]. From the [1]Combined Neurosurgical and Orthopaedic Spine Program, University of British Columbia, Vancouver, BC; and [2]Department of Anaesthesia, University of British Columbia, Vancouver, BC.**

Background: In health systems of limited resources, institutions utilize booking priority target times (BPTTs) to facilitate emergency surgeries based on perceived clinical need. Adverse events (AEs) in emergency spinal surgery have reported rates ranging from 9.5% to 38%. Although the importance of patient and surgical factors has been evaluated, little is known of the effect of institutional or systematic factors on the occurrence of AEs. This study examined adherence to BPTTs at a single institution and the effect of failed adherence on the occurrence of AEs. **Methods:** We conducted an ambispective study of all emergent spine surgery at a quaternary trauma centre between Jan. 1, 2009, and Dec. 31, 2013. At our institution emergency surgery BPTTs are < 1, < 4, < 8, or < 24 hours. All patients were prospectively enrolled in the Canadian Spine Outcomes and Research Network (CSORN) database, with AEs identified using the Spine Adverse Events Severity System (SAVES). Operating room and timing data were available using the ORMIS iSoft system. We used χ^2 tests for statistical analysis. **Results:** A total of 1387 patients were enrolled. Of these, 9.5% were booked as < 1 hour, 4.6% as < 4 hours, 67.1% as < 8 hours and 18.6% as < 24 hours. The mean waiting time in these groups was 2.1h ± 3.08, 3.9h ± 3.75, 7.8h ± 14.3 and 23.5h ± 23.9, respectively. In total, 35.9% of patients failed to meet target surgical times, 77.8% of < 1 hour, 16.1% of < 4 hours, 29.1% of < 8 hours, and 26.7% of < 24 hours did not meet BPTT. Failure to meet BPTT was significantly associated with adverse events ($p < 0.001$). Deep wound infections ($p < 0.001$), pressure sores ($p < 0.05$) and urinary tract infections ($p < 0.05$) were all associated with failure to meet the BPTT and resulted in an increased acute care length of stay (LOS). **Conclusion:** Emergency surgical cases that did not meet BPTTs were associated with a significant increase in major postoperative adverse events and LOS. These AEs could potentially be avoided with improved access to the operating room in institutions where emergency spinal services are provided.

0122

Sarcopenia, but not frailty, predicts the occurrence of adverse events after emergent surgery for metastatic disease of the spine. ***Étienne Bourassa-Moreau*[1,2], *Anne Versteeg*[3], *Raphaële Charest-Morin*[4], *Nicolas Dea*[5], *Micheal Boyd*[1], *Marcel Dvorak*[1], *Charles Fisher*[1], *Brian Kwon*[1], *Scott Paquette*[1]. From the [1]Combined Spine Program, University of British Columbia, Vancouver, BC; [2]Department of Orthopedic Surgery, Université de Montréal, Montreal, Que.; [3]Department of Orthopaedic Surgery, University Medical Center Utrecht, Utrecht, The Netherlands; [4]Department of Orthopedic Surgery, Centre Hospitalier Universitaire de Québec, Québec, Que.; and [5]Department of Neurosurgery, Université de Sherbrooke, Sherbrooke, Que.**

Background: Frailty and sarcopenia are often considered synonymous, and both have been shown to predict adverse events (AEs) in a number of surgical populations. Patients with metastatic disease to the spine may be either frail or have sarcopenia or both. The aim of this study was to investigate the independent prognostic values of frailty and sarcopenia for the occurrence of AEs following emergent surgery for metastases. **Methods:** We conducted an ambispective study of 281 patients undergoing emergent surgery for spinal metastases between 2009 and 2015. Data included demographics, tumour type and burden, neurologic status, surgical and nonsurgical treatment. AEs, including mortality, were identified using Spine Adverse Events Severity System (SAVES) V2. Sarcopenia was measured with normalized total psoas area (NTPA) on preoperative computed tomography. Frailty was defined with the Modified Frailty Index, calculated from extensive detailed comorbidity data. Logistic regression and forward selection modelling with Hosmer–Lemeshow testing was used for statistical analysis. **Results:** In total, 23% of patients had an intraoperative and 52% a major postoperative AE (surgical site infection 3%, delirium 18%, urinary tract infection 35%). A total of 22% of the patients died within 3 months of surgery. NTPA

measurement took approximately 30 seconds per patient. Patients without a postoperative AE had an average NTPA 20% greater than patients with an AE ($p = 0.004$). Postoperative AEs occurred in 30% of nonsarcopenic (NTPA ratio > 1) and 68% of sarcopenic (NTPA ratio < 1) patients ($p = 0.003$); they occurred within 3 months of surgery in 11% of nonsarcopenic patients and 30% of sarcopenic patients ($p < 0.05$). Modified Frailty Index did not correlate with intraoperative or postoperative AEs or mortality. **Conclusion:** Sarcopenia, as measured rapidly with psoas muscle area on computed tomography, independently predicts postoperative mortality and postoperative AEs in patients undergoing emergent surgery for spinal metastasis. The Modified Frailty Index, requiring data often not available in emergency situations, did not predict AEs or life-expectancy. Sarcopenia, rather than frailty, may be a more appropriate indicator of vulnerability and adverse outcomes in patients with metastatic disease of the spine.

0030

Treatment of thoracolumbar burst fractures: extended follow-up of a randomized clinical trial comparing orthosis versus no orthosis. ***Jennifer Urquhart*[1], *Osama Alrebaili*[1], *Charles Fisher*[2], *Alyssa Fleming*[1], *Parham Rasoulinejad*[1], *Kevin Gurr*[1], *Stewart Bailey*[1], *Fawaz Siddiqi*[1], *Chris Bailey*[1]. From the [1]Division of Orthopaedics, Department of Surgery, Schulich School of Medicine and Dentistry, Western University, Lawson Health Research Institute and London Health Sciences Centre, London, Ont.; and [2]Vancouver Hospital and Health Sciences, University of British Columbia, Vancouver, BC.**

Background: We recently conducted a multicentre, prospective, randomized equivalence trial comparing orthosis (TLSO) to no orthosis (NO) in the treatment of acute AO type A3 thoracolumbar burst fractures and demonstrated that treatment with or without a TLSO following an otherwise similar treatment protocol is equivalent at 3 months postinjury. The purpose of the present study was to determine whether there is a difference in the long-term clinical and radiological outcome between groups. Here we present the outcomes of 5–10 year follow-up (7.9 ± 1.1 years) from a single site of the original multicentre trial. **Methods:** Participants were enrolled if they had an AO–A3 burst fracture between T11 and L3 with kyphotic deformity less than 35°, no neurologic deficit, were 16–60 years old, and were 72 hours postinjury. Between 2002 and 2009, a total of 96 participants were enrolled in the primary trial. The present study includes a subset of patients including 16 patients in the TLSO group and 20 patients in the NO group. Treatment comparison was performed at the longest available follow-up, and the time-weighted average treatment effect was determined over all time periods. Missing data were replaced using a multiple imputation procedure. **Results:** Roland-Morris Disability Questionnaire (RMDQ) score at 5–10 years postinjury was 3.6 ± 0.9 for the TLSO group and 4.8 ± 1.5 for the NO group ($p = 0.486$, 95% CI –2.3 to 4.8). Average kyphosis was 18.3 ± 2.2° for the TLSO group and 18.6 ± 3.8° for the NO group ($p = 0.934$, 95% CI –7.8 to 8.5). No differences were found between NO and TLSO groups with time-weighted average treatment effects for RMDQ total score (2.1, 95% CI –0.9 to 5.0), physical component score (–2.7, 95% CI –7.9 to 2.5), mental component score (–1.8, 95% CI –6.1 to 2.6) and average pain (0.8, 95% CI –0.3 to 2.1). **Conclusion:** Compared with patients treated with a TLSO, patients treated using early mobilization without orthosis maintain similar pain relief and improvement in function for 5–10 years.

0014

Lumbar spine fusion: a RAND/UCLA appropriateness study. ***Daniel Yavin*[1,2], *Steven Casha*[1,3], *Samuel Wiebe*[2,4], *Thomas E. Feasby*[2,4], *Jayna Holroyd-Leduc*[2,5], *R. John Hurlbert*[6], *Hude Quan*[2,7], *Andrew Nataraj*[8], *Garnette R. Sutherland*[1,3], *John D. Bartleson*[9], *Sean Christie*[10], *W. Jeptha Davenport*[3,4], *Ted Findlay*[11], *Ian G. Fleetwood*[12], *Andrea Furlan*[13,14], *Clare Gallagher*[1,3], *Karim Mukhida*[15], *Jean A. Ouellet*[16], *John O'Toole*[17], *Charles A. Reitman*[18], *Mohammed F. Shamji*[19], *Owen Williamson*[20], *Perry Dhaliwal*[21], *Stephan du Plessis*[1], *Nathalie Jette*[2,4]. From the [1]Division of Neurosurgery, Department of Clinical Neurosciences, University of Calgary Cumming School of Medicine, Calgary, Alta.; [2]Department of Community Health Sciences, University of Calgary Cumming School of Medicine, Calgary, Alta.; [3]Hotchkiss Brain Institute, University of Calgary Cumming School of Medicine, Calgary, Alta.; [4]Division of Neurology, Department of Clinical Neurosciences, University of Calgary Cumming School of Medicine, Calgary, Alta.; [5]Department of Medicine, University of Calgary Cumming School of Medicine, Calgary, Alta.; [6]Division of Neurosurgery, Department of Surgery, University of Arizona Health Sciences, Tucson, Ariz.; [7]O'Brien Institute for Public Health, University of Calgary Cumming School of Medicine, Calgary, Alta.; [8]Division of Neurosurgery, Department of Surgery, University of Alberta, Edmonton, Alta.; [9]Department of Neurology, Mayo Clinic, Rochester, Minn.; [10]Division of Neurosurgery, Department of Surgery, Dalhousie University, Halifax, NS; [11]Alberta Health Services Chronic Pain Centre, University of Calgary Cumming School of Medicine, Calgary, Alta.; [12]Division of Neurosurgery, Department of Surgery, University of British Columbia, Victoria, BC; [13]Toronto Rehabilitation Institute, Toronto, Ont.; [14]Division of Physiatry, Department of Medicine, University of Toronto, Toronto, Ont.; [15]Department of Anesthesia, Pain Management, and Perioperative Medicine, Dalhousie University, Halifax, NS; [16]Division of Orthopaedic Surgery, McGill University, Montreal, Que.; [17]Department of Neurosurgery, Rush University Medical Center, Chicago, Ill.; [18]Department of Orthopaedics, Medical University of South Carolina, Charleston, S.C.; [19]Division of Neurosurgery, Department of Surgery, University of Toronto, Toronto, Ont.; [20]Pain Management Clinic, Jim Pattison Outpatient Care and Surgery Centre, Fraser Health Authority, Surrey, BC; [21]Division of Neurosurgery, Department of Surgery, University of Manitoba, Winnipeg, Man.**

Background: The purpose of this study was to develop a tool to identify patients appropriate for lumbar fusion for degenerative indications. **Methods:** The RAND/UCLA Appropriateness Method was used to identify degenerative indications for lumbar fusion. A North American expert panel of 13 physicians independently rated clinical scenarios for lumbar fusion. Panellists rated 1296 scenarios from 1 to 9 for their appropriateness for lumbar fusion. A meeting was then convened in a modified Delphi process, and scenarios were again rated. The resulting

criteria were applied in 150 patients who underwent elective instrumented lumbar fusion. **Results:** Of the 1296 final scenarios, fusion was appropriate in 133 (10%), uncertain in 375 (29%) and inappropriate in 735 (57%). Disagreement occurred in the remaining 53 scenarios (4%). Of the appropriate indications, spondylolisthesis accounted for 98 (74%), spinal stenosis for 18 (14%), spondylosis for 9 (7%) and disc herniation for 8 (6%). Appropriate fusion was associated with mechanical low back pain ($p < 0.001$) and radiologic signs of instability or sagittal imbalance ($p < 0.001$). Of the 150 operated patients, fusion was appropriate in 72 (48%), uncertain in 70 (47%) and inappropriate in 8 (5%). In the 2 years after surgery, patients who underwent appropriate fusion required less cross-sectional imaging for persistent, worsening, or recurrent symptoms (adjusted hazard ratio [HR] 2.42, 95% CI 1.31–4.48, $p < 0.01$) and fewer spinal injections (adjusted HR 2.53, 95% CI 1.29–4.96, $p < 0.01$). There was, however, no significant difference between groups in the probability of reoperation ($p = 0.84$), rehospitalization ($p = 0.50$), or use of prescription pain medication ($p = 0.23$). **Conclusion:** Criteria for the appropriate use of lumbar fusion for degenerative indications were identified (web-based decision tool accessible at www.appropriatelumbarfusion.com/site). In operated patients, appropriate fusion was associated with reduced health care demands. The criteria will require further validation and regular revision.

0005

A simplified clinical prediction rule for prognosticating independent walking after spinal cord injury: a prospective study from a Canadian multicentre spinal cord injury registry. ***Katharine Hicks*[1,2], *Yichen Zhao*[3,4], *Nader Fallah*[3,4], *Carly Rivers*[3], *Vanessa Noonan*[3,4], *Tova Plashkes*[3,4], *Eugene Wai*[5,6], *Darren Roffey*[2,5], *Eve Tsai*[2,5], *Jerome Paquet*[7], *Najmedden Attabib*[8,9], *Travis Marion*[10], *Henry Ahn*[11,12], *Philippe Phan*[2,5]. From the [1]University of Ottawa, Ottawa, Ont.; [2]Ottawa Combined Adult Spinal Surgery Program, Ottawa, Ont.; [3]Rick Hansen Institute, Vancouver, BC; [4]University of British Columbia, Vancouver, BC; [5]Ottawa Hospital Research Institute, Ottawa, Ont.; [6]The Ottawa Hospital, Ottawa, Ont.; [7]Département des Sciences Neurologiques, Université du Québec à Montréal, Montreal, Que., [8]Dalhousie University, Halifax, NS; [9]Saint John Regional Hospital, Saint John, NB; [10]University of Calgary, Calgary, Alta.; [11]University of Toronto Spine Program, Toronto, Ont.; and [12]St. Michael's Hospital, Toronto, Ont.**

Background: The purpose of this study was to revalidate an existing clinical prediction model for independent ambulation following traumatic spinal cord injury (SCI; van Middendorp et al.; 2011) using acute and long-term postinjury follow-up data and to investigate the accuracy of a simplified model using prospectively collected data from a Canadian multicentre SCI database, the Rick Hansen Spinal Cord Injury Registry (RHSCIR). **Methods:** The analysis cohort consisted of 278 adults with traumatic SCI enrolled in the RHSCIR for whom complete neurologic examination data and Functional Independence Measure (FIM) outcome data were available. A logistic regression (LR) model based on age and 4 neurologic variables was applied to our cohort of 278 RHSCIR participants. Additionally, a simplified LR model was created. The Hosmer–Lemeshow goodness of fit test was used to check if the predictive model is applicable to our data set. The performance of the model was verified by calculating the area under the receiver operating characteristic curve (AUC). The accuracy of the model was tested using a cross-validation technique. **Results:** The fitted prediction model generated 85% overall classification accuracy, 79% sensitivity and 90% specificity. The prediction model was able to accurately classify independent walking ability (AUC 0.889, 95% CI 0.846–0.933, $p < 0.001$) compared with the existing prediction model, despite the use of a different outcome measure (FIM v. SCIM) to qualify walking ability. A simplified, 3-variable LR model based on age and 2 neurologic variables had an overall classification accuracy of 84% with 76% sensitivity and 90% specificity, demonstrating comparable accuracy to its 5-variable prediction model counterpart. The AUC was 0.866 (95% CI 0.816–0.916, $p < 0.01$), only marginally less than that of the existing prediction model. **Conclusion:** A simplified predictive model with similar accuracy to a more complex model for predicting independent walking was created. Such models will allow clinicians to better predict the prognosis of ambulation in individuals who have sustained a traumatic SCI.

0108

A comparison between cerebrospinal fluid and MRI biomarkers for classifying injury severity and predicting outcome in acute SCI. ***Turker Dalkilic*[1,2], *Femke Streijger*[3], *Nader Fallah*[2,4], *Vanessa Noonan*[2,4], *Lise Belanger*[5], *Tamir Ailon*[1,2], *John Street*[1,2], *Michael Boyd*[1,2], *Charles G. Fisher*[1,2], *Marcel F. Dvorak*[1,2], *Brian K. Kwon*[1,2]. From the [1]Vancouver Spine Surgery Institute, Vancouver, BC; [2]University of British Columbia, Vancouver, BC; [3]International Collaboration on Repair Discoveries, Vancouver, BC; [4]Rick Hansen Institute, Vancouver, BC; and [5]Vancouver Spine Program, Vancouver General Hospital, Vancouver, BC.**

Background: Establishing the severity of acute spinal cord injury (SCI) and then predicting neurologic outcome is challenging. We previously demonstrated that proteins, such as interleukin (IL)-6, S100β, and glial fibrillary acidic protein (GFAP) measured within the cerebrospinal fluid (CSF) of acute SCI patients at 24 hours postinjury can objectively stratify injury severity (Abbreviated Injury Scale [AIS] A, B and C) and can be used to predict AIS conversion and motor score recovery 6 months postinjury. One could argue, however, that obtaining a CSF sample for biomarker analysis is unwarranted given that MRI can provide objective measures of spinal cord damage (e.g., cord edema and hemorrhage). In this study, we compare how well CSF biomarkers and MRI biomarkers predict outcome in the same set of acute SCI patients. **Methods:** We prospectively enrolled patients with acute cervical SCI to obtain CSF samples for the measurement of IL-6, IL-8, monocyte chemoattractant protein-1 (MCP-1), tau, S100β and GFAP at 24 hours postinjury. For the patients within this cohort who had preoperative MRI scans, we measured length of cord edema, length of cord swelling, maximum spinal cord compression (MCC) and size and extent of hemorrhage. The CSF and MRI measures were incorporated into logistic regression models to predict AIS conversion and total motor score improvement over 6 months. **Results:** When considering MRI alone, the vertical length of edema was the best predictor of AIS conversion. However, CSF biomarkers were more far more important in the logistic regression models than MRI biomarkers or baseline

clinical examination features for predicting AIS conversion. In fact, we found that the MRI measures and even baseline clinical characteristics essentially provided little additional predictive value in the model beyond that provided by the 24 hour post-injury CSF biomarkers. **Conclusion:** While obtaining a CSF sample at 24 hours postinjury is an invasive procedure in acute SCI patients, in comparison to conventionally acquired MRI scans the objective information provided by the analysis of CSF biomarkers provides considerably better prediction of neurologic recovery than traditional MRI measures of injury severity.

0034

Geomapping of traumatic spinal cord injury in Canada and factors related to triage pattern. ***Christiana Cheng*[1], *Vanessa Noonan*[1,2], *Jayson Shurgold*[1], *Jason Chen*[1], *Carly Rivers*[1], *Hamid Khaleghi Hamedani*[1], *Suzanne Humphreys*[1], *Christopher Bailey*[3], *Najmedden Attabib*[4], *Jean-Marc Mac Thiong*[5], *Michael Goytan*[6], *Jerome Paquet*[7], *Richard Fox*[8], *Henry Ahn*[9], *Brian Kwon*[2], *Daryl Fourney*[10]; *RHSCIR Network*.** **From the [1]Rick Hansen Institute, Vancouver, BC; [2]University of British Columbia, Vancouver, BC; [3]Western University, London, Ont.; [4]Dalhousie University, Halifax, NS; [5]Université de Montréal, Montreal, Que.; [6]University of Manitoba, Winnipeg, Man.; [7]Université Laval, Québec, Que.; [8]University of Alberta, Edmonton, Alta.; [9]University of Toronto, Toronto, Ont.; and [10]University of Saskatchewan, Saskatoon, Sask.**

Background: Current research indicates that more than half of traumatic spinal cord injury (tSCI) patients experience delays in transfer and receive surgery more than 24 hours postinjury. The objectives of this study were to determine the geographic distribution of tSCI in Canada relative to specialized treatment facilities, assess clinical and logistical factors at play for indirect admissions to those facilities and explore differences in current time to admission and simulated scenarios in an attempt to assess the potential impact of changes to triage protocols **Methods:** This study derived data from 876 patients with tSCI enrolled in the prospectively collected acute Rick Hansen Spinal Cord Injury Registry (RHSCIR) between Jan. 1, 2010, and Dec. 31, 2013, and had provided injury location data. RHSCIR was active at 18 acute SCI and 13 rehabilitation facilities located in 16 cities across Canada. **Results:** Patients transported directly to an RHSCIR acute facility were more likely to reach the facility within 1 hour of injury, whereas those transported indirectly were more likely to arrive 7 hours later. Considering the injuries occurring within 40 km of an RHSCIR acute facility (n = 323), 249 patients (77%) were directly and 74 (23%) were indirectly admitted. In the multivariate regression analysis, only older age and longer road distance remained significantly associated with being indirectly admitted to an RHSCIR facility. Compared with the current status, the median time to admission decreased by 20% (3.5 hours) in the 100% direct admission scenario and increased by 102% (8.9 hours) in the 100% indirect admission scenario. **Conclusion:** Our findings indicate potential to improve early transport to SCI care. Furthermore, our findings of older age and longer road distance decreasing the likelihood of direct admission suggest that recognizing tSCI at the injury scene by paramedics and lack of SCI centre destination might contribute to the delayed access to SCI care. This study will inform further research into factors that influence triage and optimal prehospital care for individuals with tSCI.

0062

Quality of life after spinal cord injury - results from a Canadian national cross-sectional survey. ***Christian Iorio-Morin*[1], *Nicolas Dea*[1], *Vanessa Noonan*[2], *Barry White*[2], *Frédéric Dumont*[3], *Jean Leblond*[3], *Luc Noreau*[3].** **From [1]Université de Sherbrooke, Sherbrooke, Que.; [2]Rick Hansen Institute, Vancouver, BC; and [3]Centre for Interdisciplinary Research in Rehabilitation and Social Integration, Québec, Que.**

Background: Underlying all medical and physical interventions in spinal cord injury (SCI) management is the assumption that maximizing neurologic function and improving functional autonomy will improve the patient's long-term quality of life (QoL). As such, many interventional studies in SCI management use QoL as a primary outcome. The goal of this study was to provide overall QoL, health-related QoL (HRQoL) and health utility values for patients with traumatic SCI stratified by injury level and neurologic status **Methods:** The Canadian SCI Community Survey was sent to Canadians living in the community following SCI. The survey covered demographics, SCI classification, overall health status and overall QoL. QoL was measured using the 12-Item Short Form Survey (SF-12) v2 and a direct question. SF-12 v2 answers were used to generate a health utility score using published preference weights. The impact of demographics, complications and SCI classification on QoL was assessed using analysis of variance, multiple linear regressions and ordinal logistic regression analyses. **Results:** There were 1109 respondents with traumatic SCI; 70% were male. Mean age was 48.3 years at a mean of 18.5 years following injury. Injury level or Abbreviated Injury Scale (AIS) grade had no impact on either health utility or QoL assessed by a direct question. Factors affecting HRQoL (utility scores) included depressed mood, fatigue, injuries caused by a loss of sensation and not working. With a mean health utility score of 0.64 ± 0.12, SCI patients living in the community reported having HRQoL similar to patients with rhinosinusitis, symptomatic hand osteoarthrosis and healed hip fracture. **Conclusion:** Once in the community, SCI patients report having a very good HRQoL. In the years after the injury, chronic medical conditions have more impact on QoL than strictly SCI-related complications. Moreover, injury level and AIS grade do not affect long-term QoL. As such, we believe HRQoL should not be used as outcomes to assess the effectiveness of interventions targeting neurologic function and autonomy in traumatic SCI and that a better tool should be developed.

0022

Radiological predictors of kyphosis after thoracolumbar burst fractures managed using thoracolumbarsacral orthosis and long-term follow-up of outcomes. ***Michael M.H. Yang, Baldeep Dulku, Steven Casha.*** **From the University of Calgary, Calgary, Alta.**

Background: Thoracolumbar burst fractures (TLBF) in neurologically intact patients can be treated nonoperatively with an orthosis. This study aims to determine the radiological predictors of progressive kyphosis after TLBF in patients managed with a

thoracolumbarsacral orthosis and to correlate clinical outcomes with severity and progression of kyphotic deformity. **Methods:** We retrospectively identified patients who, during the period 2008–2012, sustained a thoracolumbar burst fracture and were managed nonoperatively using an orthosis. Sagittal Cobb angle, coronal Cobb angle, sagittal canal diameter, facet apposition, interpedicular distance, anterior/mid/posterior body height loss and maximum retropulsed fragment were determined. Measurements were made on initial computed tomography (CT) scan, initial upright radiography (XR1) and follow-up upright radiography (XR2) at greater than 3 months. Long-term clinical outcomes were collected (36-Item Short Form Health Survey [SF-36], Oswestry Disability Index [ODI] and visual analogue scale [VAS]). **Results:** Ninety-five patients were included in the study. The mean sagittal Cobb angles on CT, XR1 and XR2 were 10.3°, 11.3° and 14.9°, respectively. The mean changes in Cobb angle between each time point were CT–XR1 1.0° (NS), XR1–XR2 3.6° ($p < 0.001$) and CT–XR2 4.6° ($p < 0.001$). The average time between CT and XR2 was 9.2 months. There was significant correlation between initial CT anterior/mid/posterior body height loss and interpedicular distance to progression of kyphosis ($p = 0.047$). There was no correlation between initial sagittal Cobb angle, magnitude of retropulsed fragment, facet apposition, coronal Cobb angle and sagittal canal diameter to progression of kyphosis. Seventy-one patients (75%) completed the clinical outcome surveys. In that subset of patients, no significant correlation was seen between SF-36, ODI, VAS and initial, final or progression of kyphosis. Mean time from injury to health outcomes questionnaires was 64 months. **Conclusion:** The majority of TLBFs treated with a thoracolumbarsacral orthosis exhibit little progressive kyphotic deformity. Anterior/mid/posterior body height loss and increased interpedicular distance were predictors of sagittal kyphotic progression. The magnitude of kyphosis does not correlate with clinical outcomes.

0101

Use of decision tree analysis to determine optimal stratification groups to best identify true treatment effects in clinical research in traumatic spinal cord injury. ***Nader Fallah[1,2], Jin W. Tee[2], Vanessa K. Noonan[1,2], Carly S. Rivers[1], Brian K. Kwon[2,3], Charles Fisher[3], John Street[3], Marcel F. Dvorak[2,3].*** **From the [1]Rick Hansen Institute, Vancouver, BC; [2]University of British Columbia, Vancouver, BC; and [3]Vancouver Spine Surgery Institute, Vancouver, BC.**

Background: Heterogeneity inherent in spinal cord injury (SCI) introduces variation in natural recovery, compromising the ability to identify true treatment effects in clinical research. Optimization of stratification factors to create homogeneous groups of participants would improve accurate identification of the true effect of study treatments; our aim was to use decision tree modelling to identify optimum stratification groups. **Methods:** Patients who sustained an acute traumatic SCI were identified from the Vancouver Rick Hansen Spinal Cord Injury Registry (RHSCIR) and made up the analysis cohort. All patients were assessed with the International Standards for Neurological Classification of Spinal Cord Injury (ISNCSCI) examination, providing in-hospital admission and discharge neurologic severity (Abbreviated Injury Scale [AIS] A–D, with A being most severe), level of injury (cervical C1–T1, thoracolumbar T2/below) and total motor score (TMS); morphological injury to the spine with AOSpine classification (AOSpine A–C, with C being most severe) and age were also included. Decision trees were used to determine the most homogeneous groupings of participants based on TMS at admission and discharge from in-hospital care. **Results:** The analysis cohort included 849 participants; 79.2% were male, and mean age was 46.3 ± 19.9 years. Distribution of admission neurologic severity was 38.2% A, 11.0% B, 18.5% C and 29.4% D; baseline level was 66.8% cervical and 33.2% thoracolumbar; and AOSpine was 35.2% A, 24.4% B and 36.5% C. Decision tree analysis identified 6 optimal stratification groups for assessment of TMS: 1) AOSpine A/B, cervical, age 30 years or younger; 2) AOSpine A/B, cervical, age 31–52 years; 3) AOSpine A/B, cervical, age > 52 years; 4) AOSpine A/B, thoracic; 5) AOSpine C, cervical; and 6) AOSpine D, thoracic. **Conclusion:** Appropriate stratification factors are fundamental to the accurate identification of treatment effects. Inclusion of AOSpine improves homogeneity, and age is important for AOSpine A/B (less severe spinal column injury). Use of the 6 stratification groups from this work could minimize the confounding effects of natural neurologic recovery so truly effective treatments can be identified in SCI clinical research.

0024

Validity and test–retest reliability of the Spine Oncology Study Group Outcomes Questionnaire (SOSGOQ). ***Anne Versteeg[1,2], Arjun Sahgal[3], Laurence Rhines[4], Daniel Sciubba[5], James Schuster[6], Michael Weber[7], Michael Fehlings[8], Michelle Clarke[9], Paul Arnold[10], Zia Gokaslan[11], Charles Fisher[12]; AOSpine Knowledge Forum Tumor.*** **From the [1]Department of Orthopedics, University Medical Center Utrecht, Utrecht, The Netherlands; [2]Research Department, AOSpine International, Davos, Switzerland; [3]Department of Radiation Oncology, Sunnybrook Odette Cancer Centre and University of Toronto, Toronto, Ont.; [4]Department of Neurosurgery, The University of Texas MD Anderson Cancer Center, Houston, Tex.; [5]Department of Neurosurgery, Johns Hopkins University School of Medicine, Baltimore, Md.; [6]Department of Neurosurgery, Hospital of the University of Pennsylvania, Philadelphia, Pa.; [7]Division of Surgery, McGill University and Montreal General Hospital, Montreal, Que.; [8]Division of Neurosurgery, University of Toronto and Toronto Western Hospital, Toronto, Ont.; [9]Department of Neurosurgery, Mayo Clinic, Rochester, Minn.; [10]Department of Neurosurgery, The University of Kansas Hospital, Kansas City, Kans.; [11]Department of Neurosurgery, The Warren Alpert Medical School of Brown University and Rhode Island Hospital and The Miriam Hospital, Providence, R.I.; [12]Division of Spine, Department of Orthopaedics, The Combined Neurosurgical and Orthopaedic Spine Program at Vancouver Coastal Health, Vancouver, BC.**

Background: The Spine Oncology Study Group Outcomes Questionnaire (SOSGOQ) was developed in response to the lack of spine oncology–specific quality of life measures. Association of the questions of the SOSGOQ to the domains of the International Classification of Functioning confirmed content validity. To implement the SOSGOQ in clinical care and/or research setting, its clinical usefulness was evaluated by testing the construct

validity and reliability. **Methods:** The AOSpine Knowledge Forum Tumor performed an international multicentre prospective observational study for patients who underwent surgery and/or radiotherapy for the treatment of symptomatic spinal metastases. Patient demographics, cancer type, treatment and quality of life data were collected. The domains of the SOSGOQ were correlated (Spearman rank) with the corresponding domains of the 36-Item Short Form Health Survey (SF-36) or the Numeric Rating Scale (NRS) pain score to assess construct validity. The reliability (Intraclass coefficient [ICC]) of the SOSGOQ was evaluated at 12 weeks posttreatment and the retest followed after 1 week. **Results:** A total of 238 patients were included in 9 participating centres for the evaluation of construct validity. The test–retest reliability of the SOSGOQ was performed by 2 of the 9 centres. A total of 36 patients participated in the reliability study, 26 received radiotherapy alone and 10 underwent surgical intervention with or without adjuvant radiotherapy treatment. The SOSGOQ domain demonstrated a strong to very strong correlation (Spearman rank range –0.61 to –0.83) with the corresponding subdomains of the SF-36 and the NRS score. The ICC for the total SOSGOQ score was 0.84, representing excellent reliability. **Conclusion:** Association of the SOSGOQ domains to the SF-36 and NRS score confirmed the construct validity of the SOSGOQ. In addition, reliability of the SOSGOQ was excellent. The SOSGOQ is a valid and reliable spine oncology–specific quality of life tool for patients with metastatic spine disease.

0063

Predictive factors for survival in surgical series of symptomatic metastatic epidural spinal cord compression: a prospective North American multicentre study in 142 patients. ***Anick Nater[1,2], Michael Fehlings[1,2], Lindsay Tetreault[2], Branko Kopjar[3], Paul Arnold[4], Mark Dekutoski[5], Joel Finkelstein[6], Charles Fisher[7], John France[8], Ziya Gokaslan[9], Laurence Rhines[10], Peter Rose[11], Arjun Sahgal[6], James Schuster[12], Alexander Vaccaro[13].*** **From the [1]University of Toronto, Toronto, Ont.; [2]Toronto Western Hospital, Toronto, Ont.; [3]University of Washington, Seattle, Wash.; [4]Kansas University Medical Center, Kansas City, Kans.; [5]The Core Institute, Pheonix, Ariz.; [6]Sunnybrook Hospital, Toronto, Ont.; [7]University of British Columbia and Vancouver Coastal Health, Vancouver, BC; [8]West Virginia University, Morgantown, W.Va.; [9]Rhode Island Hospital, Providence, R.I.; [10]MD Anderson Cancer Center, Houston, Tex.; [11]Mayo Clinic, Rochester, Minn.; [12]University of Pennsylvania, Philadelphia, Pa.; and [13]Thomas Jefferson University, Philadelphia, Pa.**

Background: Symptomatic metastatic epidural spinal cord compression (MESCC) afflicts up to 10% of all cancer patients and is associated with shortened survival and worsened quality of life. This study aims to identify the key predictive survival factors in MESCC patients who were surgically treated for a single symptomatic lesion. **Methods:** We enrolled 142 MESCC patients in a prospective North American multicentre study and followed them postoperatively until death or for at least 12 months. Using univariate analyses, Kaplan–Meier methods and log-rank tests, the predictive value of various clinical variables were assessed. Noncollinear predictors with results of $p < 0.05$ in univariate analyses were included in the final Cox proportional hazards model. **Results:** The overall median survival was 7.7 months (range 3 days to 35.6 months); patients with breast cancer had the longest median survival (12.1 months). Ten patients (7%), whose primary cancers were lung ($n = 3$), kidney ($n = 3$), sarcoma ($n = 2$), prostate ($n = 1$), and breast ($n = 1$), died within 30 days postoperatively, and 88 (62%) had died at 12 months. Univariate analyses yielded 8 significant predictors for survival: the growth of primary tumour (Tomita grade 1 v. grade 2 and 3), body mass index, sex, preoperative 36-Item Short Form Health Survey (SF-36) physical component score, EQ-5D, and Osestry Disability Index (ODI) scores as well as the presence of either visceral or extraspinal bony metastasis. The multiple regression analysis revealed that the Tomita grade (grade 1 v.grade 2 and 3; hazard ratio [HR] 2.81, $p = 0.007$), the absence of visceral metastasis (HR 2.01, $p = 0.0044$) and higher score on the SF-36 physical component (HR 0.95, $p < 0.0001$) were independent predictors of longer survival. **Conclusion:** Slow growing tumour (Tomita grade 1), absence of visceral metastasis and lower degree of preoperative physical disability, as reflected by a higher score on the SF-36 physical component questionnaire, are good predictive factors for survival in selected patients who underwent surgical treatment for a focal symptomatic MESCC lesion.

0019

En bloc resection versus intralesional surgery in the treatment of giant cell tumour of the spine. ***Raphaële Charest-Morin[1], Charles G. Fisher[2], Peter P. Varga[3], Ziya L. Gokaslan[4], Laurence D. Rhines[5], Jeremy J. Reynolds[6], Mark B. Dekutoski[7], Nasir A. Quraishi[8], Mark H. Bilsky[9], Michael G. Fehlings[10], Dean Chou[11], Niccole M. Germscheid[12], Alessandro Luzzati[13], Stefano Boriani[14].*** **From [1]Université Laval, Québec, Que.; [2]University of British Columbia, Vancouver, BC; [3]National Center for Spinal Disorders, Budapest, Hungary; [4]The Warren Alpert Medical School of Brown University, Providence, R.I.; [5]The University of Texas MD Anderson Cancer Center, Houston, Tex.; [6]Oxford University Hospitals, Oxford, UK; [7]The CORE Institute, Phoenix, Ariz.; [8]Nottingham University Hospital, Nottingham, UK; [9]Memorial Sloan Kettering Cancer Center, New York, NY; [10]University of Toronto, Toronto, Ont.; [11]University of San Francisco California, San Francisco, Calif.; [12]AO Spine International, Davos, Switzerland; [13]Galeazzi Orthopaedic Institute, Milan, Italy; and [14]Rizzoli Institute, Bologna, Italy.**

Background: Giant cell tumour of the spine is a rare primary bone tumour known for its local aggressiveness. Optimal surgical treatment remains to be determined. The objectives of this multicentre, ambispective observational study were to quantify local recurrence and mortality after surgical treatment of spinal giant cell tumour and to determine whether en bloc resection with wide/marginal margins is associated with improved prognosis compared with an intralesional procedure. **Methods:** The AOSpine Knowledge Forum Tumor developed a comprehensive multicentre database, including demographics, presentation, diagnosis, treatment, mortality and recurrence rate data, for giant cell tumour of the spine. Patients were analyzed based on surgical margins, including Enneking appropriateness. **Results:** Between 1991 and 2011, 82 patients underwent surgery for spinal giant cell tumour. According to the Enneking classification, 59 (74%)

were classified as S3-aggressive and 21 (26%) as S2-active. The surgical margins were wide/marginal in 27 (36%) patients and intralesional in 48 (64%) patients. Thirty-nine of 77 (51%) underwent Enneking-appropriate (EA) treatment, and 38 (49%) underwent Enneking-inappropriate (EI) treatment. Eighteen (22%) patients experienced local recurrence (LR). LR occurred in 11 (29%) EI-treated patients and 6 (15%) EA-treated patients ($p = 0.151$). There was a significant difference between wide/marginal margins and intralesional margins for LR ($p = 0.029$). Seven (9%) patients died. LR is strongly associated with death (relative risk 8.9, $p < 0.001$). Six (16%) EI-treated patients and 1 (3%) EA-treated patient died ($p = 0.056$). With regards to surgical margins, all patients who died underwent intralesional resection ($p = 0.096$). **Conclusion:** En bloc resection with wide/marginal margins should be performed when technically feasible as it is associated with decreased LR. Intralesional resection is associated with increased LR, and mortality correlates with LR.

0025

Stereotactic body radiotherapy followed by surgical stabilization for patients with unstable spinal metastases: first-in-human study according to the IDEAL recommendations. ***Anne Versteeg[1], Joanne van der Velden[2], Wietse Eppinga[2], Nicolien Kasperts[2], Helena Verkooijen[2], Sophie Gerlich[2], Jochem Hes[2], Enrica Servalli[2], Marco van Vulpen[2], Cumhur Oner[1], Jorrit-Jan Verlaan[1]*.** **From the [1]Department of Orthopedics, University Medical Center Utrecht, Utrecht, The Netherlands; and [2]Department of Radiation Oncology, University Medical Center Utrecht, Utrecht, The Netherlands.**

Background: Current standard of care for unstable spinal metastases consists of surgery followed by conventional radiotherapy after a minimum of 2 weeks. The waiting time between surgery and radiotherapy is necessary for wound healing, but delays the time before radiotherapy-induced pain relief can be achieved. An alternative treatment strategy resulting in faster and effective pain relief would be preferred. Therefore the aim for this study is to investigate the safety and feasibility of the combination of stereotactic body radiotherapy (SBRT) followed by surgery within 48 hours for the treatment of unstable spinal metastases. **Methods:** A total of 13 patients will be included in this first-in-human study. Demographic, clinical characteristics, treatment, toxicity (according to the Common Terminology Criteria for Adverse Events, 4.0 within 60 days), adverse events and survival data will be collected. Patients with unstable spinal metastases undergo SBRT on a priority basis, with 18Gy on the metastasis and 8Gy on the rest of the vertebral body, followed by surgery within 48 hours. The surgical area will actively be avoided in the SBRT plan, without compromising the maximum dose limits of the surrounding organs. **Results:** Ten patients have successfully been treated with the new treatment strategy. Eight patients underwent solely percutaneous pedicle screw fixation and 2 patients underwent conventional open procedures with decompression. The mean duration of surgery was 82 ± 33 minutes, and the median blood loss was 50 mL (range 50 mL–300 mL). The median length of hospital stay was 5 days. No wound healing problems or other procedure-related complications occurred. One grade 3 neurologic adverse event occurred, but resolved after reoperation. None of the patients experienced any discomfort during the SBRT procedure before surgery. We expect to be able to present the results for all 13 patients at the time of the conference. **Conclusion:** Our first results propose that the new treatment strategy combining SBRT and surgery within 48 hours is feasible and safe.

0045

MicroRNA-181a-5p and MicroRNA-4454 as potential biomarkers of facet joint osteoarthritis. ***Akihiro Nakamura[1,2], Y. Raja Rampersaud[1,3], Anirudh Sharma[1,2], Stephen J. Lewis[1,3], Brian Wu[1,2], Poulami Datta[1,2], Kala Sundararajan[1,3], Helal Endisha[1,2], Evgeny Rossomacha[1,2], Jason S. Rockel[1,2], Igor Jurisica[4], Mohit Kapoor[1,5]*.** **From the [1]Arthritis Program, University Health Network, Toronto, Ont.; [2]Division of Genetics and Development, Krembil Research Institute, University Health Network, Toronto, Ont.; [3]Spinal Program, Krembil Neuroscience Centre, Toronto Western Hospital, University Health Network, University of Toronto, Toronto, Ont.; [4]Princess Margaret Cancer Centre, University Health Network and Departments of Medical Biophysics and Computer Science, University of Toronto, Toronto, Ont.; and [5]Department of Surgery and Department of Laboratory Medicine and Pathobiology, University of Toronto, Toronto, Ont.**

Background: Osteoarthritis (OA) of spine facet joints (FJ) is one of the major causes of low back pain and disability worldwide. In this study we aimed to identify if microRNAs (small noncoding RNA) are potential biomarkers to detect and assess the degree of FJ-OA disease severity. **Methods:** Based on MRI and histopathology, we first established a patient cohort (control group: normal or mild FJ cartilage degeneration; FJ-OA group: moderate to severe FJ cartilage degeneration). Using FJ cartilage from this cohort ($n = 55$), we screened 2100 miRNAs using miRNA-array/quantitative polymerase chain reaction analysis to identify differentially regulated miRNAs and investigated their correlation with FJ-OA disease severity based on MRI grading (grade 0: normal; grade 1: mild; grade 2: moderate; grade 3: severe). We also investigated if the expression of these miRNAs can be detected in the blood (plasma) of patients with varying degree of disease severity ($n = 40$) to devise a blood-based test for clinical testing in future. We also investigated the role of miRNAs in FJ cartilage degeneration. **Results:** Out of 2100 miRNAs tested, we for the first time identified 2 miRNAs (miR-181a-5p/miR-4454) whose expression markedly increases in the FJ cartilage with increased degree of FJ degeneration and the expression levels exhibit significant correlation with clinical disease severity based on MRI grading. Our pilot data also show that circulating forms of both miRNAs are detectable and elevated in patients' blood plasma with increased degree of FJ-OA disease severity. Interestingly, our data suggest that these 2 miRNAs play active roles in destroying cartilage. **Conclusion:** Our data thus far suggest that these 2 miRNAs are potential biomarkers to detect and determine the stage of FJ-OA disease. Our ongoing work is testing the levels of these miRNAs in patients' blood from 200 patients to determine the specificity and reliability of these miRNAs to detect and determine the stage of FJ-OA disease. Positive results will help in creating a miRNA-based panel for FJ-OA clinical testing. We are also testing if inhibition of these miRNAs (using antisense inhibitors) can stop FJ degeneration in preclinical animal models of FJ-OA to determine their therapeutic potential.

0069

Feasibility of mesenchymal stem cells differentiation under compressive loading for intervertebral disc tissue regeneration. ***Rayan Fairag[1,2], Derek Rosenzweig[1,2], Janet Moir[1,2], Michael Weber[3], Lisbet Haglund[1]*. From the [1]Orthopedic Research Laboratory, Montreal, Que.; [2]Department of Surgery, Faculty of Medicine, McGill University, Monteal, Que.; and [3]McGill Scoliosis and Spine Group, Montreal, Que.**

Background: Stem cell–based therapy is a promising concept to treat early-stage intervertebral disc degeneration. The ability to differentiate into multiple cell types makes mesenchymal stem cells a potential cell source to promote or enhance the repair of intervertebral discs (IVDs). However, delivery of cells requires suitable injectable scaffold to enhance viability, promote neomatrix integration and reduce stress. The purpose of this study is to investigate the influence of hydrogel (HA-PNIPAM) on mesenchymal stem cells, determine feasibility and asses the effect of dynamic compressive loading on these cells. **Methods:** Human mesenchymal stem cells were obtained commercially. The potential of these cells to differentiate into multiple lineages was assessed histologically. The ability of cell differentiation under load was assessed by dynamic compressive culture system. Cells were mixed with HA-PNIPAM hydrogel and embedded within silicon/agarose constructs mimicking IVD structure, cultured without load or under dynamic compression for 3 weeks. Cell viability was determined with LIVE/DEAD assay and DAPI staining, histological manifestations were assessed using saffrin-O staining, and DNA was quantified using HOECHST assay. **Results:** Hydrogels seeded with human mesenchymal stem cells after 3 weeks show cell viability above 80%. Mesenchymal stem cells cultured in chondrogenic media differentiated to a disc-like phenotype, as evidenced by producing proteoglycan histologically. Histological analysis of constructs showed proteoglycan synthesis in cells of the loaded and unloaded cultures. DNA quantification showed no significant difference in cell number between loaded cells or unloaded ones. **Conclusion:** Silicon/agarose model can withstand compressive loading. The bioreactor system proved its consistency by providing constant compression throughout culture period. HA-PNIPAM hydrogel is viable composition to be used as an injectable medium for delivery of cells into degenerate discs. Mesenchymal stem cells have the ability to differentiate and produce nucleus pulposus-like matrix in HA-PNIPAM hydrogel. This system can be used to evaluate various hydrogels, bioactive factors and cell types. It can also be used to study the effect of coculture of mesenchymal stem cells and nucleus pulposus cells from IVDs of different degree of degeneration.

0081

Comparison of adult human and rat spinal cord neural stem/progenitor cell neurogenic behaviour. ***Ahmad Galuta[1,2], Catherine Smith[2], Krystal L.A. Walker[2], Diana Ghinda[2,3], Suzan Chen[2], Eve Tsai[2,3]*. From the [1]University of Ottawa, Ottawa, Ont.; [2]Ottawa Hospital Research Institute, Ottawa, Ont.; and [3]The Ottawa Hospital, Ottawa, Ont.**

Background: Neural stem/progenitor cells (NSPCs) reside within and around the central canal of the mammalian spinal cord (SC) and can be modulated toward more beneficial fates to restore synaptic connectivity following SC injury in animal models. However, it is unclear how efficient human SC NSPCs can be modulated toward similarly beneficial fates. Using an in vitro neurosphere assay, adult human and rat SC NSPCs were assessed for their proliferation and differentiation characteristics to reveal species differences in their neurogenic behaviour. **Methods:** Primary- and secondary-derived NSPCs (pd- and sdNSPCs) from human thoracic and lumbar SC and rat thoracic SC were cultured using the same serum-free media. Proliferation assessment was with bromodeoxyuridine (BrdU) administration 24 hours before fixing, after treating NSPCs with epidermal growth factor (EGF; 20 ng/mL), fibroblast growth factor 2 (FGF2; 20 ng/mL) and unfractionated heparin (UFH; 2 µg/mL) for 14 days. Differentiation was assessed with administration of 1 of the following exogenous factors for 1 week: retinoic acid (RA; 500 ng/mL] to assess neural differentiation, bone morphogenetic protein 4 (BMP4; 100 ng/mL) to assess glial differentiation, or 1% fetal bovine serum (FBS) for intrinsic differentiation potential. NSPCs were then characterized by immunostaining against β-III tubulin, glial fibrillary acidic protein (GFAP), BrdU, or terminal deoxynucleotidyl transferase dUTP nick end labelling (TUNEL), and counter-stained with HOECHST. NSPCs were visualized by immunofluorescence and quantified as a percentage of immunopositive cells. **Results:** Rat NSPCs (n = 30) proliferated at a greater rate than human NSPCs (n = 10) from thoracic SC (2.92-fold for pdNSPCs, and 3.66-fold for sdNSPCs), but neither were inducible to differentiate when treated with RA or BMP4 for 7 days. Human sdNSPCs displayed interregional differences in the proliferation rate between thoracic and lumbar regions (52.1 ±19.9% v. 23.7 ±5.6%), and both demonstrated a high potency for neural differentiation in 1% FBS, beyond that of rat sdNSPCs (64.7 ±13.4% and 77.1 ±8.5% for thoracic and lumbar human NSPCs, respectively, v. 7.9 ±3.5% for rat NSPCs). **Conclusion:** Human and rat NSPCs differ in their proliferative index and differentiation profiles. This information may impact on the duration of potential NSPC therapeutic strategies that are translated to humans.

0009

Detection and quantification of bacteria in degenerating intervertebral discs. ***Jenny Hu, Kyle Raasck, Lisbet Haglund, Peter Jarzem*. From McGill Orthopaedics Research Laboratory, Montreal, Que.**

Background: Low back pain (LBP) is the world's leading cause of disability, with more than 632 million people affected. A major etiological factor contributing to LBP is the progressive degeneration of intervertebral discs (IVD), which leads to disc herniation. The current surgical treatment for LBP is lumbar fusion — an invasive surgery that carries considerable risk. In a recent study the inflammation and edema seen in LBP patients post–disc hernia has been attributed to bacterial infection by *Proprionibacteria acnes*. A recent double-blind randomized study demonstrated that antibacterial treatments significantly reduced LBP, but the association between bacterial infection and disc degeneration remains largely unexplored. **Methods:** To further investigate the role of *P. acnes* in LBP, we first developed a model for reliably detecting a bacterial load in IVDs. This was done by taking samples of bovine IVDs, infecting them with various known concentrations of *P. acnes*, extracting the DNA following a Chondroitinase

digest, and ultimately determining the lowest amount of bacterial genetic material detectable by quantitative poloymerase chain reaction (qPCR). We then isolated DNA from 8 separate surgical samples of deteriorated human IVDs. **Results:** At a genomic load of 3 ng, which is comparable to an infection of 10 000 cfu/mL, we reliably detected *P. acnes* presence in an IVD. Three of the 8 samples tested positive, indicating that 37.5% of the samples have bacterial infection of at least 10 000 cfu/mL. **Conclusion:** These preliminary data support the notion that bacterial infection may be a source of LBP in patients with degenerative discs. More experimental work is required to further substantiate the association between *P. acnes* and IVD deterioration. Our novel qPCR methodology for detecting bacteria in IVDs should progress this research at an accelerated pace, as it is more precise, immediate and reliable than previously described PCR procedures.

0120

SMaRT human stem cells to modify scar and optimize regeneration of the traumatically injured cervical spinal cord. ***Christopher Ahuja*[1,2], *Mohamad Khazaei*[2], *Michael Fehlings*[1,2]. From the [1]University of Toronto, Toronto, Ont.; and [2]Krembil Research Institute, Toronto Western Hospital, Toronto, Ont.**

Background: Human-induced pluripotent stem cell–derived neural precursor cell (hiPS-NPC) therapies represent an exciting regenerative approach to traumatic spinal cord injury (SCI), as they can remyelinate denuded axons, replace neural circuits and provide trophic support. Unfortunately, most patients are in the chronic phase of their injury, where dense chondroitin sulfate proteoglycan (CSPG) scar significantly hinders effective cell migration and neurite outgrowth. Several scar-modifying enzymes have been found to enhance NPC-mediated recovery; however, nonspecific intrathecal administration can produce off-target effects. We aimed to generate a unique, genetically engineered line of hiPS-NPCs, termed Spinal Microenvironment Modifying and Regenerative Therapeutic (SMaRT) cells, capable of inducibly expressing a scar-modifying enzyme within their host environment to enhance functional recovery. **Methods:** The CSPG-altering enzyme under an inducible promotor was nonvirally transfected into green fluorescent protein (GFP) + hiPS-NPCs. A monoclonal line of resultant SMaRT cells was generated by single-cell fluorescence-activated cell sorting (FACS). Enzyme expression and enzyme activity were extensively characterized in vitro by chondroitin sulfate (CS) and human CSPG assays and slot blot. T cell–deficient Rowett Nude (RNU) rats (n = 56) with chronic (8 week) C6–7 clip-contusion injuries were randomized to receive intraparenchymal injections of 1) vehicle alone, 2) GFP-hiPS-NPCs, 3) enzyme-expressing SMaRT cells, or 4) sham injury surgery (laminectomy alone) without treatment. Behavioural assessments are ongoing, with an end point of 16 weeks postinjury. **Results:** Enzyme-expression by SMaRT cells is inducible. The expressed enzyme rapidly alters CS and human CSPGs on biochemical assays. Unlike wild-type hiPS-NPC conditioned media, SMaRT cell media can modify rodent CSPGs in ex vivo cord sections similar to stock-purified enzymes confirming secreted product function. Furthermore, when differentiated to neurons and allowed to extend axons toward a CS-rich region mimicking scar, only SMaRT cells are able to extend long processes into the typically inhibitory areas. Blinded behavioural assessments and analyses are ongoing for the next 3 months. **Conclusion:** This work provides exciting proof-of-concept data that genetically engineered SMaRT cells may be able to locally modify CSPG scar and "unlock" the regenerative potential of stem cell therapies for individuals with chronic SCI.

0099

Fatigue testing of a titanium tapered rod versus two rods connected by a parallel connector across cervicothoracic junction: a biomechanical study. ***Ammar Qutub*[1,2], *Fahad Abduljabbar*[1,2], *Anas Nooh*[1,2], *Thomas Steffen*[1,3], *Lorne Beckman*[1,3], *Lauren Bould*[1,3], *Peter Jarzem*[1]. From the [1]McGill Scoliosis & Spine Centre, McGill University Health Centre, Montreal, Que.; [2]Department of Orthopedic Surgery, King Abdulaziz University, Jeddah, Saudi Arabia; and [3]Orthopedic Research Laboratory, McGill University Health Centre, Montreal, Que.**

Background: The purpose of this study is to compare the fatigue failure of a tapered titanium rod construct to 2 connected titanium rods across the cervicothoracic junction. **Methods:** Tapered and connected rod constructs were created to simulate a posterior fusion from C6 to T1 with the connectors over C7. The construct was designed with 2 fixation points separated by a distance of 31 mm and the connector or the tapered part of the construct falling in the middle. All testing was carried out in the flexion–extension plane. The 3.5 mm/6.0 mm tapered titanium rod and the 3.5 mm titanium rod attached to the 6.0 mm titanium rod with a connector were compared for fatigue failure. Six specimens of each construct were tested in a cantilever displacement control method using an 858 Material Testing Systems bionix machine at 6 different amplitudes. Each specimen was cycled to failure or to 2.5 million cycles (run out) at 10 Hz. Failure was defined as rod fracture or bending. **Results:** The connected rods construct reached the test limit of 2.5 million cycles at ± 0.45 mm (72 N), but failed at all other tested amplitudes. All failed rods broke at the junction between the connector and the 3.5 mm rods. The connected rods construct reached 323 cycles (230 N) at ± 3 mm, 2200 cycles (193 N) at ± 2 mm, 4725 cycles (149 N) at ± 1.5 mm, 27 270 cycles (115 N) at ± 0.75 mm and 393 045 cycles (80 N) at ± 0.5 mm. The tapered rod construct failed at ± 3 mm, ± 2 mm, ± 1.5 mm, ± 1.25 mm and ± 1.0 mm, with number of cycles at failure of 104 (350 N), 1182 (255 N), 9016 (160 N), 19 227 (155 N) and 328 415 (145 N), respectively. All failed rods broke at the smaller end of the tapered area. It reached the test run out limit of 2.5 million cycles at ± 0.9 mm. **Conclusion:** The tapered rod construct sustained higher loads before failure compared with the connected rods construct. We suggest the use of tapered rods when connecting screws across the thoracolumbar junction. Further evaluation of these constructs in a cadaver model using fatigue testing is warranted.

0064

MRI analysis of the combined AOSpine North America and International studies: the prevalence and spectrum of pathologies in a global cohort of patients with degenerative cervical myelopathy. ***Aria Nouri*[1,2], *Allan Martin*[1,2], *Lindsay Tetreault*[2], *Anick Nater*[1,2], *So Kato*[1], *Hiroaki Nakashima*[1], *Narihito Nagoshi*[1], *Hamed Reihani-Kermani*[1], *Michael***

Feblings[1,2]. **From the [1]University of Toronto, Toronto, Ont.; and [2]Toronto Western Hospital, Toronto, Ont.**

Background: Degenerative cervical myelopathy (DCM) encompasses a spectrum of conditions, including spondylosis and ossification of the posterior longitudinal ligament (OPLL), that result in progressive spinal cord (SC) impairment. Through detailed review of MRIs, the global prevalence of degenerative pathologies of patients with DCM is reported. **Methods:** MRIs of 458 patients (mean age 56.4 ± 11.8 years, 285 men, 173 women) were obtained from North America (n = 200), Europe (n = 93), Latin America (n = 58) and Asia-Pacific (n = 107) and assessed for the type of pathology, directionality of stenosis, level of maximum cord compression, levels of SC compression, and signal changes on T2WI and T1WI. Data were analyzed for differences between sex using χ^2 tests and geographic variations using Kruskal–Wallis tests. **Results:** Globally, spondylosis was most frequently present (89.7%) and was commonly accompanied by enlargement of the ligamentum flavum (LF; 59.9%). Single-level disc pathology, OPLL and spondylolisthesis had a prevalence of about 10% each. OPLL was accompanied by spondylosis in 91.7%. Associated abnormalities, such as Klippel–Feil syndrome and congenital stenosis, were observed in 2.0% and 8.4%, respectively. The Asia-Pacific region had more OPLL (29%, $p = 3 \times 10^{-11}$) and less spondylolisthesis (1.9%, p = 0.002). Women presented more commonly with single-level disc pathology (13.9% v. 6.7%, p = 0.013), and men presented more commonly with spondylosis (92.3% v. 85.6%, p = 0.02) and enlargement of LF (61.4% v. 49.1%, p = 0.01). C5–6 was the most frequent maximum compressed site (39.5%) and region for T2WI hyperintensity (38.9%). T2WI hyperintensity more commonly presented in men (82.4% v. 66.7%, $p < 0.001$). **Conclusion:** This is the largest report on the prevalence and spectrum of pathology in patients with DCM. Herein it has been demonstrated that degenerative features are highly interrelated, that women presented with milder MRI evidence of DCM, and that variations exist in the prevalence of pathologies among geographical regions.

0067

Efficacy and safety of riluzole in acute spinal cord injury (SCI). Rationale and design of AOSpine phase III multicentre double-blinded randomized controlled trial. (RISCIS). ***Michael Fehlings*[1], *Branko Kopjar*[2], *Robert Grossman*[3]. From the [1]University of Toronto, Toronto, Ont.; [2]University of Washington, Seattle, Wash.; and [3]The Methodist Hospital, Houston, Tex.**

Background: There is convincing evidence from the preclinical realm that the pharmacologic agent riluzole attenuates certain aspects of the secondary injury cascade leading to diminished neurologic tissue destruction in animal spinal cord injury (SCI) models. The safety and pharmacokinetic profile of riluzole have been studied in a multicentre pilot study in 36 patients. Efficacy of riluzole in acute human SCI has not been established. **Methods:** This ongoing multicentre, international double-blinded phase III randomized controlled trial will enroll 351 patients with acute C4–C8 SCI and American Spinal Injury Association (ASIA) Impairment Scale grade A, B or C randomized 1:1 to riluzole and placebo. Primary outcome is the change in ASIA motor score (MS) between baseline and 180 days. Other outcomes include ASIA upper- and lower-extremity MS, ASIA sensory score, ASIA grade, spinal cord independence measure (SCIM), 36-Item Short-Form Health Survey (SF-36v2) score, EQ-5D score and Graded Redefined Assessment of Strength, Sensibility and Prehension (GRASSP) score. Two-stage sequential adaptive trial statistical design has 90% power to detect 9 points difference in the ASIA MS at 1-sided $\alpha = 0.025$. **Results:** A matched cohort analysis performed in the phase I study showed that riluzole-treated cervical SCI patients experienced an additional 15.5 points in AMS recovery at 90 days postinjury. Although the phase I study was underpowered to investigate efficacy, the current phase III study is poised to definitively address this question. Participant enrolment for this trial began on Oct. 1, 2013. To date, 57 participants have been enrolled. Mean age of the enrolled participants is 49.7 ± 16.3 years, and 78% are men. ASIA at arrival and preinjury status were as follows: ASIA grade A 50%, B 26% and C 24%; GRASSP 67.1 ± 62.0; SF-36v2 physical component score 53.1 ± 9.2; and SF-36v2 mental component score 54.8 ± 11.2. **Conclusion:** This is a phase III study of riluzole in acute SCI.

0077

Dynamic morphometric changes in degenerative lumbar spondylolisthesis: a pilot study of standing magnetic resonance imaging. ***Raphaële Charest-Morin*[1], *Michael Bond*[1], *David Wilson*[2], *Honglin Zhang*[2], *John Street*[1]. From the [1]Combined Neurosurgical and Orthopedic Spine Program, University of British Columbia, Vancouver, BC; and [2]University of British Columbia, Vancouver, BC.**

Background: Patients with L4/5 degenerative lumbar spondylolisthesis (DLS) typically have leg symptoms when standing. Recent Canadian studies have questioned the necessity for instrumented fusion in all cases of DLS. The Canadian Spine Outcomes and Research Network (CSORN) is currently undertaking an observational study of the treatment of this common condition. This pilot study examines the utility of upright standing MRI in identifying dynamic morphometric changes that may allow refinement of individualized surgical treatment of DLS. **Methods:** Patients with single-level grade I or II L4/5 DLS on the surgical waiting list at a single institution were invited to participate. Participants were imaged in the upright MRI scanner (sagittal and axial T_2 images) in both the supine and standing positions using an imaging protocol developed with a group of healthy volunteers (n = 15). The following morphometric parameters were measured: lateral recess height, disc height, magnitude of slip, disc angle, volume of subarticular space, diameter of mid foramen and cross-sectional area of the thecal sac. Measures from supine and standing images were compared using paired t test statistics. **Results:** Ten patients (mean age 66.4 years) with DLS were included, 7 of whom were women. Patients scanned in the standing position had reliably measureable and significantly lower cross-sectional area ($p < 0.01$), disc height ($p < 0.001$) and both left and right mid-foramen diameter ($p < 0.001$) than on supine imaging. The magnitude of volumetric change was significantly greater in grade II than in grade I slips ($p < 0.0001$). The change in absolute slip percentage was found to be 5.5% in grade I DLS ($n = 5$, $p = 0.0638$) and 13.7% in grade II DLS ($n = 5$, $p < 0.0001$). The magnitude of change in disc angle was the same for both grade I and II DLS. **Conclusion:** In this pilot study, standing

MRI scanning reliably detects dynamic morphometric differences in a number of clinically important radiographic parameters in patients with DLS. The observed differences between grade I and grade II DLS provides further evidence for the belief that many patients may be appropriately treated surgically without a fusion.

0086

Prognostic utility of pain diagrams for predicting surgical intervention among spine referrals. *Michael M.H. Yang, Khaled Ali Almansoori, Stephan Du Plessis*. From the University of Calgary, Calgary, Alta.

Background: Pain diagrams (PD) have been used as screening tools for the evaluation of back pain but show variability in their diagnostic and prognostic utility. Several studies have compared different PD methods, but none have investigated their role in predicting surgical intervention. Therefore, a prospective cohort study was undertaken to evaluate 5 different PD interpretation methods: Uden, Ransford, Margolis, Ohnmeiss and the Quebec Task Force (QTF) approaches. Primary objectives were to compare the methods' likelihood of predicting operative versus nonoperative management among patients referred for low back pain (LBP) pathologies. **Methods:** Consecutive patients meeting inclusion criteria were asked to complete a PD before their first encounter with their spine surgeon. Clinical management details were retrospectively collected over a 24-month subsequent period, and patients meeting inclusion criteria were evaluated. Statistical analysis of independent and dependent variables were performed using descriptive statistics, Spearman correlative analysis and binomial logistic regression analysis using SPSS software version 22 (SPSS Inc.). **Results:** A total of 317 patients were included in the study, 12.9% of whom underwent surgical intervention. Binomial logistic regression showed weak associations between PD interpretations and surgical intervention, as demonstrated by Nagelkerke variability estimations (Uden: $R^2 = 0.32$; Ransford: $R^2 = 0.21$; Margolis: $R^2 = 0.17$; Ohnmeiss: $R^2 = 0.15$; QTF: $R^2 = 0.31$). Positive predictive value was highest with the QTF method (39.6%), and negative predictive value was highest with the Uden method (82.9%). In general, interrater agreement was highest with the Ohnmeiss method (88.5%) and lowest with the Margolis method (66.7%). **Conclusion:** Pain diagrams demonstrate good interrater agreement and generally provide negative predictive value for evaluating the likelihood that a patient will undergo operative intervention. However, they are not useful in predicting who will undergo surgery.

0091

Attitudes of Canadian spine surgeons toward medical assistance in dying: a national survey. *Ginette Thibault-Halman, Nelofar Kureshi, Sean Christie, Sean Barry*. From Dalhousie University, Halifax, NS.

Background: Clinical situations where medical assistance in dying (MAID) is requested are particularly challenging, given the emotional, legal and ethical issues involved. These matters are of particular importance to spine surgeons, who care for a significant percentage of patients in chronic pain or who suffer permanent disability. The objective of this survey was to determine the level of support among Canadian spine surgeons for MAID. We also sought to determine the attitudes of surgeons toward duty of referral and conscientious objection. **Methods:** The study design was a cross-sectional bilingual survey of active Canadian Spine Society (CSS) members. Demographic characteristics and responses for each survey item were expressed as percentages. All analyses were conducted using SPSS and R statistical software. **Results:** A total of 38 complete survey responses were received. The majority of respondents were attending physicians (97%) who had been practising for 11–30 years at an academic centre. Most spine surgeons supported (42%) or strongly supported (18%) the Supreme Court of Canada's decision to decriminalize MAID in Canada, and 45% felt that this decision would have some impact on their individual practices. Most (81%) respondents stated that they supported the right of physicians to participate in MAID. Only 16% had ever been asked by a patient to provide MAID. A large proportion of surgeons supported (32%) or strongly supported (61%) the right of conscientious objection. Moreover, 47% felt that there should be a mandatory duty to refer to a MAID service; 42% felt they would refer patients to a MAID service, but only 5% felt they would be actively involved in ending a patient's life. **Conclusion:** Our preliminary results demonstrate that Canadian spine surgeons support the legalization of MAID. This group of surgeons also strongly supported the right to conscientiously object to participating in MAID. A minority of spine surgeons would be willing to actively end the life of a patient.

0013

Lumbar fusion for degenerative disease: a systematic review and meta-analysis. *Daniel Yavin[1,2], Steven Casha[1,3], Samuel Wiebe[2,4], Thomas E. Feasby[2,4], Callie Clark[4], Albert Isaacs[1], Jayna Holroyd-Leduc[2,5], R. John Hurlbert[6], Hude Quan[2,7], Andrew Nataraj[8], Garnette R. Sutherland[1,3], Nathalie Jette[2,4]*. From the [1]Division of Neurosurgery, Department of Clinical Neurosciences, University of Calgary Cumming School of Medicine, Calgary, Alta.; [2]Department of Community Health Sciences, University of Calgary Cumming School of Medicine, Calgary, Alta.; [3]The Hotchkiss Brain Institute, University of Calgary Cumming School of Medicine, Calgary, Alta.; [4]Division of Neurology, Department of Clinical Neurosciences, University of Calgary Cumming School of Medicine, Calgary, Alta.; [5]Department of Medicine, University of Calgary Cumming School of Medicine, Calgary, Alta.; [6]Division of Neurosurgery, Department of Surgery, University of Arizona Health Sciences, Tucson, Ariz.; [7]O'Brien Institute for Public Health, University of Calgary Cumming School of Medicine, Calgary, Alta.; and [8]Division of Neurosurgery, Department of Surgery, University of Alberta, Edmonton, Alta.

Background: Owing to uncertain evidence, lumbar fusion for degenerative indications is associated with the greatest measured practice variation of any surgical procedure. We therefore sought to summarize the current evidence on the comparative safety and efficacy of lumbar fusion, decompression alone, or nonoperative care for degenerative indications. **Methods:** A systematic review using PubMed, MEDLINE, EMBASE, and the Cochrane Central Register of Controlled Trials (up to June 30, 2016) was conducted. Comparative studies reporting validated measures of safety or efficacy were included. Treatment effects were calculated through DerSimonian and Laird random-effects models. **Results:** The literature search yielded 65 studies (19 randomized

controlled trials, 16 prospective cohort studies, 15 retrospective cohort studies and 15 registries) enrolling 302 620 patients in total. Disability, pain and patient satisfaction following fusion, decompression alone, or nonoperative care were dependent on surgical indications and study methodology. Relative to decompression alone, the risk of reoperation following fusion was increased for spinal stenosis (relative risk [RR] 1.17, 95% CI 1.06–1.28, $p < 0.005$) and decreased for spondylolisthesis (RR 0.75, 95% CI 0.68–0.83, $p < 0.001$). Among patients with spinal stenosis, complications were more frequent following fusion (RR 1.87, 95% CI 1.18–2.96, $p < 0.01$). Mortality was not significantly associated with any treatment modality. **Conclusion:** Positive clinical change was greatest in patients undergoing fusion for spondylolisthesis, while complications and the risk of reoperation limited the benefit of fusion for spinal stenosis. The relative safety and efficacy of fusion for chronic low back pain suggests careful patient selection is required. PROSPERO registration number CRD42015020153.

0076

Quantitative multiparametric spinal cord MRI detects subclinical tissue injury in asymptomatic cervical spinal cord compression. ***Allan R. Martin[1], Benjamin De Leener[2], Julien Cohen-Adad[2], David W. Cadotte[1,3], Jefferson R. Wilson[1], Lindsay Tetreault[1,4], Aria Nouri[1], Adrian Crawley[1], David J. Mikulis[1], Howard Ginsberg[1], Michael G. Fehlings[1].*** **From the [1]University of Toronto, Toronto, Ont.; [2]École Polytechnique de Montréal, Montreal, Que.; [3]University of Calgary, Calgary, Alta.; and [4]University College Cork, Cork, Ireland.**

Background: Degenerative cervical myelopathy (DCM) is a condition in which extrinsic compression and dynamic injury causes spinal cord (SC) tissue injury and neurologic dysfunction. Degenerative SC compression has also been observed in 8%–26% of the asymptomatic population, increasingly with age. Quantitative MRI (qMRI) accurately measures SC tissue injury in DCM, but it is unknown if asymptomatic SC compression involves similar pathological changes. **Methods:** Thirty-two healthy individuals without neurologic symptoms/signs underwent T_2-weighted (T2w) diffusion tensor imaging (DTI), magnetization transfer (MT) and T_2*-weighted (T2*w) 3 T MRI covering C1–C7. Participants were grouped based on presence of cord compression (indentation, flattening, or focal torsion). SC cross-sectional area (CSA), fractional anisotropy (FA), MT ratio (MTR), and T2*w white to grey matter signal intensity ratio (T2*w WM/GM) were calculated at the maximally compressed (MCL), rostral (C1–C3), and caudal (C6–7) levels and normalized for confounding variables (including age). One-tailed *t* tests and a single binomial test assessed if asymptomatic compression caused similar pathological changes in 10 qMRI metrics, as previously observed in DCM ($n = 56$). Area under receiver operating characteristic curves (AUC) measured diagnostic accuracy. **Results:** SC compression participants ($n = 12$, 38%) were older than uncompressed participants (53.9 years v. 38.9 years, $p = 0.004$) and showed decreased rostral MTR (50.8 v. 53.5, $p = 0.005$, AUC = 0.765), decreased MCL MTR (*t*: –0.255 v. 0.254, $p = 0.05$, AUC = 0.604) and increased rostral T2*w WM/GM (0.875 v. 0.857, $p = 0.05$, AUC = 0.675). The other 7 metrics did not show significant differences. The directional pattern of changes matched differences seen in DCM in 8 of 10 measures ($p = 0.05$). **Conclusion:** Asymptomatic individuals with SC compression show a similar pattern of macro- and microstructural changes as DCM individuals, suggesting the presence of subclinical tissue injury. Although these results require further validation, they offer the intriguing possibility of injury detection before the onset of clinical symptoms and signs. These findings have far-reaching implications, including earlier diagnosis and treatment for all spinal pathologies.

0093

Quantitative microstructural cervical spinal cord MRI provides an accurate diagnostic tool for detecting clinical myelopathy. ***Allan R. Martin[1], Benjamin De Leener[2], Julien Cohen-Adad[2], David W. Cadotte[3], Jefferson R. Wilson[1], Lindsay Tetreault[1,4], Aria Nouri[1], Stefan F. Lange[1], Adrian Crawley[1], David J. Mikulis[1], Howard Ginsberg[1], Michael G. Fehlings[1].*** **From the [1]University of Toronto, Toronto, Ont.; [2]École Polytechnique de Montréal, Montreal, Que.; [3]University of Calgary, Calgary, Alta.; and [4]University College Cork, Cork, Ireland.**

Background: The clinical diagnosis of myelopathy, defined as spinal cord (SC) dysfunction, is sometimes challenging, as symptoms (e.g., fine motor dysfunction, numbness, gait impairment) and signs (e.g., hyperreflexia) are subjective. Anatomic MRI showing cord compression has poor specificity (present in 8%–20% of healthy individuals), and electrophysiology assessments (e.g., somatosensory evoked potentials) have poor sensitivity. Quantitative MRI techniques that measure axonal loss, demyelination and atrophy may provide enhanced diagnostic accuracy. This study compares 3 diagnostic models using multiparametric MRI data for classification between healthy individuals and those with degenerative cervical myelopathy. **Methods:** Thirty-two healthy individuals and 56 patients with degenerative cervical myelopathy (DCM) participated. Clinical data included age, sex, height, weight and cervical cord length. 3 T MRI data included SC cross-sectional area (CSA), diffusion fractional anisotropy (FA), magnetization transfer ratio (MTR), and T_2*-weighted white to grey matter signal intensity ratio (T2*w WM/GM) extracted from maximally compressed level (MCL) and rostral (C1–C3) and caudal (C6–C7) levels. Diagnostic models were built with a maximum of 3 degrees of freedom (df) using 1) logistic regression (LR) with backward stepwise elimination, 2) linear discriminant analysis (LDA) and 3) principle component analysis followed by logistic regression (PCA-LR). Bootstrap validation provided unbiased estimation of diagnostic accuracy, reported as corrected area under receiver operating characteristic curves (AUC). **Results:** All 3 models showed good diagnostic accuracy, with LR (AUC = 93.8%) slightly outperforming PCA-LR (AUC = 91.4%) and LDA (AUC = 85.2%). The LR model retained only MCL CSA ($p = 0.0003$), rostral T2*w WM/GM ($p = 0.06$) and MCL T2*w WM/GM ($p = 0.06$), while the PCA-LR and LDA models used all of the available input data (reducing them to 3 and 1 df, respectively). **Conclusion:** Quantitative multiparametric SC MRI shows promise as an accurate diagnostic tool for the detection of myelopathy. A simple diagnostic test based on only CSA and T2*w WM/GM can be performed using a standard clinical 3 T scanner with 10 minutes acquisition time. These results warrant further investigation in a large series of cases with diagnostic uncertainty of myelopathy to fully establish the clinical utility of this approach.

0114

Decompression surgery improves tibialis anterior muscle strength in cases of painful and painless foot drop caused by neurodegenerative lumbar disease: a systematic review. ***Shawn Brophy, Jaclyn Ferris, Jill Hayden, Sean Barry, Sean Christie*. From Dalhousie University, Halifax, NS.**

Background: In cases of painful foot drop caused by neurodegenerative lumbar disease, spinal decompression surgery is indicated to relieve pain. In many cases, an added benefit to this surgery is improved tibialis anterior (TA) muscle strength, effectively diminishing or eliminating the foot drop. In cases of painless foot drop, there is currently no expert consensus guiding when and if surgery is indicated to improve TA strength. The objective of this systematic review was to summarize and contrast the available evidence about the efficacy of lumbar decompressive surgery to improve TA muscle strength in cases of painful and painless foot drop caused by neurodegenerative lumbar disease.**Methods:** We comprehensively searched the PubMed, CINAHL, EMBASE and the Cochrane Library up to June 2015. Two independent reviewers selected relevant studies. We included observational and experimental studies. We extracted information about study characteristics and patient outcomes (muscle strength and recovery), and assessed study risk of bias. **Results:** We identified 3724 potential citations. For painless foot drop, 2 studies reporting outcomes for 31 patients met the selection criteria. For painful foot drop, 7 studies involving 234 participants met the selection criteria. Recovery, defined as postoperative TA strength of 3 or higher on the Medical Research Council Scale for Muscle Strength, was reported in 60.7%–62.0% of patients with painless foot drop. The overall recovery rate in participants with painful foot drop was 64.5%. No significant adverse events were reported. **Conclusion:** Spinal decompression surgery can improve TA muscle strength in patients with painless foot drop at rates comparable to patients with painful foot drop. Well-conducted primary research is needed on this subject.

0100

OLIF early and late complications profile. ***Michael Yang*[1], *Godefroy Hardy St-Pierre*[2], *Richard Haines*[3]. From the [1]University of Calgary, Calgary, Alta.; [2]Western University, London, Ont.; and [3]BACK centre, Melbourne, Fla.**

Background: Oblique lumbar interbody fusion (OLIF) is a novel lateral access technique for fusion in the lumbar spine. Initially devised to circumvent the inability of the lateral lumbar interbody fusion (LLIF) to access the L5/S1 disc space, OLIF quickly emerged as a potentially safer and more anatomically sound alternative bypassing the need to go through the psoas while instead using a more anterior corridor closer to the large vessels. Despite growing popularity, long-term outcomes and complications data remain lacking in the literature. **Methods:** We retrospectively reviewed prospectively collected data on patients undergoing OLIF between 2011 and 2013 performed by a single surgeon in a single institution. We analyzed data regarding preoperative symptomatology, early complications (< 1 week), late complications and outcomes. We analyzed 2 primary end points: presence of any early complication and presence of any late complication. Secondary end points were early numbness, early weakness, major complication, subsidence, postoperative numbness, or weakness at 1 year. We conducted a multivariate analysis via logistical regression. **Results:** There were 157 patients. Average age was 62 years. Average preoperative visual analogue scale (VAS) score for pain was was 7.05, whereas the postoperative VAS score was 3.07. One major complication occurred, with injury of the ileolumbar vein requiring intraoperative repair and intraoperative blood transfusion. Blood loss was still less than 1 L in that instance. The rate of early numbness was 26.8% and that of early weakness was 6.8%. The rate of late numbness was 7.2% and that of late weakness was 0%. Fusion rate was 96.8% and subsidence was 7%. Average improvement on the VAS was –3.86. Neither preoperative symptoms nor patient characteristics were associated with occurrence of either early or late complications. **Conclusion:** OLIF has a low complication profile that compares favourably to reported rates for LLIF, around 9% for early weakness and 2.5% for permanent deficits. Clinical improvement is good, and fusion rate is excellent. Further analysis of long-term outcomes is needed.

0073

The infectious etiology of degenerative disc disease: Myth or reality? ***Peter Jarzem, Ahmed Aoude, Michael Weber, Carlo Santaguida, Jean Albert Ouellet, Patrick Wang*. From McGill University, Montreal, Que.**

Background: The infectious etiology of degenerative disc disease has been hypothesized in the literature. The objective of this study is to determine if degenerative disc disease is associated with colonization of the disc with low virulence micro-organisms. **Methods:** Disc cultures were carried out systematically in all patients undergoing spine surgery for degenerative disc disease at our institution by 1 surgeon. All patients with disc cultures sent to microbiology laboratories were analyzed. All patients included in the study provided consent for tissue donation for research. Patients without disc specimens, without cultures or with known discitis were excluded. The species of micro-organism was documented. **Results:** We identified 138 patients undergoing spine surgery between December 2015 and July 2016 at our institution. Of these, 77 were excluded: 6 owing to discitis and 71 because the disc was not sampled. Therefore, 61 patients (with 88 disc cultures) were analyzed. The average patient age was 59 years (range 20–86 years). In total, 12 patients (20%) had positive disc cultures. Subgroup analysis indicated that 29% ($p < 0.05$) of disc hernias and 100% ($p < 0.05$) of the revision fusions grew bacteria from the disc space. *Staphylococcus epidermidis* was the most common organism (33%), but other bacteria included *Propionibacterium acnes*, *Clostridium*, *Corynebacterium*, *Escherichia coli*, *Streptococcus* and *Staphylococcus* species. None of the patients with positive cultures had a history of chronic infection. **Conclusion:** This is the first study to sample the discs from a cohort of patients considered to have primary degenerative conditions of the spine. Our study demonstrates that degenerated discs are frequently co-infected with bacterial species. The highest infection rates were in disc hernias and revision fusions, where 29% and 100%, respectively, of the discs culture grew bacteria. Although one-third of organisms were *S. epidermidis*, no specific micro-organism was identified as the main source. Thus, the etiology of disc degeneration can be questioned, and in a significant proportion there may be an infectious etiology. Although this is a preliminary study, the results warrant further investigation.

0103

Recurrent adjacent segment disease: A different entity? ***Michael Yang*[1], *Godefroy Hardy St-Pierre*[2], *Chris Bailey*[2], *Andrew Nataraj*[3]. From the [1]University of Calgary, Calgary, Alta.; [2]Western University, London, Ont.; and [3]University of Alberta, Edmonton, Alta.**

Background: Adjacent segment disease (ASD) is a clinical entity limiting the durability of spinal arthrodesis. Analysis of long-term results using the Dynesys system cast doubt on the commonly proposed pathophysiological mechanism of ASD: nonfusion did not prevent ASD. Furthermore, the recurrence of ASD in patients already operated on for that very indication was very high, suggesting that the natural history of the disease was the preponderant factor at play. We sought a similar longitudinal data set of fusion procedure to compare the rate of recurrent ASD between Dynesys and fusion. **Methods:** We reviewed 2 databases of patients from 2006 to 2010: 1 from Edmonton, in which the Dynesys system was implanted, and 1 from London, with fusion procedures. Our primary outcome was recurrence of clinically significant ASD requiring a repeat operation. We collected secondary outcomes at 2 years via the visual analogue scale (VAS) for leg pain and the Oswestry Disability Index (ODI). We used Student *t* tests to compare the groups. **Results:** We had 310 patients to review: 98 with Dynesys and 212 with fusion. Among these, 8 had Dynesys after initial ASD and 12 had fusion for the same indication. The rate of second ASD was 67% (8 of 12) in the Dynesys cohort and 21% (4 of 19) in the fusion cohort. This rate was significantly larger in this subgroup than the overall rate of ASD (15% in the Dynesys cohort and 9% in the fusion cohort). There was no difference between groups among either cohort in preoperative ODI ($p = 0.77$ and $p = 0.63$, respectively) or VAS leg pain ($p = 0.62$ and $p = 0.30$, respectively). **Conclusion:** ASD potentially has its own pathogenesis beyond the hypothesis of increased motion in segments adjacent to fusion, as evidenced by similar rates in fusion and nonfusion cohorts. Furthermore, the even higher rate of recurrent ASD suggests that the natural history overcomes the treatment. Further research will be needed.

0121

Patient-reported outcomes following spinal surgery for degenerative disc disease, disc herniation, spondylolisthesis and spinal stenosis: a national comparison. ***Greg McIntosh*, *Charles Fisher*, *Hamilton Hall*, *Neil Manson*, *Y. Raja Rampersaud*, *Kenneth Thomas*. Canadian Spine Outcomes and Research Network, Toronto, Ont.**

Background: The purpose of this study was to compare satisfaction, back and leg pain, disability and quality of life outcomes at 1-year follow-up after elective spine surgery based on presurgical diagnosis. **Methods:** There were 18 Canadian Spine Outcomes and Research Network (CSORN) sites representing 14 cities from 8 provinces used to derive the sample: 1531 patients who consented and then proceeded to thoracolumbar spine surgery between October 2008 and September 2015. One-way analysis of variance was used to compare outcomes by diagnosis. Patient-reported outcome measures were patient satisfaction and change in leg pain, disability score and health-related quality of life based on the 12-Item Short-Form Survey (SF-12) and the EQ-5D from baseline to 1 year postsurgery. Four presurgical diagnoses were evaluated: degenerative disc disease (DDD; $n = 88$), disc herniation ($n = 429$), spondylolisthesis ($n = 377$) and spinal stenosis ($n = 637$). **Results:** There were no significant differences in change in mental component score (SF-12) or EQ-5D score by diagnosis. Those who had surgery for DDD had the least improvement in back pain, leg pain, disability scores and physical component scores. Back pain change (–2.68) showed significantly less improvement than surgery for spondylolisthesis (–3.98, $p < 0.01$) and stenosis (–3.55, $p < 0.04$). Leg pain change (–2.61) showed significantly less improvement than surgery for disc herniation (–4.11, $p < 0.0001$), spondylolisthesis (–4.38, $p < 0.0001$) and stenosis (3.98, $p < 0.001$). Disability score change (–15.98) showed significantly less improvement than surgery for disc herniation (–25.47, $p < 0.0001$) and spondylolisthesis (–21.82, $p < 0.04$). SF-12 physical component score change (7.82) showed significantly less improvement than surgery for disc herniation (12.35, $p < 0.001$). There were no significant differences in satisfaction rates between those who had surgery for DDD and those who had surgery for disc herniation or stenosis. Those with spondylolisthesis were significantly more satisfied with surgery than those with all other diagnoses ($p < 0.01$). **Conclusion:** Clinically significant improvements in patient-reported outcomes were achieved across all diagnoses at 1 year postsurgery; however, patients with DDD had the least amount of improvement.

0090

Investigating the association between modic changes and chronic lower back pain in patients receiving surgical therapy for lumbar disc herniation: a retrospective chart review. ***Mark MacLean*, *Ginette Thibault-Halman*, *Nelofar Kureshi*, *Jai Jai Shankar*, *Sean Barry*, *Jacob Alant*, *Andrew Glennie*, *William Oxner*, *Sean Christie*. From Dalhousie University, Halifax, NS.**

Background: Modic changes (MCs) are visible on spinal MRI and have been reportedly linked to occult infection and worse clinical outcomes. The objective of this study was to assess the utility of MCs in predicting response to surgical therapy (lumbar discectomy [LD] or transforaminal lumbar interbody fusion [TLIF]) for disc herniation. **Methods:** We performed a retrospective review of prospective data for adult patients who underwent LD or TLIF at a single spinal level. Presence/type of MC on preoperative imaging was recorded by a single neuroradiologist. Clinical outcomes were assessed using the visual analogue scale (VAS), Oswestry Disability Index (ODI), and 36-Item Short-Form Health Survey (SF-36). **Results:** A total of 161 patients (114 LD and 47 TLIF) were included. The mean age was 53 ± 14 years. Preoperative prevalence (%) of MC types 1, 2, 3 and mixed were 16, 35, 3 and 8, respectively. In total, 37.8% of patients had no MC. Preoperative clinical outcome scores were similar among all patients. Patients with type 1 MC responded better to therapy (SF-36/ODI/VAS) at 12 months than those without MC, but this difference was not statistically significant. Patients with type 2 MC had a greater response to therapy (SF-36, $p = 0.001$; ODI, $p = 0.005$) than those without MC. Patients with type 1 MC had a poorer response to therapy (SF-36/ODI) than those with type 2 MC, but this difference was not statistically significant. **Conclusion:** This is the first study to evaluate clinical outcomes after surgery in patients stratified for MC. All groups demonstrated significant improvement of clinical

outcomes at 12 months. The preoperative prevalence of MC in this study was similar to rates previously identified. Contrary to previous reports, our results suggest that patients with type 2 MC have better clinical outcomes than those without MC. A prospective study of MC progression during the postsurgical period may provide insight into the utility of MC as a prognostic marker of therapeutic response.

0072

Nonspecific low back pain is really a highly specific group and not a homogeneous one. *Greg McIntosh[1], Hamilton Hall[1], Chris Gregg[2], Tom Carter[1], Chris Hoffman[2]*. From the [1]CBI Health Group, Toronto, Ont.; and [2]TBI Health, Wellington, New Zealand.

Background: The purpose of this study was to compare clinical characteristics of low back pain (LBP) based on a syndrome approach to classification. **Methods:** This retrospective study of prospectively collected LBP cases was a collaborative effort of spine care rehabilitation clinics in New Zealand and 4 Canadian provinces. Patient enrolment occurred between January 2008 and October 2012. The syndrome approach to the classification of LBP recognizes patterns of pain based on clinical presentation rather than emphasis on demographics, anatomic site or pathological process. There were 1912 patients: pattern 1 = 1653 (86.5%), pattern 2 = 196 (10.3%), pattern 3 = 62 (3.2%), pattern 4 = 1 (excluded from this study). **Results:** For dominant pain location, significantly more pattern 3 patients had leg pain (71%) than pattern 1 (2%) and pattern 2 (1%, $p < 0.01$). Aggravating position of each pattern was significantly different ($p < 0.01$); pattern 1 increased with flexion (73%), pattern 2 increased with extension (57%) and pattern 3 increased with both flexion and extension (80%). Relieving position of each pattern was significantly different ($p < 0.01$); pattern 1 reduced in extension (91%), pattern 2 reduced in flexion (85%) and pattern 3 reduced when lying down (55%). The neurologic profile of each pattern was significantly different ($p < 0.01$). Pattern 1 had 27% with at least 1 positive neurologic finding, pattern 2 had 12% and pattern 3 had 72%. There was no statistically significant difference in baseline numeric pain rating among patterns; perceived level of functional ability was significantly different among all 3 patterns ($p < 0.01$). Pattern 1 had the highest and pattern 3 had the lowest perceived function based on Low Back Outcome Scores. **Conclusion:** The response to flexion is what dictates initial treatment. Pattern 1 is back-dominant pain, which worsens in flexion and/or extension. Pattern 2 is back-dominant pain that is improved or unchanged in flexion. Pattern 1 patients are very different from those who are never worse with flexion (pattern 2). Pattern 3 is constant leg-dominant pain affected by back movement/position. These multiprovincial and international data suggest that LBP is heterogeneous with recognizable and unique clinical markers. These findings contradict a categorization of LBP as 1 homogeneous nonspecific entity.

0104

Elucidating the prevalence and predictors associated with spine surgery revisions at a single orthopaedic site. *Michael Fry[1,2,3], Neil Manson[1,3,4], Erin Bigney[1,3], Kate Wagg[1,3], Edward Abraham[1,3,4]*. From the [1]Canada East Spine Centre, Saint John, NB; [2]Dalhousie School of Medicine, Research in Medicine Program, Saint John, NB; [3]Dalhousie School of Medicine, Department of Surgery, Saint John NB; and [4]Saint John Regional Hospital, Horizon Health Network, Saint John, NB.

Background: A portion of patients who undergo spine surgery will eventually require revision surgery. Not only do revision surgeries strain our health care system, they are also associated with higher risks owing to anatomic alterations caused by the initial surgery. The objectives of the current study were to determine rate of revision at the Canada East Spine Centre (CESC), explore reasons for revision and investigate potential predictors for revision. **Methods:** Rate of revision was determined by examining the total population of patients who received thoracolumbar surgery at CESC. Separately, a retrospective cohort study was conducted ($n = 214$) using prospectively collected data in the Canadian Spine Outcomes Research Network (CSORN) database. Descriptive statistics were used to summarize data. Continuous variables were compared with analysis of variance and categorical variables with χ^2 analyses. Univariate analyses were conducted to determine significant associations between patient/surgical factors and revision. Significant factors were entered into a binary logistic regression. Significance was set at $\alpha < 0.05$. **Results:** The overall revision rate was 9.8%. The 2 primary reasons for revision were recurrence of pathology (54.64%) and adjacent segment degeneration (ASD; 21.64%). ASD was the primary reason for revision in patients with stenosis (45.71%) and deformity (27.27%). Type of surgery (open/minimally invasive) and pathology differed significantly between groups and was included in the regression; both types significantly contributed to the model ($p = 0.001$ and $p = 0.028$, respectively). Patients receiving open surgery were 1.3 times as likely to require revision. Surgery type and pathology are significantly correlated ($r = –3.53$, $p = 0.001$); open surgery was more likely for all pathologies with the exception of disc herniation. Rates of revision by pathology were 100% for degenerative disc disease, 78.57% for deformity, 46.87% for disc herniation, 39.32% for stenosis and 25% for spondylolisthesis. **Conclusion:** The overall revision rate was comparable to previously published Canadian data. Patient expectations could be managed given the trends in revision rates based on pathology/surgery type. The difference noted in surgery type warrants further investigation, matching patients based on symptoms and severity to control for those effects in determining surgical type.

0098

Spine surgery *a mari usque ad mare*: preoperative patient metrics across Canada. *Jonathan Bourget-Murray[1], Godefroy Hardy St-Pierre[1,2], Michael Yang[1], John Hurlbert[3]*. From the [1]University of Calgary, Calgary, Alta.; [2]Western University, London, Ont.; and [3]University of Arizona, Tucson, Ariz.

Background: The Canadian Spine Outcomes and Research Network (CSORN) is the spine registry of the Canadian Spine Society. For the first time, we use this powerful tool to directly compare preoperative characteristics in patients undergoing thoracolumbar procedures among 5 surgical centres across the country: Vancouver, BC; Calgary, Alta.; Edmonton, Alta.; Toronto, Ont.; and Saint John, NB. Patients were not stratified according to procedure performed. **Methods:** We extracted data from the main CSORN database concerning preoperative

metrics. Those 32 variables included patient characteristics (age, body mass index [BMI], smoking status, etc.), comorbidities (medical, psychiatric, type of medications, prior spine operation, etc.) and functional indicators (visual analogue scale [VAS] for leg pain, VAS for back pain, 12-Item Short-Form Survey [SF12], EQ-5D, Patient Health Questionnaire [PHQ9] and Oswestry Disability Index [ODI]). Analysis of variance was used for preliminary analysis, followed by multinomial logistic regression. **Results:** There was a total of 1534 patients across the 5 centres. Average age ranged from 37 years in Edmonton to 50 years in Vancouver. Average BMI ranged from 26.4 in Edmonton to 29.9 in Saint John. Average VAS leg score ranged from 6.93 in Toronto to 7.71 in Calgary. Average VAS back score ranged from 6.12 in Toronto to 7.08 in Saint John. Average ODI ranged from 43 in Toronto to 51 in Edmonton. Univariate analysis revealed significantly older age in Vancouver ($p < 0.001$), higher BMI in Saint John ($p = 0.004$), lower VAS leg score and VAS back score in Toronto ($p = 0.04$ for both) and lower ODI ($p = 0.03$) in Toronto. There were no significant differences among other variables. The multivariate analysis found no statistically significant difference across centres. **Conclusion:** Remarkable homogeneity in preoperative patient characteristics exists among surgical centres across Canada despite varying surgical caseloads, procedures of choice and focus or lack thereof on academic pursuits. Canada's universal health care system might partially explain this intriguing finding. The consistency of patient populations across centres bodes well for the strength and reproducibility of findings from the CSORN registry.

0102

Long-term surgical relief of back pain — minimum 5-year follow-up outcomes of lumbar TDR. ***Jonathan Bourget-Murray[1], Godefroy Hardy St-Pierre[2], Kevin Gurr[2], Jacques Bouchard[1]*. From the [1]University of Calgary, Calgary, Alta.; and [2]Western University, London, Ont.**

Background: Modern lumbar total disk replacement (TDR) has been used in clinical practice for more than 20 years, but limited clinical data on results in North America exist outside of the large U.S. Food and Drug Administration (FDA) investigational device exemption (IDE) studies. Critics also point out that few published studies confirm benefits beyond 2 years. We elected to examine long-term results of lumbar TDR by comparing 2 data sets in Calgary and London. **Methods:** All patients had a single level lumbar TDR with at least 5 years of follow-up by a single surgeon in Calgary or London. We prospectively collected 23 variables (demographics and clinical characteristics). We analyzed 1 primary end point: a composite indicator of clinical outcomes, complications and reoperation. Secondary end points included visual analogue scale (VAS) for leg and back pain and Oswestery Disability Index (ODI) scores. We conducted multivariate analysis via logistical regression. The 2 data sets were compared for clinical variables and outcomes via *t* test. **Results:** We had 79 patients to review in Calgary; 57% had excellent results, defined as greater than 50% improvement in both VAS and ODI scores as well as no complications and no reoperation. We compared these results to those of 61 patients in London; 59% had excellent results. Average follow-up was 8.3 years in Calgary and 8.7 years in London. The reoperation rate was 1%. The best convergent model (pseudoR^2 0.60) revealed 2 variables associated with prediction of an excellent outcome: clinical pain duration (odds ratio [OR] 2.39, $p = 0.01$) and narcotic use (OR 0.01, $p = 0.05$). At final follow-up, average VAS back pain scores were 3.05 and 3.00, VAS leg pain scores were 1.79 and 2.67 and ODI scores were 21.3 and 18.7 in Calgary and London, respectively. Those outcomes and the clinical variables were not significantly different between locations. **Conclusion:** Success rates comparable to the large FDA IDE studies are achievable in clinical practice. In strictly selected patients, lumbar TDR provides surgical relief of back pain in the long term on a sustained basis.

0113

Determining spine surgeon supply and demand in Canada. ***Ginette Thibault-Halman[1], Nelofar Kureshi[1], Hamilton Hall[2], Sean Barry[1], Jacob Alant[1], Andrew Glennie[1], William Oxner[1], Sean Christie[1]*. From [1]Dalhousie University, Halifax, NS; and [2]University of Toronto, Toronto, Ont.**

Background: There has been a trend over the past few years for government to have a greater influence on physician manpower resources. We previously conducted a survey of the membership of the Canadian Orthopaedic Association, Canadian Neurosurgical Society and the Canadian Spine Society in 2012–13 to develop an understanding of the number of spine surgeons providing clinical care as well as their distribution across the country. The purpose of the present study was to confirm the survey results using national and institutional databases. **Methods:** The number of spine procedures (cases and interventions) in 2012–13 was obtained from the Canadian Institute of Health Information (CIHI) by province and specialty (orthopedics and neurosurgery). The volume of spine surgery by province was calculated based on population estimates provided by Statistics Canada. Operating room data from the Queen Elizabeth II (QEII) Health Sciences Centre were used to corroborate the proportion of spine surgeries for Nova Scotia respondents. **Results:** Our initial survey reported that 42% of spine surgeons were orthopedic surgeons and 58% of were neurosurgeons. The survey median was 4 full-time spine surgeons per million population, which was less than half of the American recommendation. Operating room data from Nova Scotia's tertiary care facility confirmed that 46% of orthopedic surgeons and 54% of neurosurgeons were providers of spine surgical services in the province. However, according to CIHI, only 37% (259 of 698) of spine surgeries were performed by orthopedic surgeons in Nova Scotia. **Conclusion:** There is significant variation in data collected from physician surveys and national databases, making it challenging to estimate the actual number of spine surgery providers. With a growing population of seniors, the need for spine surgery is predicted to increase. This demographic shift underlies the importance of quantifying the supply and demand of spine surgeons in Canadian provinces. Our next phase will quantify the need for spine surgeons in Nova Scotia and Canada using a demand model, incorporating elements of population size, spine cases, and proportion of spine surgeons' workload.

0118

Supine MRI versus standing radiograph regarding cervical spine sagittal alignment in patients with cervical spondylotic myelopathy. ***Catherine Boudreau[1], Jessica Ruel-Laliberté[1], Sylvine Cottin-Carrondo[1,2], Nicholas Gélinas-Phaneuf[1,2], David Mercier[1,2], Jérôme Paquet[1,2]*. From**

[1]Université Laval, Québec, Que.; and [1]CHU de Québec L'Enfant-Jesus Hospital, Québec, Que.

Background: Selecting the most appropriate surgical approach for patients with cervical spondylotic myelopathy (CSM) requires a thorough analysis of sagittal cervical alignment. The effects of supine MRI positioning on cervical sagittal alignment have not been consistently documented. The aim of this study was to compare preoperative cervical sagittal alignment parameters measured with both plain standing radiographs and supine MRI in a CSM population. **Methods:** Consecutive patients with CSM were retrospectively extracted from a surgical database. Preoperative standing lateral cervical radiographs and supine cervical MRIs were analyzed using a software measurement program. Cervical lordosis was assessed on both radiographs and MRI using the Cobb and posterior tangent methods of Jackson and Harrison. Correlations between radiographic and MRI measurements were determined using Pearson correlation coefficients. Intra- and interobserver reliability were assessed using intraclass correlation coefficients (ICC) for continuous variables and κ values for categorical variables. Paired t tests were performed to compare MRI and radiograph-measured angles. A McNemar test was performed to evaluate lordosis detection according to the image techniques. **Results:** A total of 105 patients with CSM were reviewed. Correlations of cervical lordosis measures between radiographs and MRI were strong using the Cobb (0.648) and Jackson (0.617) methods and moderate using the Harrison (0.433) method. Mean cervical lordosis angle was significantly lower on MRI than on standing radiograph for all methods (Cobb: 11.32 v. 7.81; Jackson: 13.82 v. 9.86; Harrison: 25.44 v. 13.62 on radiograph v. MRI, respectively). A significantly higher rate of lordosis was detected using standing radiographs than with supine MRI using the Cobb method; 18 patients (18.6%) without lordosis on supine MRI were revealed to have lordosis on standing radiographs. **Conclusion:** Plain standing cervical radiographs seemed to be better than supine cervical MRI for appreciating cervical sagittal alignment using all lordosis measuring methods, as a substantial proportion of patients had discrepancies in their sagittal alignment between the 2 exams. Plain standing radiographs of the cervical spine should still be included in the surgical planning of CSM patients.

0048

Predictors of blood transfusion in posterior lumbar spinal fusion: a Canadian Spine Outcomes and Research Network (CSORN) study. ***Mina Morcos[1], Fan Jiang[1], Greg McIntosh[2], Michael Weber[1]*. From [1]McGill University, Montreal, Que.; and [2]Canadian Spine Society, Toronto, Ont.**

Background: The rate of posterior lumbar spinal fusion (PSF) surgery has increased significantly over the past few years. It remains the most common surgical procedure used to stabilize the spine for a variety of spinal pathologies; however, the impact of blood loss requiring blood transfusions remains a significant concern in this population. The purpose of this study was to identify patient-related, disease-related or procedure-related predictors of postoperative blood transfusions. **Methods:** We performed an ambispective analysis of data from the Canadian Spine Outcomes and Research Network (CSORN). Patients who underwent PSF between 2008 and 2015 were identified. Multivariate analysis was used to identify predictors of blood transfusion from routinely collected patient information, including both preoperative and intraoperative items. **Results:** Of the 772 patients identified to have undergone PSF, 18% required blood transfusion. Overall, there were 54.8% women, and the mean age was 60 years. Multivariable logistic regression analysis revealed 5 significant predictors of blood transfusion: American Society of Anesthesiologists (ASA) class, duration of surgery, number of level fused, sacral involvement and open posterior approach. The odds of transfusion for those with ASA class greater than 1 were 6 times the odds for those with ASA class 1 (OR 6.1, 95% CI 1.4–27.1, $p < 0.018$). For each 60-minute increase in duration of surgery, the odds of transfusion increased by 4.2% (OR 1.007, 95% CI 1.004–1.009, $p < 0.001$). The odds of transfusion were 6 times higher for multilevel fusion (OR 5.8, 95% CI 2.6–13.2, $p < 0.001$). Extending fusion to the sacrum showed 3 times higher odds for blood transfusion (OR 3.2, 95% CI 1.8–5.8, $p < 0.001$). Finally, the odds of transfusion for patients undergoing an open posterior approach were 12 times the odds for those who had minimally invasive surgery (OR 12.5, 95% CI 1.6–97.4, $p < 0.016$). In addition, patients receiving transfusions who underwent lumbar fusion were more likely to have an extended hospital stay. **Conclusion:** ASA class higher than 1, prolonged duration of surgery, multilevel fusion surgery, sacral involvement and open posterior approach were significant predictors of blood transfusion in patients undergoing PSF.

0004

Association of preoperative hyponatremia with morbidity and mortality in patients undergoing spine surgery. ***Nizar AlGarni, Yousef Marwan, Anas Nooh, Abdullah Addar, Rakan Bokhari, Carlo Santaguida, Michael Weber*. From McGill University Health Centre, Montreal, Que.**

Background: The purpose of this study was to study the association of preoperative hyponatremia with postoperative adverse events in patients undergoing spinal surgery. **Methods:** We performed a retrospective search of the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) database of all patients who underwent spinal surgery between 2011 and 2013. Patients were divided into 2 groups based on their serum sodium level, which was obtained within 90 days from the date of surgery: hyponatremia group (sodium level < 135 meq/L) and normonatremia group (normal sodium level). The 2 groups were then compared in terms of major and minor adverse surgical events in addition to hospital stay, reoperation rate and readmission. Pearson χ^2 and Student t tests were used to assess the association between patients' characteristics and sodium levels as required. Furthermore, multivariate logistic regression was conducted to compare the occurrence of complications between normonatremic and hyponatremic patients. A result of $p < 0.05$ was considered the cut-off level of statistical significance. **Results:** A total of 58 049 patients were included, of whom 55 012 (94.8%) were normonatremic and 3037 (5.2%) were hyponatremic preoperatively. When all comorbidities were controlled for, preoperative hyponatremia was associated with increased overall postoperative adverse events (odds ratio [OR] 1.22, $p < 0.001$, 95% CI 1.10–1.40) and a higher rate of minor complications (OR 1.22, $p = 0.005$, 95%CI 1.10–1.40), but not major complications. Specifically, these patients had an increased

rate of urinary tract infections (OR 1.60, $p = 0.001$, 95% CI 1.20–2.11), were more likely to require a blood transfusion (OR 1.23, $p = 0.008$, 95% CI 1.10–1.43) and more likely to have a prolonged hospital stay of more than 6 days (OR 1.52, $p < 0.001$, 95% CI 1.33–1.75). **Conclusion:** This study finds an association between preoperative hyponatremia and postoperative adverse events in patients undergoing spinal surgeries. This suggests a role for routine sodium measurement preoperatively, even in low-risk cases, and warrants further study to assess if its correction leads to cost savings and improved outcomes.

0028

Perioperative and intraoperative predictors of ICU length of stay in patients undergoing long fusion spinal surgery. ***Aaron Gazendam, Jennifer Cape, So Kato, Stephen Lewis.* From the University Health Network, Toronto, Ont.**

Background: The purpose of this study is to review the intraoperative and perioperative factors that may impact the clinical outcomes of patients undergoing multilevel spinal instrumentation procedures who were admitted to the intensive care unit (ICU). It is hypothesized that positive operative and ICU fluid balance are associated with increased ICU length of stay (LOS). **Methods:** The records of 102 consecutive patients who underwent elective spinal fusion and were admitted to the ICU were retrospectively reviewed. Demographic, intraoperative and perioperative data were collected. Postoperative fluid balance was calculated following day 1 and day 2 in the ICU. Intraoperative and postoperative complications were recorded. Patients were stratified based on ICU LOS. The short stay group (SS) consisted of patients with an ICU LOS less than 3 days. The long stay (LS) group consisted of patients with an ICU LOS of 3 or more days. Statistical tests were performed to determine factors that contribute to ICU LOS. **Results:** The cumulative ICU fluid balance (median, 25th–75th percentile) on day 2 in the ICU was significantly greater in the LS group than the SS group (4.0 L, range 2.0–6.7 L v. 2.3 L, range 0.4–4.0 L, $p = 0.006$). The frequency of pleural tears was significantly greater in the LS group than the SS group (19.3% v. 4.8%, $p = 0.03$). There was no difference in demographics, anesthetic time, intraoperative fluid balance, osteotomies, blood loss or opioid use between groups. Multivariate analysis demonstrated that cumulative ICU fluid balance on day 2 and pleural tears were both independent predictors of ICU LOS (adjusted OR 1.27, 95% CI 1.081–1.482 and 5.73, 95% CI 1.081–30.327, respectively). **Conclusion:** A better understanding of the perioperative factors that affect ICU LOS following spinal surgery is critical in achieving optimal patient care. This study shows that the postoperative day 2 cumulative ICU fluid balance and the need for postoperative chest tubes are independent predictors of increased ICU LOS following major spinal reconstructions that require postoperative ICU care. Alternatives to fluid should be considered when attempting to maintain a target mean arterial pressure to protect spinal cord perfusion in the early postoperative period. The introduction of evidence-based postoperative fluid balance and administration guidelines may improve clinical practice.

0071

Effect of smoking on clinical outcomes for postoperative back pain patients completing rehabilitation. ***Greg McIntosh[1], Chris Gregg[2], Hamilton Hall[1], Chris Hoffman[2], Tom Carter[1]*. From the [1]CBI Health Group, Toronto, Ont.; and [2]TBI Health, Wellington, New Zealand.**

Background: The purpose of this study was to compare clinical outcomes based on smoking status of those with a recent history of lumbar spine surgery ($n = 1017$) completing postoperative rehabilitation. **Methods:** This retrospective study of prospectively collected low back pain (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. **Results:** There were 395 cases from New Zealand and 622 from Canada. Of the total cohort, 518 (51%) were smokers. At baseline, smokers had significantly higher numeric pain ratings, higher rates of general practitioner visits and lower perceived function (assessed by a modified version of the Low Back Outcome Score, $p < 0.05$) than nonsmokers. Adjusting for baseline differences, postsurgical smokers had significantly less functional improvement after rehabilitation than the nonsmokers ($p < 0.001$), but achieved similar levels of improvement in pain and similar return to work rates. **Conclusion:** LBP patients with a history of smoking had pain and return to work outcomes postoperatively that were comparable to those of nonsmokers, but failed to reach similar levels of functional improvement.

0036

Prophylaxis of surgical site infection in adult spine surgery: a systematic review. ***Reina Yao[1], Terence Tan[2], Jin Wee Tee[3,4], John Street[1]*. From the [1]University of British Columbia, Vancouver, BC; [2]St. Vincent's Hospital, Melbourne, Australia; [3]The Alfred Hospital, Melbourne, Australia; and [4]National Trauma Research Institute, Melbourne, Australia.**

Background: Surgical site infection (SSI) after spine surgery is reported at rates varying from 0.7% to 16%. While numerous prophylactic strategies have been presented in the literature, levels of evidence vary. Our objectives were to identify all strategies studied for prophylaxis of SSI in adult spine surgery and to systematically review and evaluate the evidence. **Methods:** Two concurrent independent systematic searches were conducted, 1 each in Canada and Australia, encompassing PubMed, ClinicalTrials.gov, the Cochrane Database of Systematic Reviews, EBSCO Medline, ScienceDirect, Ovid Medline, EMBASE (Ovid), and MEDLINE. All references were combined and screened by all authors, then distilled down to 69 independent studies included for our review. **Results:** Eleven randomized controlled trials (RCTs), 51 case–control studies (CCS) and 7 case series were identified. Wide variation exists in surgical indications, approaches, procedures and even definitions of SSI. Intrawound vancomycin powder was the most widely studied intervention (19 studies, although only 1 RCT). Multiple studies examined perioperative antibiotic protocols, closed-suction drainage, povidone-iodine solution irrigation, and 2-octyl-cyanoacrylate skin closure. Eighteen interventions were examined by only a single study each. Despite numerous studies, there is limited evidence for the efficacy of intrawound vancomycin. There is strong evidence that use of closed-suction drainage does not affect SSI rates, whereas there is moderate evidence for the efficacy of povidone-iodine irrigation and that single-dose preoperative antibiotic is as effective as multiple doses. There is limited evidence for the efficacy of 2-octyl-cyanoacrylate. Few conclusions can be

drawn about other interventions given the paucity and poor quality of studies. **Conclusion:** Although a small body of evidence underscores a select few interventions for SSI prophylaxis in adult spine surgery, most proposed measures have not been investigated beyond a single study. Further high-quality research is needed to appraise their potential value. Despite extensive reports on intrawound vancomycin, questions remain about its efficacy, requiring at least 1 further RCT.

0046

Design-based comparison of spine simulation models: optimizing educational features of surgical simulators. ***Won Hyung A. Ryu[1], Ahmed E. Mostafa[1], Navjit Dharampal[1], Ehud Sharlin[1], Gail Kopp[1], W. Bradley Jacobs[1], R. John Hurlbert[2], Sonny Chan[1], Garnette R. Sutherland[1].*** **From the [1]University of Calgary, Calgary, Alta.; and [2]University of Arizona, Tucson, Ariz.**

Background: Simulation-based teaching has progressively become an important component of surgical residency training, particularly as an adjunct to hands-on clinical experience. Although the theoretical benefit of these supplemental educational models has been recognized, one of the ongoing challenges to wide adoption is the capacity of the simulators to incorporate educational features required for effective learning. The aim of this study was to identify strengths and limitations of current spine simulators to characterize design elements that are essential in enhancing supplemental educational models. **Methods:** We performed a prospective cohort study with a focused survey and interviews of stakeholders in spine surgery pertaining to their experiences using 3 spinal surgery simulators (2 computer simulators and 1 synthetic model). Ten participants were recruited from the University of Calgary spine program spanning all levels of training and clinical expertise. Participants were asked to perform lumbar pedicle screw insertion on each of the simulators. After completion of the specified task, a 10-question user survey was collected, and a focused interview was conducted to explore topics pertaining to the educational design features of the simulators. **Results:** Overall impressions of the simulators were positive with regards to their educational benefit, but for different reasons. Main design strengths of the computer-based spine simulators were incorporation of procedural guidance and provision of performance feedback. Conversely, the synthetic model excelled in achieving more realistic haptic feedback and incorporating use of actual surgical tools. Based on the stakeholder interviews, the most important design elements for simulator-based education are the incorporation of deliberate practice with varying difficulty levels and the provision of directly transferrable performance feedback. **Conclusion:** Most stakeholders, from trainees to expert surgeons, acknowledged the growing role of simulation-based education in resident training. However, different simulation modalities (computer simulators v. synthetic models) have varying design elements that augment effective learning in distinct ways. Characterizing these design strengths and limitations may allow evidence-based creation of surgical simulation curriculum for resident education with maximal buy-in and knowledge translation.

0047

Use of incisional vacuum-assisted closure in the prevention of postoperative infection in spinal surgery. ***Bailey Dyck[1,2], Chris Bailey[1,2], Chris Styne[2], Julia Petrakis[1,2], Parham Rasoulinejad[1,2].*** **From the [1]Orthopaedic and Neurosurgical Spine Program, London Health Sciences Centre and Lawson Health Research Institute, London, Ont.; and [2]Schulich School of Medicine and Dentistry, Western University, London, Ont.**

Background: Surgical site infection (SSI) in spinal surgery has an incidence of up to 20%, and is associated with significant morbidity, prolonged antibiotic use, and increased length of hospital stay (LOS). Negative pressure wound therapy (NPWT) has been shown to decrease SSI when prophylactically applied to surgical incisions. This study aimed to explore the difference in the incidence of SSI in high-risk spinal surgery patients treated with NPWT through the use of incisional vacuum-assisted closure (VAC) compared with standard wound closure. **Methods:** The study used a retrospective case–control design and was conducted at a large university tertiary hospital. Sixty-four patients (21 VAC and 43 controls) who underwent open posterior spinal surgery between 2012 and 2014 were included. Patients who underwent conventional wound closure with standard postoperative wound dressing made up the control group. Data were compared with 21 patients identified as high-risk based on location and nature of surgery as well as associated comorbid conditions (body mass index of 35 or higher, diabetic, previous radiation at surgical site, chemotherapy, or immunocompromised state) who underwent standard wound closure followed by VAC application. The primary outcome was SSI. Comparison of baseline demographics, intraoperative parameters and postoperative wound infection rate was performed. **Results:** Patient demographics were similar with the exception that VAC-treated patients underwent significantly longer surgeries and required significantly more postoperative intensive care unit admissions. Median LOS did not differ between groups. In total, 9 control patients (21%) developed an SSI versus 2 VAC-treated patients (10%, $p = 0.314$). **Conclusion:** NPWT application in high-risk spinal surgery patients resulted in a 50% reduction in SSI. Owing to small sample sizes, this result was nonsignificant. No adverse effects were noted secondary to VAC application. These preliminary data strongly support a role for prophylactic NPWT in spinal surgery, with further research required. The results of this pilot study support the need for a prospective randomized trial.

0070

A modified technique of paraspinal muscle flaps for complex dural tears performed by the spine surgeon. ***Marie-Laurence Monast, Zhi Wang, Daniel Shedid, Dominique Dussault, Ghassan Boubez.*** **From the Centre Hospitalier de l'Université de Montréal, Montreal, Que.**

Background: The purpose of this study was to evaluate the efficacy of the spine surgeon's management of complex dural tears (CDT) with paraspinal muscle flaps for wound closure in a primary or secondary intention. The senior author used a modified technique: shorter drainage duration, smaller size of drains. Otherwise, the classic dissection and "vest-over-pants" closure were performed in the case of each patient studied. **Methods:** This is a retrospective clinical study. The records of 29 patients with incidental CDT managed by the senior author with the modified paraspinal muscle flaps technique for the period January

2010 to August 2016 were reviewed. We defined a complex tear if 1 of the following conditions were met: revision surgery, multiple tears, extensive tear (> 3 cm) and a tear close to or at the nerve root origin. The spine surgeon performed the modified paraspinal muscle flap technique after attempting primary closure. This technique was modified from the original vest-over-pants technique described by the plastic surgeon by using shorter drainage duration and smaller drains. **Results:** For the 29 patients with CDT managed using the modified paraspinal muscle flaps technique, the average time of drainage was 4.9 days. The average time of bed rest was 3.4 days. In all cases, no reoperation was needed for cerebrospinal fluid leak. One infection (3.4%) occurred that needed surgical drainage. Thirteen patients (45%) experienced a postoperative seroma, 12 of whom needed 1 or more percutaneous drainages. None of the patients needed additional surgical procedures for pseudomeningocele. **Conclusion:** This modified technique of paraspinal muscle flaps for CDT allows effective prevention and treatment of cerebrospinal fluid fistulas, with a low infection rate similar to that reported in spine surgery series. This study suggests paraspinal muscle flaps should be considered whenever a CDT is encountered. The paraspinal muscle flap can be performed successfully by the plastic surgeon as well by the trained spine surgeon.

0123

Modalities to control blood loss during spine surgery: a systematic review of the literature. ***Étienne Bourassa-Moreau*[1,2], *Michael Sunmin Kim*[3], *John Street*[2]. From the [1]Department of Orthopedic Surgery, Université de Montréal, Montreal, Que.; [2]Combined Spine Program, University of British Columbia, Vancouver, BC; and [3]Schulich School of Medicine and Dentistry, Western University, London, Ont.**

Background: To safely perform complex spine procedures, the surgeon has to maintain adequate hemostasis. Increasing blood loss is associated with inadequate oxygenation of organs and spinal epidural hematoma and necessitates allogeneic blood transfusion. To limit blood loss, many adjuncts to surgical skills exist, including topical, intravenous, electrical and transfusion strategies. We aimed to systematically review the literature, searching for evidence supporting intraoperative modalities to limit blood loss. **Methods:** English literature from 1970 to 2015 was reviewed using PubMed and Medline databases. All studies with a focus on therapeutic modalities to limit intraoperative blood loss during adult spine surgery were included. Randomized or nonrandomized comparative studies in adults with intraoperative blood loss, allogeneic transfusion or postoperative hemoglobin as outcomes were identified. We excluded studies without explicit methodology. Two assessors independently reviewed the quality of the studies using a standardized study quality checklist. **Results:** In total, 210 articles were retrieved and 71 were included in our review. There is limited evidence to support the use of cell saver, hemodilution, thrombin-soaked gelatin, aprotinin and topical tranexamic acid. Some quality evidence was available to support magnesium sulfate (MgSO4; 1 small randomized controlled trial [RCT]), patient positioning (1 small RCT) and recombinant activated factor VII (1 small RCT). Some high-quality evidence supports the safe use of epoetin α (1 RCT). High-quality evidence supports the use of tranexamic acid (4 RCTs), gelatin-based hemostatic sealant (1 RCT), epsilon aminocaproic acid (2 RCTs) and bipolar tissue sealant (1 RCT). **Conclusion:** Blood loss during spine surgery is multifactorial and influenced by the underlying pathology, the invasiveness of the surgery and the associated comorbidities. Clinical studies support a variety of intraoperative modalities to help maintain hemostasis during surgery.

0112

Frailty index in spinal cord injury patients: an indicator that may change surgical management strategy. ***Mustafa Nadi*, *Nelofar Kureshi*, *Ginette Thibault-Halman*, *Sean Barry*, *Jacob Alant*, *Andrew Glennie*, *William Oxner*, *Kenneth Rockwood*, *Sean Christie*. From Dalhousie University, Halifax, NS.**

Background: The assessment of frailty may be an important determinant in the appropriate management of older spinal cord injury (SCI) patients. A series of standard laboratory values and clinical data has been previously used to determine a frailty index (FI-LABORATORY), which has been linked to clinical outcomes in the elderly. We sought to investigate whether the FI-LABORATORY was associated with in-hospital mortality in SCI patients. **Methods:** Local site data from the Rick Hansen Spinal Cord Registry were reviewed for the period 2008–2016 for patients older than 60 years with SCIs seen at the Queen Elizabeth II Health Sciences Centre in Halifax, NS. The FI-LABORATORY was calculated from 21 routine blood tests as well as systolic and diastolic blood pressure measurements. Patients were categorized by FI-LABORATORY as low (< 0.10), low–intermediate (0.11–0.23), intermediate–high (0.23–0.45) and high (> 0.45). The primary outcome was in-hospital mortality. Demographic and clinical characteristics were expressed as percentages or as means ± standard deviations. **Results:** Seventy-one medical charts were reviewed, 42 of which (59%) had 65% or more of laboratory variables available and were analyzed. The mean age of patients was 72.7 ± 7.9 years, and 74% were men. In total, 60% of patients had intermediate–high (0.23–0.45) FI-LABORATORY and 36% had high (> 0.45) FI-LABORATORY values. The mean age of patients in the most frail group was significantly different from the mean age of patients in the intermediate–high group (76.1 ± 7.5 years v. 70.4 ± 7.5 years, p = 0.03). In-hospital mortality was 20% in the most frail group compared with 8% in the intermediate–high group (p = 0.35). **Conclusion:** The FI-LABORATORY can be used to identify and stratify frail patients following SCI and is associated with increased in-hospital mortality. This result may be useful in informing patients or their families on the appropriateness of surgical intervention following SCI in elderly patients or when palliative treatment may be a reasonable option.

C1

Implementation of a patient triage and prioritization system for a pediatric spine clinic. ***Marie Beausejour*[1,2,3], *Kelly Thorstad*[1], *Sharon Brissette*[1], *Marie-Annie Lagacé*[1], *Rita Yap*[1], *Neil Saran*[1], *Astrid Brousselle*[2], *Mylaine Breton*[2], *Michael Eshiemokhai*[2], *Jean Ouellet*[1]. From the [1]Shriners Hospital for Children, Montreal, Que.; [2]Research Centre, Hôpital Charles-Le Moyne, Montreal, Que.; and [3]CHU Sainte-Justine, Montreal, Que.**

Background: Management of referrals in spine clinics of young patients with suspected scoliosis or related disorders are

suboptimal, and waiting times are too long. The objective of the study is to implement a model based on expert consensus and literature on best practices for triage and prioritization of patients in spine clinics. **Methods:** This project included 1) identification of key components for triage and prioritization intervention success from the literature, 2) elaboration of a health care delivery model with the professionals of the local pediatric spine clinic, and 3) implementation and testing of the best consensual model derived from best evidence and local context requirements. **Results:** The model relies on 7 key components: centralized review of referral requests, list of consensual objective criteria for triage, fast track evaluation of urgent cases, management at point of triage, case prioritization to main consultant, multidisciplinary evaluation and alternative pathways. The triage and prioritization algorithm showed an excellent interrater agreement (92.4% and 98.2% after refinements to include comorbidities) as well as a very good discriminant capacity. We concluded on the acceptability, compatibility and clinical relevance of the new model. In a 10-month testing period, more than 400 patients were triaged and prioritized using the new system, with referral letters and appointment allocation managed in real time. In total, 18%, 19% and 9% of patients, respectively, were referred for PI, PII and PIII orthopedic surgeon assessment; 23% were oriented to the triage clinic; 10% to physical therapy assessment; 5% to general orthopedics; and 16% to the early onset scoliosis clinic. Up to 15 more new patients are seen per month in the clinic, and 100% of patients are now seen within wait time targets. **Conclusion:** The model was harmoniously implemented in routine care. It improves management of referral letters and more timely and appropriate access to care.

C2

Segmental derotation versus en bloc derotation versus no direct derotation in adolescent idiopathic scoliosis: Is there a difference in terms of 3D correction? ***Laure Boyer[1,2], Stephan Parent[2], Lawrence G. Lenke[3], Carl-Eric Aubin[1,2].***

From the [1]École Polytechnique de Montréal, Montreal, Que.; [2]CHU Sainte-Justine, Montreal, Que.; and [3]Washington University School of Medicine, St. Louis, Mo.

Background: Various modern surgical techniques intend to address the scoliotic deformities in 3D. Concerns about the lordogenic effect of vertebral derotation techniques on sagittal curvatures have been raised. The ability of the different manipulations to achieve adequate 3D correction remains to be investigated. Our objective was to compare the 3D correction obtained by segmental (local) derotation, en bloc (regional) derotation and no direct derotation in adolescent idiopathic scoliosis (AIS) surgery. **Methods:** We reviewed 31 AIS cases operated with a segmental derotation technique, 25 with an en bloc derotation technique and 21 with a no direct derotation technique. 3D reconstruction of the spine was performed pre- and postoperatively, and 3D correction indices were statistically compared among the groups. Association between transverse plane deformity and thoracic restoration was assessed. **Results:** There was no preoperative difference in initial 3D deformities and in main thoracic Cobb angle correction (mean 72% ± 12%). A statistical difference of apical vertebral rotation and intervertebral rotation correction was found between the segmental technique and the 2 others: AVR was decreased by 53% ± 24%, 36% ± 16% and 38% ± 23% and intervertebral rotation by 50% ± 16%, 38% ± 18% and 31% ± 21% with segmental derotation, en bloc derotation and no direct derotation, respectively. The average T4–T12 radiographic kyphosis was maintained in both segmental and en bloc derotation groups, and decreased by 7° in the no direct derotation group. Increase of transverse plane correction was not associated with a loss of kyphosis between preoperative and postoperative states. **Conclusion:** A significant reduction of the coronal and transverse plane deformity of the thoracic curve was achieved with the different local and global manipulation techniques. The individual manipulation of each vertebra with the segmental technique induced a more local transverse plane correction. Correction of the transverse plane was not at the expense of thoracic kyphosis restoration, as it was normalized with en bloc and segmental techniques.

C3

Spinopelvic parameters predict development of proximal junctional kyphosis in early-onset scoliosis. ***Ozren Kubat, Virginie Lafage, Jennifer Hurry, Alexandra Soroceanu, Frank Schwab, David L. Skaggs, Ron El-Hawary.***

From the IWK Health Centre, Children's Spine and Growing Spine Study Groups, Halifax, NS.

Background: Proximal junctional kyphosis (PJK) is diagnosed radiographically using the proximal junctional angle (PJA) and clinically with the requirement for proximal extension of the upper instrumented vertebrae (UIV) during revision surgery. Our hypothesis was that abnormal spinopelvic alignment will increase the risk of developing PJK in children with early-onset scoliosis (EOS). **Methods:** We performed a retrospective cohort study of children treated with distraction-based implants from 2 EOS registries (minimum 2-year follow-up). Sagittal radiographs were analyzed to measure spinopelvic parameters and PJA (angle between caudal end plate of the UIV to the cephalad end plate 2 vertebrae above UIV). Risk ratios were calculated and analyzed using χ^2 tests. **Results:** In total, 135 children with EOS who were treated with distraction surgery and had a follow-up longer than 2 years were identified. Etiologies included 54 congenital, 10 neuromuscular, 37 syndromic, 32 idiopathic and 2 unknown. Eighty-nine rib-based and 46 spine-based implant surgeries were performed in patients with a mean age of 5.2 years, scoliosis 71°, kyphosis (TK) 39°, lumbar lordosis (LL) 52°, pelvic incidence (PI) 49° and pelvic tilt (PT) 11°. Twenty-four children required revision surgery with proximal extension of UIV. Measures at final follow-up were scoliosis 56°, TK 42°, LL 55° and PT 13°. Patients with preoperative TK greater than 50° had a risk ratio of 1.67 (95% CI 0.98–2.83)* for final PJA greater than 10°. Increased preoperative LL, PI and PT did not increase the risk for final PJA greater than 10°. None of these preoperative parameters were associated with increased risk of revision surgery with proximal extension. Final PI–LL greater than 20° and PT greater than 30° were each associated with increased risk for revision surgery with proximal extension (risk ratios of 2.1* and 2.5*; *denotes statistical significance. **Conclusion:** For patients undergoing growth-friendly surgery, preoperative hyperkyphosis increased the risk for postoperative PJK. Final postoperative PI–LL greater than 20° and final postoperative PT greater than 30° were each associated with increased risk for revision surgery with extension of UIV.

Preoperative thoracic kyphosis and postoperative spinopelvic parameters influence the development of PJK in children undergoing growth friendly surgery for EOS.

C4

Using ultrasonography to assist brace casting for adolescent idiopathic scoliosis. *Edmond Lou*[1,2], *Doug Hill*[1,2], *Andreas Donauer*[2], *Melissa Tilburn*[2], *Sarah Southon*[1,2], *Douglas Hedden*[1,2], *Marc Moreau*[1,2]. From the [1]University of Alberta, Edmonton, Alta.; and [2]Alberta Health Services, Edmonton, Alta.

Background: In standard practice, the first in-brace correction is measured during the first follow-up clinic, typically 6 weeks after the brace has been prescribed. Brace adjustments are attempted if there is unsatisfactory in-brace correction. This study was to compare the benefits of using real-time ultrasonography (US) to assist brace casting versus the standard brace design method. **Methods:** Thirty-four full-time thoracolumbosacral orthosis (TLSO) candidates who met Scoliosis Research Society (SRS) brace recommendation criteria were recruited; 17 in the intervention group (2 male, 15 female, major Cobb angle 35° ± 8°, mean age 12.9 ± 1.6 years) and 17 in the control group (2 male, 15 female, major Cobb angle 32° ± 9°, mean age 13.2 ± 1.4 years). For the intervention group, each patient first underwent a baseline US standing scan. A custom standing Providence brace design system with a pressure pad adjustment system provided real time feedback while orthotists were deciding on the brace pad locations and pressure levels. After the proposed pressure pad locations were set, the first US scan was taken. The simulated coronal in-brace Cobb measurement was displayed. The orthotist then decided if an adjustment was needed. Another US scan was taken if a second configuration was required. The orthotist used the best simulated in-brace correction configuration to cast the brace. **Results:** For the US group, only 1 patient (6%) required adjustment. The average in-brace correction at the first in-brace follow-up clinic was 46% ± 20%. For the standard brace design (control) group, 8 of 17 (47%) patients required brace adjustments. The average in-brace correction from the initial in-brace clinics was 40% ± 20%. There is a statistically significant difference (improvement) in using US to reduce the number of brace adjustments, but no significant difference for the in-brace correction. In addition, the reduction of the number of total in-brace radiographs was large: 18 in-brace radiographs from the US group versus 28 in-brace radiographs from the control group. **Conclusion:** The use of the US system provided a radiation-free method that was able to reduce the number of brace adjustments and corresponding radiographs.

C5

Using curve flexibility to predict in-brace correction for adolescent idiopathic scoliosis (AIS): a pilot study. *Edmond Lou*[1,2], *Doug Hill*[1,2], *Melissa Tilburn*[2], *Andreas Donauer*[2], *Sarah Southon*[1,2], *Douglas Hedden*[1,2], *Marc Moreau*. From the [1]University of Alberta, Edmonton Alta.; and [2]Alberta Health Services, Edmonton Alta.

Background: Brace treatment outcomes for adolescent idiopathic scoliosis (AIS) are associated with in-brace correction, which is affected by spinal flexibility. More flexible spines should be more correctable in a brace, which should lead to better long-term outcomes. A new ultrasound (US) imaging method to measure proxy Cobb angles on spinal images was developed. We extended this method to measure spinal flexibility to assist brace design. This pilot study aimed to study the association between spinal flexibility and in-brace correction during brace design for AIS. **Methods:** Ten female patients who met the Scoliosis Research Society (SRS) criteria for brace recommendation (major Cobb andgle 34° ± 5°, mean age 13.2 ± 1.4 years) were recruited. Prior to brace casting, 3 US scans were performed: relaxed standing and prone maximum left and right bending. Only the major curves were analyzed in this study. Spinal flexibility was calculated as (US standing Cobb angle – US bending Cobb angle) ÷ US standing Cobb angle × 100. The in-brace correction at the first follow-up clinic after the brace was made was calculated as (prebrace radiograph Cobb angle – in-brace radiograph Cobb andgle) ÷ prebrace radiograph Cobb angle × 100. **Results:** Curve flexibility and in-brace correction averaged 65% ± 18% (range 33%–89%) and 57% ± 25% (range 18%–92%), respectively. The average correction of the in-brace right thoracic (4 curves, 40%) was lower than the left thoracolumbar (6 curves, 61%). When the flexibility was 53% or higher, the in-brace correction was 40% or higher. Knowing the flexibility helped the orthotists and surgeons to aim for an achievable in-brace correction. This reduced the number of trial and error attempts in aiming for improved in-brace correction and hence reduced the number of in-brace radiographs. **Conclusion:** This study showed a non-ionizing radiation imaging method that was developed to estimate curve flexibility. Knowing the flexibility helps orthotists attain a realistic in–brace correction within patients' tolerance.

C6

A novel trunk shape analysis method to evaluate reducibility of trunk asymmetry in lateral bending. *Philippe Debanné*[1,2], *Ola Ahmad*[1,2], *Stefan Parent*[2], *Hubert Labelle*[2], *Farida Cheriet*[1,2]. From the [1]École Polytechnique de Montréal, Montreal, Que.; and [2]CHU Sainte-Justine, Montreal, Que.

Background: The lateral bending test is important for surgical planning and outcome prediction in the treatment of adolescent idiopathic scoliosis (AIS). However, radiographic bending tests are unable to predict the correction of external trunk asymmetry, even though the latter is the main concern for the patient. Our objective was to evaluate the changes in trunk shape between lateral bending and standing positions and to examine how those changes are related to the ones between the pre- and postoperative shapes. **Methods:** Our cohort comprised 14 AIS patients with right thoracic curvatures (Lenke 1A) operated at Sainte-Justine hospital between 2010 and 2012. Patients were scanned using a 3D surface topography system at their preoperative visit in a neutral standing position and in maximum voluntary left and right bending (BL and BR) as well as at their postoperative visit in a standing position. Using a novel representation of the trunk surface mesh, we extracted for each acquisition 100 cross-sections that follow the inclination of the trunk. We computed 2 cross-sectional indices: the trunk rotation (TR) and back surface rotation (BSR). We computed the differences in those indices a) between preoperative standing and each of the bending positions, and b) between standing preoperative and postoperative visits,

and we correlated the intrapatient differences measured in cases a and b. **Results:** For the intrapatient analysis of TR differences, 11 patients had significant correlations for BL and 12 for BR. For the BSR differences, 10 patients had significant correlations for BL and 10 for BR. **Conclusion:** These results give preliminary evidence that an association exists between changes in trunk asymmetry in side bending and the surgical correction of trunk shape. This could provide the basis for a surgical planning tool to help reduce residual shape asymmetry, complementary to existing practice. We will extend this study to a larger cohort and to different scoliotic curve types.

C7

Upper foundations implanted cephalad to upper end vertebrae of kyphosis decreases postoperative proximal junctional angle. ***Ron El-Hawary, Ozren Kubat, John A Heflin, Nadim Joukhadar, Mohamad S. Yasin, Anna M. McClung, Tara Flynn, David L. Skaggs.*** **From the IWK Health Centre, Children's Spine and Growing Spine Study Groups, Halifax, NS.**

Background: Proximal junctional kyphosis (PJK) is a complication of distraction-based treatment for early-onset scoliosis (EOS) and is diagnosed using sagittal plane measurements of the proximal junctional angle (PJA). Two common definitions of PJA include PJA-1 — the angle between the caudal end plate of the upper instrumented vertebrae (UIV) to the cephalad end plate 2 vertebrae above the UIV — and PJA-2 — measuring 2 levels below UIV to 2 levels above UIV. Our objective was to identify a potential risk factor for the development of PJK during the treatment of EOS. We hypothesize that the choice of UIV will affect PJA. The purpose of this study was to compare postoperative PJA in patients with UIV above, at the same level as, or below the upper end vertebrae of kyphosis (UEV). **Methods:** Children with more than 2 years follow-up treated with distraction-based implants from 2 EOS registries were evaluated. Sagittal radiographs were analyzed to measure PJA at final follow-up. Unpaired *t* tests were used to compare mean PJA measurements among 3 groups: those with the UIV above (group 1), at the same level as (group 2), or below (group 3) the UEV. **Results:** In total, 295 children with EOS who were treated with distraction surgery (mean age 5.8 years, Cobb angle 72°, and kyphosis 50° at implantation) were identified. Etiologies included 56 congenital, 77 neuromuscular, 82 syndromic, 40 idiopathic and 40 unknown. In total there were 164 rib-based and 131 spine-based anchors. Group 1 had 88 patients with a mean PJA1 of 5.5° and PJA2 of 14.2°. Group 2 had 62 patients with a mean PJA1 of 8.4° and PJA2 of 17.7°. Group 3 had 145 patients with a mean PJA1 of 8.0° and a mean PJA2 of 18.2°. The mean PJA1 of group 1 was significantly less than that of group 2 ($p = 0.02$), group 3 ($p = 0.03$) and groups 2 and 3 combined ($p = 0.01$). The mean PJA2 of group 1 was also significantly less than that of group 3 ($p = 0.04$) and of groups 2 and 3 combined ($p = 0.03$). Comparison of the PJA2 of groups 1 and 2 approached significance ($p = 0.08$). **Conclusion:** For patients undergoing growth-friendly surgery, those who had a UIV above the UEV had significantly lower PJAs than those who had a UIV at or below the UEV. This may decrease the risk of PJK after growth-friendly surgery; however, the clinical significance of this finding is currently being studied.

C8

Results of growth-friendly surgery versus casting for the treatment of EOS in patients with Prader–Willi syndrome. ***Jonathan Oore[1,2], Braydon Connell[1,2], Burt Yazcay[3], Amer Samdani[4], Tricia St. Hilaire[5], Tara Flynn[5], Ron El-Hawary[1,2]; Children's Spine Study Group[5]; Growing Spine Study Group[6].*** **From the [1]IWK Health Centre, Halifax, NS; [2]Dalhousie University, Halifax, NS; [3]Rady Children's Hospital, San Diego, Calif.; [4]Shriners Hospital for Children, Philadelphia, Pa.; [5]Children's Spine Study Group, Philadelphia, Pa.; and [6]Growing Spine Study Group, Milwaukee, Wis.**

Background: The purpose was to compare the results of casting to growth-friendly surgery (GFS) for children with early-onset scoliosis (EOS) secondary to Prader–Willi syndrome (PWS). **Methods:** PWS patients were identified from international multicentre EOS databases. Scoliosis, kyphosis, spine height (T1–S1), right and left hemithoracic heights and widths (R/L HT H/W) were measured pretreatment, postoperatively and at 2-year follow-up. Severity of complications (SV) were recorded. **Results:** Twenty-three patients with 2-year follow-up were identified. Pretreatment, casted patients ($n = 10$) were younger (mean age 1.8 years v. 5.8 years, $p < 0.001$), had lower body mass index (BMI; 16 v. 21, $p < 0.05$), less scoliosis (45° v. 76°, $p < 0.01$), similar kyphosis (56° v. 59°), similar T1–S1 (22.4 cm v. 24.1 cm), similar RHTH (8 cm v. 10 cm), similar LHTH (8.52 cm v. 10.6 cm), reduced RHTW (6.56 cm v. 9.4 cm, $p < 0.05$) and similar LHTW (8 cm v. 8.1 cm) compared with GFS patients ($n = 13$). At final follow-up (mean 1.9 ± 0.4 years v. 2.2 ± 0.2 years), scoliosis improved to 37° in the cast group ($p = 0.06$) and 42° in the GFS group ($p < 0.000001$). Scoliosis correctability was 13% in the cast group versus 46% in the GFS group ($p < 0.05$). Kyphosis did not change significantly. T1–S1 improved to 26.4 cm in the cast group ($p < 0.01$) and 31.5 cm in the GFS group ($p < 0.00001$). RHTH improved to 12 cm in the GFS group ($p < 0.01$). LHTH improved to 9.98 cm in the cast group ($p < 0.01$) and 2.0 cm in the GFS group ($p < 0.01$). RHTW improved to 7.43 cm in the cast group ($p < 0.01$). RHTH correctability was 6% in the cast group versus 31% in the GFS group ($p = 0.05$). LHTH, RHTW, and LHTW correctabilities were not significantly different between groups. Casted patients had 9 complications (4 device-related, 5 disease-related) and GFS had 28 complications (23 device-related, 5 disease-related). Complications per patient were 0.9 in the cast group versus 2.2 in the GFS group ($p < 0.01$). Patients with a BMI above 17 had more device-related complications ($p = 0.09$), and GFS patients older than 5 years of age had fewer complications than those aged 5 years or younger ($p < 0.05$). **Conclusion:** At 2-year follow-up, both treatments were effective in treating EOS in PWS patients. GFS patients had greater improvements in scoliosis, T1–S1 and RHTH, but a greater complication rate than casted patients.

C9

Growth-friendly surgery is effective at treating scoliosis associated with Goldenhar syndrome. ***Braydon Connell[1,2], Jonathan Oore[1,2], Ron El-Hawary[1,2], Joshua Pahys[3], George Thompson[3], Tricia St. Hilaire[4], Tara Flynn[4]; Children's Spine Study Group[4]; Growing Spine Study Group[5].*** **From [1]Dalhousie University, Halifax, NS; [2]IWK Health Centre, Halifax, NS; [3]Shriner's Hospital, Philadelphia, Pa., [4]Children's**

Spine Study Group, Philadelphia, Pa.; and [5]Growing Spine Study Group, Milwaukee, Wis.

Background: The purpose was to evaluate the results of growth-friendly (GF) surgical treatment in patients with oculoauriculovertebral dysplasia spectrum (OVAS) or Goldenhar syndrome. **Methods:** Patients with OVAS and early-onset scoliosis (EOS) with 2-year follow-up data were identified from 2 international multicentre EOS databases. Scoliosis, kyphosis, spine height and hemithoracic height/width were determined preimplant, immediately postoperatively and at 2-year follow-up. Severity of complications (SV) was recorded. **Results:** Ten patients met the inclusion criteria, and their mean age at GF implantation was 4.6 ± 2.5 years (1 spine and 9 rib-based implantations). Preoperative scoliosis was 64°, at postimplant 52°, and at a mean follow-up of 2.4 ± 0.5 years 50° (p = 0.09). Preoperative kyphosis was 36°, at postimplant 38°, and at final follow-up 42° (p = 0.08). Preoperative T1–S1 height was 23.5 cm, at postimplant 23.6 cm, and at final follow-up 27.3 cm (p = 0.06). Preoperative right hemithoracic height was 8.84 cm, at postimplant 9.62 cm, and at final follow-up 10.71 cm (p = 0.08). Preoperative left hemithoracic height was 9.89 cm, at postimplant 10.16 cm, and at final follow-up 12.35 cm (p = 0.11). Preoperative right hemithoracic width was 8.02 cm, at postimplant 7.22 cm, and at final follow-up 7.86 cm (p = 0.07). Preoperative left hemithoracic width was 7.18 cm, at postimplant 7.86 cm, and at final follow-up 8.60 cm (p = 0.43). Eight patients had 1 or more complications with SV I (n = 7), SV II (n = 2), and SV IIA (n = 7). These included infection (n = 4), migration (n = 3), pneumonia (n = 2) and instrumentation failure (n = 2). **Conclusion:** At 2-year follow-up, GF surgical intervention in treating EOS associated with OVAS trended toward improvements in scoliosis, spine height and hemithoracic height/width, with the majority of patients experiencing SV grade I or II complications.

0016

VEPTR implantation to treat children with early onset scoliosis without rib abnormalities: a prospective multicentre study. ***Ron El-Hawary[1], Muayad Kadhim[1], Michael Vitale[2], John Smith[3], Amer Samdani[4], Jack Flynn[5]*. From the [1]IWK Health Centre, Halifax, NS; [2]Columbia Presbyterian Hospital, New York, NY; [3]Primary Children's Hospital, Salt Lake City, Utah; [4]Shriner's Hospital, Philadelphia, Pa.; and [5]Children's Hospital of Philadelphia, Philadelphia, Pa.**

Background: The purpose of this study was to evaluate the efficacy of vertical expandable prosthetic titanium rib (VEPTR) in preventing further progression of scoliosis without impeding spinal growth in the treatment of children with progressive early onset scoliosis (EOS) without rib abnormalities. **Methods:** We conducted a prospective, multicentre, observational cohort study on patients with EOS treated with VEPTR with 2-year follow-up. Data were analyzed based on measurements done preimplant, immediately postoperatively and at 2-year follow-up. **Results:** Sixty-three patients met the inclusion criteria: 35 boys and 28 girls. Mean age at time of implantation was 6.1 ± 2.4 years. Etiologies included congenital (n = 6), neuromuscular (n = 36), syndromic (n = 4) and idiopathic (n = 17). Mean follow-up was 2.2 ± 0.4 years. Scoliosis (72° ± 18°) decreased after implant surgery (47° ± 17°) followed by slight increase at 2-year follow-up (57° ± 18°, p < 0.0001). Kyphosis (48° ± 22°) also showed significant decrease after surgery (40° ± 14°) but increased after 2 years (48° ± 16°, p < 0.0001). Spinal height measurements, including T1–T12 (15.7 cm ± 3 cm) and T1–S1 (25 cm ± 6 cm) showed significant increase after surgery (17.7 cm ± 4 cm and 28.6 cm ± 6 cm, respectively) and at 2 years (18.4 cm ± 4 cm and 29.1 cm ± 5 cm, respectively, p < 0.0001). The increase in coronal spine height represents 139% of expected age-matched T1–T12 growth and 186% of expected age-matched T1–S1 growth. Similarly, sagittal spinal length (SSL) of T1–T12 and T1–S1 increased from 16.9 cm ± 2.7 cm and 27.1 cm ± 3.9 cm, respectively, preoperatively to 19.7 cm ± 3.5 cm and 31.9 cm ± 5.1 cm, respectively, at 2-year follow-up (p < 0.0001). SSL of the instrumented segment continued growth from 25.8 cm ± 5.2 cm at implantation to 27.4 cm ± 5.3 cm at 2-year follow-up (p < 0.0001). **Conclusion:** This large prospective, multicentre study demonstrated the ability of VEPTER to effectively treat EOS without rib abnormalities. Goals of preventing further scoliosis progression and of maintaining normal spine growth were achieved. VEPTR provided greater than 100% of expected age-matched spine growth and the instrumented spinal segment continued to grow during the distraction phase.

0088

Adult spinal deformity patients with previous fusions have an equal chance of reaching substantial clinical benefit thresholds in health-related quality of life measures but do not reach the same absolute level of improvement. ***Tamir Ailon[1], Justin Smith[2], Christopher Shaffrey[2], Alex Soroceanu[3], Virginie Lafage[4], Frank Schwab[4], Doug Burton[5], Robert Hart[6], Han Jo Kim[4], Jeffrey Gum[7], Michael Kelly[8], Rick Hostin[9], Steven Glassman[7], Justin Scheer[10], Shay Bess[11], Christopher Ames[12]*. From the [1]University of British Columbia, Vancouver, BC; [2]University of Virginia, Charlottesville, Va.; [3]University of Calgary, Calgary, Alta.; [4]Hospital for Special Surgery, New York, NY; [5]University of Kansas, Kansas City, Kans.; [6]Swedish Medical Centre, Seattle, Wash.; [7]Norton Leatherman Spine Center, Louisville, Ky.; [8]Department of Orthopedic Surgery, Washington University School of Medicine, Saint Louis, Mo.; [9]Department of Orthopedic Surgery, Baylor Scoliosis Center, Plano, Tex.; [10]University of Illinois, Chicago, Ill.; [11]Presbyterian/St. Luke's Medical Center, Denver, Colo.; and [12]University of California San Francisco, San Francisco, Calif.**

Background: Substantial clinical benefit (SCB) represents a threshold above which a patient recognizes substantial benefit and may therefore be a desirable target outcome. We investigated the impact of prior spinal fusion on the likelihood of reaching SCB thresholds for 2-year health-related quality of life (HRQoL) after adult spinal deformity (ASD) surgery. **Methods:** We included ASD patients who achieved a minimum 2-year follow-up. We compared baseline demographic, HRQoL and radiographic features for patients undergoing primary versus revision procedures. The primary outcome measure was reaching SCB threshold on the Oswestry Disability Index (ODI), 36-Item Short-Form Health Survey (SF-36) physical component summary (PCS) score, and the Numeric Rating Scale for back and leg pain (NRS). Secondary outcomes included absolute and change scores on the ODI, SF-36 PCS, and NRS for back and leg pain.

We used SCB thresholds previously reported for outcome following lumbar fusion. **Results:** In total, 332 patients achieved 2-year follow-up, including 228 primary and 104 revision cases. Those undergoing revision surgery had similar demographic features (age 58.3 v. 55.9 years, female sex 80.8% v. 82.9%, Charlson Comorbidity Index 1.9 v. 1.6) to primary surgery patients. They had worse baseline HRQoL (ODI 48.5 v. 41.2, PCS 29.5 v. 33.4, back 7.5 v. 7.0, and leg pain 4.9 v. 4.3, $p < 0.001$) and radiographic deformity (sagittal vertical axis 111.4 v. 45.1, pelvic incidence to lumbar lordosis mismatch 26.7 v. 11.0, pelvic tilt 29.5 v. 21.0, $p < 0.0001$). Nevertheless, the number of patients who reached SCB for ODI (38.3 v. 36.3%), PCS (48.5% v. 53.4%), back (53.1% v. 60.5%) and leg pain (28.6% v. 36.9%) did not significantly differ between revision and primary operations. Revision patients had worse 2-year HRQoL for all measures. **Conclusion:** Patients undergoing revision ASD surgery have worse baseline HRQoL and radiographic deformity. Although they do not achieve the same absolute level of 2-year HRQoL outcome scores as patients undergoing primary surgeries, they have a similar likelihood of reaching SCB threshold for improvement in 2-year HRQoL.

0084

Radiographic assessment of spinopelvic parameters in surgically treated patients with symptomatic low-grade spondylolisthesis. ***Alex Soroceanu*[1], *Paul Park*[2], *Kai-Ming Fu*[3], *Shay Bess*[4], *Douglas Burton*[5], *Matthew Cunningham*[6], *Robert Eastlack*[7], *Thomas Errico*[8], *Munish Gupta*[9], *Han-Jo Kim*[6], *Eric Klineberg*[10], *Gregory Mundis*[11], *Darren Lebl*[6], *Themistocles Protopsaltis*[8], *Frank Shwab*[6], *Lafage Virginie*[6].**

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Background: Although the importance of spinopelvic parameters is well established in the context of adult spinal deformity, there is little data in the current literature on their importance in the context of low-grade spondylolisthesis. The objectives of this study were to examine pre- and postoperative global, regional and segmental sagittal alignment in low-grade spondylolisthesis, to look at the correlation between these parameters and patient-reported outcomes and to assess the influence of different surgical strategies on postoperative sagittal alignment. **Methods:** We performed a retrospective multicentre data analysis of patients undergoing 1- and 2-level fusions for low-grade spondylolisthesis. Baseline patient characteristics, baseline and 1-year postoperative radiographic alignment, surgical parameters (including the use of interbody fusion), and baseline and 1-year postoperative health-related quality of life (HRQoL) data were assessed using *t* tests, analyses of variance and Pearson correlations, as appropriate. **Results:** In total, 110 patients were included in the study. Baseline sagittal malalignment was observed in a large proportion of patients (37.27% pelvic incidence [PI]–lumbar lordosis [LL] > 10°, 58.18% pelvic tilt [PT] > 20°, 47.71% sagittal vertical axis [SVA] > 40 mm). Postoperatively, an important proportion had residual sagittal malalignment (34.86% PI–LL > 10°, 56.88% PT > 20°, 45.19% SVA > 40). Postoperative improvement in sagittal alignment correlated with postoperative improvement in back pain (correlation coefficient 0.3177, $p = 0.04$), but not leg pain or Oswestry Disability Index score. The use of interbody fusion, more particularly anterior lumbar interbody fusion (ALIF) or lumbar lateral interbody fusion (LLIF) improved the focal lordotic alignment at the spondylolisthesis level (+0.63° without interbody fusion, +1.5° for posterior/transforaminal lumbar interbody fusion, and +4.96° for ALIF/LLIF), but did not influence global spinopelvic parameters (SVA, PT, PI-LL). **Conclusion:** Our study highlights that an important proportion of patients with low-grade spondylolisthesis had global sagittal malalignment preoperatively, which was not adequately addressed by a short segment fusion. This emphasizes the significance of global sagittal alignment and spinopelvic parameters in low-grade spondylolisthesis.

0066

Congenital cervical spine stenosis in a global cohort of patients with degenerative cervical myelopathy: a report based on an MRI diagnostic criterion. ***Aria Nouri*[1,2], *Lindsay Tetreault*[2], *Allan Martin*[1,2], *Anick Nater*[1,2], *Satoshi Nori*[2], *Mohammed Shamji*[2], *Michael Fehlings*[1,2].**

From the [1]University of Toronto, Toronto, Ont.; and [2]Toronto Western Hospital, Toronto, Ont.

Background: Congenital spinal stenosis (CSS) is a known predisposing factor for degenerative cervical myelopathy (DCM). However, current diagnostic criteria for CSS do not consider the size of the spinal cord, and methods to establish pre-existing CSS in patients with DCM do not presently exist. Using a global cohort of patients with DCM, MRI-based criteria were developed to diagnose pre-existing CSS and to evaluate differences between patients with and without CSS. **Methods:** Study data (including 349 MRIs for quantitative analysis) were derived from 2 international prospective and multicentre studies collected between 2005 and 2011. Spinal canal and cord anteroposterior diameters were measured above and below the region of interest at non-compressed sites, and a spinal cord occupation ratio (SCOR) was calculated. A SCOR of 70% or more was used to diagnose CSS. Torg–Pavlov ratios and spinal canal diameters from radiographs were correlated with SCOR. Clinical and MRI factors were compared between patients with and those without CSS using *t* tests. Multiple linear regression was used to assess surgical outcome. **Results:** Calculation of SCOR was feasible in 311 of 349 patients (89%). Twenty-six patients with CSS were identified (8.4%). Patients with CSS were younger than patients without CSS (50.8 years v. 56.3 years, $p = 0.03$) and had worse baseline severity as measured by the modified Japanese Orthopaedic Association ($p = 0.04$), Nurick ($p = 0.05$) and Neck Disability Index ($p < 0.01$). CSS patients also presented more commonly with T2 cord hyperintensity changes ($p = 0.09$), and worse physical component scores on the 36-Item Short-Form Health Survey ($p = 0.06$), though this did not reach statistical significance. SCOR was correlated with Torg–Pavlov ratio and spinal canal diameter at C3 but not C5. Patients with a SCOR of 65% or higher were also younger but did not have differences in baseline severity. **Conclusion:** CSS patients develop myelopathy at a younger age

and have greater impairment and disability than other patients with DCM. Despite this, CSS patients have comparable duration of symptoms, MRI presentations and surgical outcomes to DCM patients without CSS.

0006

The impact of living with scoliosis: a utility outcomes score assessment. ***Sultan Aldebeyan[1,2], Hani Sinno[1], Asim Makhdom[1], Jean A. Ouellet[1], Neil Saran[1].* From [1]McGill University, Montreal, Que.; and [2]National Neuroscience Institute, Riyadh, Saudi Arabia.**

Background: Adolescent idiopathic scoliosis (AIS) is a common spinal deformity that can affect individuals on many levels. Patients with big curves usually seek medical advice for surgical correction of their deformity. The aim of this study was to objectify the burden of AIS to better advocate for scoliosis care in the future. **Methods:** Participants completed an online questionnaire to help measure the health burden of AIS. Three utility outcome measures were then calculated: visual analogue scale (VAS), time trade off (TTO) and standard gamble (SG). Student *t* test and linear regression were used for statistical analysis. **Results:** In total, 110 participants were included in the analysis. The mean VAS, TTO, and SG scores for AIS were 0.77 ± 0.16, 0.90 ± 0.11, and 0.91 ± 0.13, respectively. Factors such as age, sex, income, and level of education were not independent predictors of utility scores for AIS. **Conclusion:** Our participants demonstrated a significant perceived burden of AIS. If faced with AIS, participants were willing to sacrifice 3.6 years of their lives and undergo a procedure associated with 9% mortality to gain perfect health. Such findings can guide future allocation of resources for better scoliosis care and management.

0031

The psychosocial impact of AIS: Any need for concern? ***Firoz Miyanji[1], Sameer Desai[1], Arvindera Ghag[1], Suken Shah[2], Amer Samdani[3], Baron Lonner[4], Peter O. Newton[5].* From the [1]BC Children's Hospital, Vancouver, BC; [2]Alfred I. duPont Hospital for Children, Wilmington, Del.; [3]Shriners Hospital for Children, Philadelphia, Pa.; [4]Mount Sinai Medical Center, New York, NY; and [5]Rady Children's Hospital, San Diego, Calif.**

Background: The negative psychological impact of adolescent idiopathic scoliosis (AIS) has been well documented in the literature. However, most studies focus on patients with large curves requiring operative intervention or conservative treatment, such as bracing. Our study aims to explore the prevalence of psychosocial issues in skeletally mature AIS patients under observation using a validated psychological instrument for adolescents. **Methods:** Skeletally mature AIS patients with curves of 30° or greater were emailed an Internet-based Strength and Difficulties Questionnaire (SDQ). The SDQ comprises 5 domains of 5 questions each. Domains include emotional, conduct, peer relations, hyperactivity, prosocial and impact of difficulties on daily life. The sum of the first 4 domains generates a total difficulties score out of 40. Cut-off points for categorization of scores into average, slightly raised, high and very high likelihood of psychosocial issues in each domain are based on established normative data. SDQ domains and total scores were the primary outcomes of interest. **Results:** Of 98 eligible patients, 55 responded (56%). Mean age was 18.2 ± 2.0 years, with a mean baseline major Cobb angle of 39.9° ± 7.4°. All mean domain scores were within the average category. However, the mean total difficulties score (11.2), emotional problems (4.0), peer problems (2.1) and impact (0.9) domains were trending toward the slightly raised category for a psychosocial issue. Upon further examination, 15 of the 55 respondents (27%) had an abnormal score in the impact domain, indicating high or very high likelihood of a psychological issue. Of these 15 patients, 5 (9.1%) also had associated abnormal scores for emotional and peer relations domains. **Conclusion:** We present results from a descriptive cross-sectional study using a validated psychological instrument exploring the prevalence of psychosocial issues in AIS. There is a high prevalence (27%) of psychological issues in patients with moderate AIS curves, predominantly in the domains of impact, emotional and peer relations. Clinicians should be cognizant of these issues and consider psychological assessment for high-risk patients, particularly patients for whom treatment may be considered as it may impact results of intervention.

0043

Development and biomechanical evaluation of a novel expanding pedicle screw. ***Parham Rasoulinejad, Stewart McLachlin, Jacob Reeves, Kevin Gurr, Fawaz Siddiqi, Chris Bailey.* From the Division of Orthopaedics, Department of Surgery, Schulich School of Medicine and Dentistry, Western University, Lawson Health Research Institute, and London Health Sciences Centre, London, Ont.**

Background: Pedicle screws are used in surgical stabilization of the spine. In cases of osteoporosis, revision surgery or severe trauma, conventional pedicle screws can be inadequate, leading to early failure. We hypothesized that a novel expanding screw design would improve bony fixation. The objective of this study was to compare the pullout strength of this new screw design to commercially available pedicle screws. **Methods:** Four different expanding pedicle screws were designed and multiple copies of each built on a selective laser melting machine. Each design was compared with a conventional screw (Xia, Stryker) in Sawbones L5 Vertebra using a materials testing machine (Instron 8874). Screw axial pullout testing was performed at 10 mm/minute. Ultimate load, energy, stiffness and yield load were calculated from load displacement curves and compared using independent *t* tests. One of these designs was further developed and tested in osteoporotic cadaveric lumbar vertebrae ($n = 3$). Standard 6.5 mm diameter pedicle screws and expandable 6.5 mm screws were randomized to the right and left pedicle of each body. **Results:** The expandable screws successfully expanded in all cases without fracturing the pedicle or vertebral body. There was no statistical difference between the expandable and standard screws for ultimate load. Furthermore, stiffness, yield and energy to peak load were statistically the same. A 36% increase in total energy was found favouring the expandable screw ($p = 0.02$). Pedicle fractures during pullout testing occurred in 3 of the specimens with the expanding screw and none with the standard screw. **Conclusion:** Expandable pedicle screws failed to demonstrate improved screw pullout compared with standard screw design. A difference was found in total energy indicating that the expandable screw was able to hold the peak load longer than the standard screw. Pedicle fractures indicate that the standard screw optimizes fixation to a

point where further pull can fracture the pedicle. Further studies are needed to examine other loading methods and modes of failure. Further design modifications are required to decrease reliance on the pedicle for fixation.

0026

Posterior versus 3-column osteotomy for late correction of residual deformity in adult patients with previous fusions for idiopathic scoliosis (AIS). ***Stephen Lewis, Sam Kesben, So Kato, Aaron Gazendam*. From the University Health Network, Toronto, Ont.**

Background: The objective of this study was to compare the early results of posterior column (PCO) and 3-column (3CO) osteotomies performed in patients with previously fused idiopathic scoliosis and review their abilities to achieve correction of residual deformities. **Methods:** Medical records and radiographs were reviewed retrospectively on 29 consecutive patients treated with late revisions of previous corrections for adolescent idiopathic scoliosis (AIS). Patients presented with residual deformity or pain secondary to adjacent segment degeneration or pseudarthrosis. Osteotomies were performed at or near the apex of the residual curve through the previous fusion mass in conjunction with proximal or distal extension of their constructs. For patients with fused anterior columns or severe deformities, 3CO was performed. In the other cases, PCO was sufficient. **Results:** Fourteen patients were treated with PCOs and 15 with 3COs, with a mean 2.5 (range 0–9) levels added to the previous fusion. Preoperative visual analogue scale, Oswestry Disability Index and Scoliosis Research Society scores were 7.0, 42.5, and 2.8, respectively. Global coronal Cobb angle improved by 20.2° in the PCO group and 19.5° in the 3CO group (p = 0.80). A mean of 1.4 PCOs were performed per curve, with a mean correction per osteotomy of 9.2°. A mean of 1 3CO was performed per curve with an average of 14.1° of correction per osteotomy. Both groups had significant improvements in coronal and sagittal balance. The PCO group had significantly less blood loss that the 3CO group (1417.5 mL v. 3199.3 mL, p = 0.008) and significantly lower complication rates (36% v. 80%, p = 0.02). **Conclusion:** PCOs and 3COs performed in patients with residual coronal deformities after fusions are effective at achieving additional correction and multiplanar global balance. In cases of posterior fusion with a remaining mobile anterior column, both 3COs and PCOs are viable options for treatment. PCOs, however, should be considered over 3COs when possible owing to their decreased risk of blood loss and complication.

0049

The predictors of patient morbidity after adult spinal deformity correction: bone mineral density and the region of deformity correction. ***Zurab Ivanishvili[1,2], Janine Hsu[3], Kashif Parvez[1,2], Sabine Boisvert[2], Melina Warren[4], Evan Frangou[1,2,3], Daniel Warren[1,2,3]*. From the [1]Department of Neurosurgery, Island Health, Victoria, BC; [2]Vancouver Island Neurosurgical Foundation, Victoria, BC; [2]University of British Columbia, Island Medical Program, Victoria, BC; and [4]Department of Radiology, Island Health, Victoria, BC.**

Background: We aim to study an association between the postoperative hardware-related morbidity (HM) and the preoperative indicators, such as bone mineral density (BMD) and the region of deformity. **Methods:** We retrospectively analyzed a single centre's data from patients with spinal deformity correction performed by a single neurosurgeon between 2012 and 2015. Postoperative HM was defined as proximal junctional kyphosis, distal junctional failure, fractured rod, loose screw, radiculopathy and nonunion. BMD groups included normal, low (osteopenia or osteoporosis) and unknown. The spine regions included lumbar, short thoracolumbar (up to 6 levels), long thoracolumbar (7 to 12 levels), and cervical. **Results:** Sixty patients (41 women and 19 men) were identified, with a mean age of 65 years. HM was identified in 29 patients (48.3%). Normal BMD was identified in 14, with half of them developing HM; low BMD was identified in 15, with one-third of them (33.3%) developing HM. Lumbar correction was performed in 19, with HM in 36.8%; short thoracolumbar correction was performed in 28, with HM in 46.4%; long thoracolumbar correction was performed in 11, with HM in 81.8%; and cervical correction was performed in 2, with no postoperative HM. **Conclusion:** The trends in our data indicated that the region and extent of deformity correction is a strong predictor of postoperative hardware-related failure: cervical region is associated with the least and thoracolumbar region (especially long segment) with the most morbidity. Surprisingly, we did not find a positive association between abnormal BMD and HM, and a larger prospective study is required to investigate this association further.

0033

Assessing the risk:benefit ratio of surgery in CP: Is surgery worth it? ***Firoz Miyanji[1], Suken Shah[2], Amer Samdani[3], Baron Lonner[4], Burt Yaszay[5], Jahangir Asghar[6], David H. Clements[7], Peter O. Newton[5]*. From the [1]BC Children's Hospital, Vancouver, BC; [2]Nemours/Alfred I. duPont Hospital for Children, Wilmington, Del.; [3]Shriners Hospital for Children, Philadelphia, Pa.; [4]Mount Sinai Medical Center, New York, NY; [5]Rady Children's Hospital, San Diego, Calif.; [6]Miami Children's Hospital, Miami, Fla.; and [7]Cooper University Hospital, Camden, NJ.**

Background: Literature around benefits for surgical intervention in patients with cerebral palsy (CP) remains inconclusive. Most long-term data rely on retrospective reviews of limited quality primarily reporting on radiographic outcomes and lack any validated patient/caregiver outcome metric. Our objective was to determine the benefit of spinal arthrodesis in CP patients as determined by the CPCHILD questionnaire at long-term follow-up and evaluate the reported complications at 2-year and 5-year follow-up. **Methods:** A prospective, longitudinal, multicentre database evaluating surgical outcomes for CP patients with 5-year follow-up was analyzed. CPCHILD outcome scores and surgeon-reported complications were the primary outcomes of interest and were compared at 2 time points: 2 years and 5 years following surgery. Radiographic data were also compared at these postoperative intervals. **Results:** Forty patients were analyzed. Mean age at surgery was 13.0 ± 2.6 years, and most patients were female (62.5%). Most patients were Gross Motor Function Classification System level V (94.9%), with a mean major preoperative Cobb angle of 89.2° ± 27.6°, improved to 30.8° ± 11.1° at 2 years and 29.8° ± 12.8° at 5 years. Improvements in CPCHILD scores were noted at 2 years and were maintained at 5 years in all domains except

communication and social interaction. Significant improvement was achieved in overall quality of life, personal care and positioning, transfer and mobility domains at 2 years, with no significant change at 5 years ($p < 0.05$). The overall complication rate was 35%, with the majority occurring within 2 years (30%, $p = 0.013$). The rate of complications occurring between 2 and 5 years requiring intervention was significantly lower than those requiring intervention within 2 years of surgery (2.5% v. 17.5%, $p = 0.03$). The only newly observed complications beyond 2 years were surgical site infection (2.5%) and instrumentation issues (2.5%). **Conclusion:** Despite a 17.5% complication rate requiring intervention within 2 years following surgery, a significant improvement was found in CPCHILD health-related quality of life scores at 2 years postoperative, which was maintained at 5 years. An insignificant rate of newly observed complications occurred between 2 and 5 years postoperative, suggesting that the benefits of surgery appear to outweigh the risks in this fragile population.

0042

Comparative cost analysis of conventional and magnetic controlled growing rods in early-onset scoliosis — a single-centre experience. ***Arvindera Ghag, Luigi Nasto, Eva Habib, Christopher Reilly, Firoz Miyanji.* From the BC Children's Hospital, Vancouver, BC.**

Backgroung: Conventional growing rods (CGR) and magnetic controlled growing rods (MCGR) are growth-friendly devices for treatment of early-onset scoliosis (EOS). CGR requires repeated surgical lengthening under general anesthesia, whereas MCGR lengthening is performed noninvasively in an office-based setting. Unit cost for MCGR is higher than CGR, but the need for repeated lengthening surgeries for GR may eventually offset the initial lower cost of the procedure. Furthermore, complications, clinical efficacy and outpatient hospital resource utilization should be taken into account when comparing these 2 systems. This study aims to provide a comprehensive single-centre cost comparison analysis of CGR and MCGR in a series of 18 children with minimum follow-up of 12 months. **Methods:** Charts of 18 consecutive patients with EOS secondary to idiopathic ($n = 8$), syndromic ($n = 9$), and neuromuscular ($n = 1$) etiologies treated with CGR ($n = 13$) and MCGR ($n = 5$) with minimum follow-up of 12 months were reviewed. Costs related to surgical procedures (i.e., implants, index surgery, lengthening surgeries, inpatient admissions), outpatient procedures (i.e., lengthenings, clinic visits) and complication management (i.e., reoperations) were gathered using service recipient costing methodology. Descriptive and Mann–Whitney *U* statistics were calculated. **Results:** In 13 patients (53.8% female) treated with CGR (follow-up 51.4 months, range 38.2–76.2 months), a total of 87 lengthening procedures and 11 surgical procedures for complications (4 infections, 7 hardware-related) were performed. In 5 patients (80% female) treated with MCGR (follow-up 26.7 months, range 13.8–29.5 months) a total of 38 outpatient lengthening procedures were performed with no revisions. Normalized costs per month of follow-up were $1102.10 for CGR and $1133.60 for MCGR. **Conclusion:** Aggregate MCGR cost at median follow-up of 2 years is similar to CGR owing to the high implant cost. No MCGR patient required revision, leading to a very low aggregate cost of lengthenings and revisions when compared with the CGR cohort. Longer-term MCGR cohort follow-up is required with a maintained low revision rate to demonstrate superior cost savings. This is the first study to report real comprehensive MCGR data compared with CGR cohorts to realize the true cost savings of MCGR.

0027

Horizontal levelling of L4 and L5 in long fusions to the pelvis results in improved coronal balance. ***Stephen Lewis, Sam Kesben, So Kato, Taylor Dear, Aaron Gazendam.* From the University Health Network, Toronto, Ont.**

Background: The purpose of this study is to identify the key aspects of curve correction that affect coronal balance in patients treated with long posterior fusion for adult spinal deformities. **Methods:** The radiographs of 46 adult coronal deformity patients treated with fusions to the pelvis were retrospectively reviewed. Pre- and postoperative coronal Cobb angles were measured to determine correction. Patients were classified as balanced (< 3 cm) or imbalanced (> 3 cm) based on the distance between the C7 coronal plumb line and the central sacral vertebral line. **Results:** Of 46 patients, 32 were balanced after surgery and 14 were imbalanced. Coronal balance was 16.0 mm in the balanced group compared with 51.3 mm in the imbalanced group ($p < 0.001$). L4 and L5 tilt were 11.2° and 7.3° in the balanced group and 18.9° and 13.8° in the imbalanced group ($p < 0.001$). Both L4 and L5 tilt were positively correlated with coronal imbalance ($r = 0.75$ and 0.61, respectively, $p < 0.001$). There were no differences in demographics, sagittal plane parameters and coronal plane correction between the groups. The coronally balanced group had higher Scoliosis Research Society self-image scores. **Conclusion:** In long spinal fusions for adult scoliosis, horizontal levelling of L4 and L5 leads to better coronal balance and self-reported self-image scores following surgery. The magnitudes of residual L4 and L5 tilt positively correlated with the magnitude of the coronal imbalance. Attention to levelling the distal lumbar spine during correction of adult deformity will help to obtain coronal balance in adult scoliosis surgery involving long fusions to the pelvis.

0032

The rate and risk of curve progression in moderate AIS following skeletal maturity. ***Firoz Miyanji*[1], *Tracey Bastrom*[2], *Amer Samdani*[3], *Suken Shah*[4], *Baron Lonner*[5], *Randal R. Betz*[3], *Peter O. Newton*[2]. From the [1]BC Children's Hospital, Vancouver, BC; [2]Rady Children's Hospital, San Diego, Calif.; [3]Shriners Hospital for Children, Philadelphia, Pa.; [4]Nemours/Alfred I. duPont Hospital for Children, Wilmington, Del.; and [5]Mount Sinai Medical Center, New York, NY.**

Background: Natural history of moderate adolescent idiopathic scoliosis (AIS; ≥ 30°) in skeletally mature patients is poorly defined. Studies reporting rates/risk factors for progression in AIS are predominantly of large curves in immature patients. Our aim was to determine the rate of curve progression in AIS following skeletal maturity and any associated changes in Scoliosis Research Society (SRS-22) functional outcome scores; additionally, we aimed to identify any potential predictors of curve progression. **Methods:** Patients enrolled in a prospective, longitudinal, multicentre nonsurgical AIS database were evaluated. All patients had

minimum 2-year follow-up data, idiopathic scoliosis of 30° or greater, and were skeletally mature. SRS-22 functional outcome scores and radiographic data were compared at baseline and 2-year follow-up. Patients were divided into 3 groups based on curve size: A = 30°–39°, B = 40°–49° and C = 50° or greater. Curve progression was defined as any change in curve magnitude. Univariate analysis explored the association between curve progression and a priori–defined variables of interest. Multivariate regression attempted to identify potential predictors of curve progression. **Results:** There were 114 patients with a mean age of 16.4 ± 1.4 years; most patients were female (90.4%). The mean major Cobb angle at baseline was 39.2° ± 7.3°. At 2-year follow-up 49.1% of curves progressed an average 3.9° ± 2.8°. In total, 62.5% of thoracic curves progressed at a rate of 2° per year compared with 37.5% progression of thoracolumbar/lumbar curves at a rate of 1.7° per year. Of progressed curves, patients in group B had the largest mean rate of progression, followed by group A. SRS-22 outcome scores on average declined significantly over 2 years (from 4.24 to 4.08, $p = 0.001$). Patients who progressed had a more significant decline on average in functional outcome scores than those who did not ($p = 0.001$ and $p = 0.05$, respectively), with the most significant change in pain and self-image domains ($p = 0.007$ and $p = 0.014$, respectively). Regression analysis did not identify any factors predictive of curve progression in this cohort. **Conclusion:** Skeletally mature patients with moderate AIS (≥ 30°) may have a risk of progression at a mean rate of 1.9° per year. Curve progression can lead to significant decline over time in SRS-22 outcome scores, in particular pain and self-image.

0089

Postoperative assessment of pedicle screw and management of breach: a survey among Canadian Spine Surgeons and a new scoring system. ***Ahmed Aoude, Saber Ghadakzadeh, Hamzah Alhamzah, Maryse Fortin, Peter Jarzem, Jean Ouellet, Michael H. Weber.*** **From the McGill Scoliosis and Spine Centre, Montreal, Que.**

Background: The purpose of this study was to analyze the opinion of spine surgeons on the assessment of pedicle screw accuracy, with the goal of establishing clinical guidelines on interventions for malpositioned pedicle screws. Accurate placement of pedicle screws is challenging, and misalignment can lead to a myriad of complications. To date, there is no recognized gold standard for the assessment of pedicle screw placement accuracy. **Methods:** A survey on the clinical methods and imaging criteria used in assessing pedicle screw placement accuracy was designed and sent to orthopedic and neurosurgery spine surgeons from the Canadian Spine Society (CSS) for their anonymous participation. **Results:** Thirty-five surgeons participated in the study. The most commonly used modalities to assess pedicle screw position postoperatively were plain radiographs (97%) and computed tomography (CT) scan (97%). In both symptomatic and asymptomatic patients, medial and inferior breaches were the most and the least worrisome breaches, respectively. The majority of surgeons tended not to reoperate on asymptomatic breaches. More than 60% of participants would reoperate on patients with new-onset pain and a medial or inferior breach of 4 mm or more in both thoracic and lumbar regions. For a patient with sensory loss and a medial or inferior breach on CT, either in the thoracic or lumbar levels, 90% and 70% of the surgeons would reoperate, respectively. According to our results, we generated a scoring system for assessment of misplaced screws. This scoring system takes into account both the imaging findings and the concomitant clinical symptoms. **Conclusion:** Postoperative clinical presentation as well as imaging findings is crucial to interpret aberrant pedicle screw placement. We have presented a preliminary scoring system to standardize the classification of pedicle screws and help surgeons decide which pedicle screws warrant corrective operation.

0040

Comparative analysis of static and dynamic intraoperative skull-femoral traction (IOSFT) in adolescent idiopathic scoliosis correction. ***Arvindera Ghag, Yale Tang, Sameer Desai, Christopher Reilly, Firoz Miyanji.*** **From the BC Children's Hospital, Vancouver, BC.**

Background: Limited literature that exists comparing outcomes in adolescent idiopathic scoliosis (AIS) correction with intraoperative skull-femoral traction (IOSFT), suggests it to be an effective, safe, and well-tolerated adjunctive technique of improving outcomes and reducing health care resource use in curves greater than 80°. Previous studies highlight the utility of IOSFT for large and rigid deformities; however, it is increasingly being popularized for smaller curves. Various IOSFT techniques exist, but to date no studies have compared the safety and efficacy of different IOSFT methods. Our aim was to compare the intra- and postoperative neurologic safety and clinical efficacy of static and dynamic IOSFT. **Methods:** Ninety-six consecutive surgical patients treated by 2 surgeons at a tertiary care facility with a mean follow-up of 1.6 years between 2011 and 2014 were identified. Sixty-three patients received static and 33 patients received dynamic IOSFT. Each surgeon used only 1 mode of traction. Primary outcomes included neuromonitoring (NM) changes, estimated blood loss (EBL), duration of surgery, length of stay (LOS), percent curve correction and complications. Descriptive statistics, t tests and Fisher exact tests for significance ($\alpha = 0.05$) were calculated for analysis. **Results:** Demographic variables and curve characteristics were similar between static and dynamic groups. Levels fused (12.3 static v. 12.1 dynamic), EBL (601 mL static v. 508 mL dynamic), duration of surgery (365 minutes static v. 376 minutes dynamic), LOS (6 days static v. 5.8 days dynamic) and curve correction (71.5% static v. 69.5% dynamic) were not significantly different. A total of 17.5% of static patients and 12.1% of dynamic patients had NM changes, and 8% of static patients and 3% of dynamic patients experienced complications. The mean number of osteotomies was significantly higher in the static group ($p < 0.001$). **Conclusion:** IOSFT in AIS correction is a safe and effective adjunctive technique in curves greater than 80°, with no neurologic complications in this cohort and similar rates of NM changes regardless of static or dynamic application. Perioperative clinical outcomes and postoperative radiographic outcomes were comparable between dynamic and static IOSFT. Further research is required to quantify safe amounts of IOSFT.

0055

Perioperative complications of spinal deformity correction in cases with single versus two attending surgeons. ***Kashif Parvez[1,2], Janine Hsu[3], Zurab Ivanishvili[1,2], Sabine Boisvert[2], Melina Warren[4], Evan Frangou[1,2,3], Daniel Warren[1,2,3].*** **From**

the [1]Department of Neurosurgery, Island Health, Victoria, BC; [2]Vancouver Island Neurosurgical Foundation, Victoria, BC; [3]University of British Columbia, Island Medical Program, Victoria, BC; and [4]Department of Radiology, Island Health, Victoria, BC.

Background: The purpose of this study was to assess the perioperative morbidity of adult spinal deformity correction based on 1 versus 2 surgeons. **Methods:** We retrospectively reviewed a single institution database of all spinal deformity correction surgeries (60 cases) performed between January 2012 and January 2015. We divided the cohort into single versus 2 surgeons (12 v. 48 cases, respectively). We analyzed cases for estimated blood loss and perioperative minor and major complications. **Results:** The average age of the single surgeon and 2 surgeon groups was 60.8 years and 65.8 years, respectively. The number of cases involving a long thoracic to pelvis correction (T3/T4/T5 or T6 to pelvis) was higher in the 2 surgeons group than in the single surgeon group (20.8% v. 8.3%). The percentage of cases with an estimated blood loss greater than 3.0 L for single versus 2 surgeons was 25% versus 41.6%. The percentage of cases requiring an intraoperative transfusion for single versus 2 surgeons was 16.6% versus 29.2%. The percentage of total major complications in the single versus 2 surgeon group was 25% versus 47.9%, and the respective revision rates were 25% versus 37.5%. The percentage of total minor complications in the single versus 2 surgeons group was 33.3% versus 14.6%. **Conclusion:** In our study, the use of 2 spine surgeons at an experienced neurosurgical centre did not result in decreased estimated blood loss, decreased need for intraoperative blood transfusions, decreased number of major complications or decreased revision rates. If a single surgeon attempts an adult spinal deformity correction case, a second surgeon should be involved to assist in the management of the anticipated perioperative morbidity. Two surgeons are often needed in long thoracic to pelvis spinal deformity correction cases. Therefore, the nature of cases leads to greater blood loss, need for transfusions and major complications.

0023

Missing neurology: deficiencies in comprehensive ASIA examination record for traumatic spinal cord injury patients is improved with institution of a registry. ***Rebecca Fox*, *Jim Kutsogiannis*, *Richard Fox*. From the University of Alberta, Edmonton, Alta.**

Background: Thorough neurologic assessment of traumatic spinal cord injury (SCI) patients in acute, rehabilitation and discharge phases of care is important for treatment, prognostication and research. Inconsistencies in quantitative contemporaneous record keeping leaves information gaps that are inaccurate and expensive to fill retrospectively. Introduction of a national SCI registry has improved this. However, shortcomings are still evident. Local data quality for SCI patients is unknown. **Methods:** A retrospective analysis was conducted of consecutive patients enrolled in the Rick Hansen Institute of Spinal Cord Injury Research (RHISCIR) registry in Northern Alberta for the period 2006–2016. Data points included motor and sensory scores and sacral sparing based on the American Spine Injury Association (ASIA) scoring method. Emergency department physicians in local or tertiary care hospitals, trauma team leaders and admitting spine service records were reviewed. Two groups were compared: 1) patients with deficient data points identified by routine registry auditing and 2) patients with complete data. A group of randomly selected registry records from the period 2015–2016 served as a reference standard, having the most scrutinized, prospectively collected data. **Results:** All phases of patient care showed record keeping deficiencies from point of injury onward. However, a significant improvement in record quality over time was noted from registry introduction in 2006 to 2016. **Conclusion:** This improvement over time acknowledges the necessity for consistent data stewardship in order to attain high-quality data and is significant to recognize in terms of advancing treatment methods and knowledge of SCI. Thus, by quantifying shortcomings in record keeping, we draw attention to its importance and encourage resource allocation to support thorough prospective record keeping.

0035

The practice of steroid use for treatment and prevention of spinal cord injury in Canada. ***Morsi Khashan*, *Jeff Golan*, *Yousef Marwan*, *Michael Weber*. From McGill University, Montreal, Que.**

Background: Traumatic and iatrogenic spinal cord injury (SCI) often results in long-term disability. High-dose methylprednisolone has been widely used for nonsurgical intervention in acute SCI; however, this practice is becoming more controversial in the literature. In the present study we aimed to estimate current practice of routine use of the high-dose steroid protocols for the treatment of acute SCI by Canadian surgeons and estimate the routine administration of steroids for the prevention of intraoperative iatrogenic SCI. **Methods:** A questionnaire was distributed via e-mail to members of the Canadian Spine Society during June 2016. The questionnaire focused on 3 areas: 1) the use of high-dose methylprednisolone for treatment of SCI, 2) the use of dexamethasone for prevention of iatrogenic intraoperative SCI and 3) adverse effects. **Results:** A total of 39 (29.5%) out of 132 Canadian Spine Society members answered the electronic questionnaire. Twenty-five (64.1%) participants were orthopedic surgeons, and 14 (35.9%) were neurosurgeons. The vast majority of the participants (33, 84.6%) do not use any protocol of steroid therapy for treatment of SCI. Seventeen (44.0%) responders reported the use of steroids for prevention of iatrogenic SCI. **Conclusion:** The majority of Canadian spine surgeons do not use steroids to treat SCI. This is a continuation of a previously reported trend in Canada, the United States and other countries. The use of preoperative steroids to prevent SCI in procedures around the spinal cord was more common. This practice is not evidence based, and studies are needed to evaluate its risks and benefits.

0053

A clinical practice guideline for the management of patients with acute spinal cord injury: recommendations on the type and timing of anticoagulation prophylaxis. ***James Harrop*[1], *Anthony Burns*[2], *Brian Kwon*[3], *Allan Martin*[2,5], *Geno Merli*[1], *James Middleton*[6], *Mohammed Shamji*[5], *Lindsay Tetreault*[5], *Jefferson Wilson*[4,5], *Albert Yee*[7], *Michael Fehlings*[4,5]. From the [1]Thomas Jefferson University, Philadelphia, Pa.; [2]Toronto Rehabilitation Institute, Toronto, Ont.; [3]University of British Columbia, Vancouver, BC;**

[4]University of Toronto, Toronto, Ont.; [5]Toronto Western Hospital, Toronto, Ont.; [6]University of Syndey, Sydney, Australia; and [7]Sunnybrook Hospital, Toronto, Ont.

Background: Patients with spinal cord injury (SCI) are at an increased risk of venous thromboembolism (VTE) due to hypercoagulability, stasis and intimal injury. The prevention of deep vein thrombosis (DVT) and pulmonary embolism (PE) is critical in this high-risk population. The objective of this study is to develop guidelines that outline optimal anticoagulation strategies in patients with SCI. **Methods:** A systematic review of the literature was conducted to address the following key questions: 1) What is the comparative effectiveness and safety of pharmacological, mechanical and/or invasive anticoagulation strategies for preventing DVT and PE; and 2) What is the optimal timing to initiate and/or discontinue anticoagulation prophylaxis following injury? A multidisciplinary guideline development group used this evidence, in combination with their clinical expertise, to develop recommendations for the optimal prophylaxis strategies. The benefits and harms, financial impact, acceptability, feasibility and patient preferences of each recommendation were carefully considered. **Results:** We made the following recommendations. 1) We suggest that prophylactic antithrombotic pharmacological therapy be offered to minimize the risk of thromboembolic events in the acute period after SCI. 2) We suggest that prophylactic antithrombotic pharmacological therapy, consisting of either subcutaneous low molecular-weight heparin or fixed-dose unfractionated heparin (UFH) be offered to minimize the risk of thromboembolic events in the acute period after SCI. Given the potential for increased bleeding events with the use of adjusted-dose UFH, we suggest avoiding this treatment option. 3) We suggest commencing prophylactic antithrombotic pharmacological therapy within the first 72 hours after injury in order to minimize the risk of venous thromboembolic complications during the period of acute hospitalization. **Conclusion:** These guidelines should be implemented into clinical practice to improve outcomes and reduce morbidity in patients with SCI by promoting standardization of care, decreasing the heterogeneity of management strategies and encouraging clinicians to make evidence-informed decisions.

0057

A clinical practice guideline for the management of patients with acute spinal cord injury: recommendations on the type and timing of rehabilitation. ***Anthony Burns[1], Sukhvinder Kalsi-Ryan[2], Brian Kwon[1,3], Ralph Marino[4], Allan Martin[2,5], James Middleton[6], Mohammed Shamji[2], Anoushka Singh[2], Lindsay Tetreault[2], Jefferson Wilson[2,5], Michael Fehlings[2,5].*** **From the [1]Toronto Rehabilitation Institute, Toronto, Ont.; [2]Toronto Western Hospital, Toronto, Ont.; [3]University of British Columbia, Vancouver, BC; [4]Thomas Jefferson University, Philadelphia, Pa.; [5]University of Toronto, Toronto, Ont.; and [6]University of Syndey, Sydney, Australia.**

BAckground: Rehabilitation plays a central role in maximizing function and facilitating community reintegration following a spinal cord injury (SCI). Despite this, many fundamental questions remain regarding the timing and efficacy of various rehabilitation strategies. The objective of this study is to develop guidelines that outline the appropriate type and timing of rehabilitation in patients with acute SCI. **Methods:** A systematic review of the literature was conducted to address the following questions: 1) Does the time interval between injury and commencing rehabilitation affect outcome? 2) What is the comparative effectiveness of different rehabilitation strategies? 3) Are there patient or injury characteristics that impact the efficacy of rehabilitation? 4) What is the cost-effectiveness of various rehabilitation strategies? A multidisciplinary guideline development group used this information, in combination with their clinical expertise, to develop recommendations for the type and timing of rehabilitation. The benefits and harms, financial impact, acceptability, feasibility and patient preferences of each recommendation were carefully considered. **Results:** We made the following recommendations. 1) We suggest rehabilitation be offered to patients with acute spinal cord injury when they are medically stable and can tolerate required rehabilitation intensity. 2) We suggest body weight-supported treadmill training as an option for ambulation training in addition to conventional overground walking, depending on resource availability, context, and local expertise. 3) We suggest that individuals with acute and subacute cervical SCI be offered functional electrical stimulation as an option to improve hand and upper-extremity function. 4) Based on the absence of any clear benefit, we suggest not offering additional training in unsupported sitting beyond what is currently incorporated in standard rehabilitation. **Conclusion:** These guidelines should be implemented into clinical practice to improve outcomes and reduce morbidity in patients with SCI by promoting standardization of care, decreasing the heterogeneity of management strategies and encouraging clinicians to make evidence-based decisions.

0058

Definitions for biomechanical and hardware-related complications in patients treated surgically for degenerative cervical myelopathy. ***Stefan Lange[1], Lindsay Tetreault[1], Silky Chotai[2], Michael Kryshtalskyj[3], Allan Martin[1,4], Christopher Ahuja[1,4], Aria Nouri[1], Clinton Devin[2], Michael Fehlings[1,4].*** **From the [1]Toronto Western Hospital, Toronto, Ont.; [2]Vanderbilt University, Nashville, Tenn.; [3]Western University, London, Ont.; and [4]University of Toronto, Toronto, Ont.**

Background: Degenerative cervical myelopathy (DCM) is a progressive, degenerative spine disease that is often treated surgically. Reported rates of surgical complications vary substantially across the literature and depend on definitions, surgeon experience, study design and methods of data collection. There is a pressing need to develop high-quality standardized definitions of surgical complications in order to accurately evaluate the safety of surgical procedures. This review aims to 1) outline how biomechanical and hardware-related complications are defined in the literature and 2) evaluate the quality of definitions using a novel 4-point rating system. **Methods:** An electronic database search was conducted in MEDLINE, MEDLINE in Process, EMBASE and Cochrane Central Register of Controlled Trials for studies that reported on complications related to DCM surgery and included at least 10 surgically treated patients. Data extracted included study design, surgical details and definitions and rates of surgical complications. A 4-point rating scale was developed to assess the quality of definitions for each complication.

Results: Our search yielded 3582 citations, 76 of which met eligibility criteria and were summarized in this review. Defined complications included nonunion (n = 55), adjacent segment pathology (n = 16), sagittal instability (n = 13), graft subsidence (n = 10), pseudoarthrosis (n = 7), vertebral slip (n = 5), graft dislodgement (n = 4), postoperative kyphosis (n = 2), heterotopic ossification (n = 2), graft collapse (n = 2), hinge fracture (n = 2) and spring-back closure (n = 1). Identification of complications was based on qualitative and quantitative criteria, often observed on radiographs or computed tomography scans. Reported rates of nonunion or pseudoarthrosis (0.0%–51.6%) and adjacent segment pathology (0.0%–60.0%) varied substantially among studies. The incidence of subsidence differed depending on whether it was evaluated qualitatively (3.2%–3.3%) or quantitatively (10.8%–36.2%). Rates of graft dislodgement varied minimally across studies (0.2%–1.7%). **Conclusion:** Reported incidence of various biomechanical and hardware-related complications vary widely in DCM surgery, especially for nonunion/pseudoarthrosis, adjacent segment pathology and instability.

0059

A review of definitions for dysphagia and dysphonia in patients treated surgically for degenerative cervical myelopathy. ***Lindsay Tetreault*[1], *Stefan Lange*[1], *Silky Chotai*[2], *Michael Kryshtalskyj*[3], *Allan Martin*[1,4], *Anick Nater*[1,4], *Christopher Ahuja*[1,4], *Clinton Devin*[2], *Aria Nouri*[1], *Michael Fehlings*[1,4]. From the [1]Toronto Western Hospital, Toronto, Ont.; [2]Vanderbilt University, Nashville, Tenn.; [3]Western University London, Ont.; and [4]University of Toronto, Toronto, Ont.**

Background: Reported rates of dysphagia and dysphonia following surgery for degenerative cervical myelopathy (DCM) vary substantially in the literature and are often dependent on method of data collection, diagnostic strategies, study design and definitions. This review aims to 1) outline how dysphagia and dysphonia are defined in the literature and 2) assess the quality of definitions using a novel 4-point rating system. **Method:** An electronic database search was conducted in MEDLINE, MEDLINE in Process, EMBASE and Cochrane Central Register of Controlled Trials for studies that reported on dysphagia, dysphonia or other related complications of DCM surgery and included at least 10 patients. Data extracted included study design, surgical details, definitions and rates of complications. A 4-point rating scale was developed to assess the quality of definitions for each complication. **Results:** Our search yielded 3582 citations, 15 of which met eligibility criteria and were summarized in this review. Defined complications included dysphagia (n = 13), dysphonia (n = 2), swelling complications (n = 2) and voice fatigue (n = 1). Rates of dysphagia varied substantially (0.0%–43.1%) depending on whether this complication was patient-reported (0.0%–10.9%), detected using a modified Swallowing Quality of Life questionnaire (43.1%) or Bazaz criteria (8.8%–50.0%), or diagnosed using an extensive protocol consisting of clinical assessment, a bedside swallowing test, evaluation by a speech and language pathologist and a modified barium swallowing test/fibreoptic endoscopy (42.9%). The reported incidence of dysphonia ranged from 0.63% to 36.5% depending on definitions (patient-reported versus patient-reported and confirmed by laryngoscope) and timing of postoperative evaluation. **Conclusion:** There is substantial variability in reported rates of dysphagia and dysphonia. As a result, there is a pressing need to standardize definitions; unification of terminology will enable improved evaluation of the overall safety of surgery, important risk factors and the impact of these complications on recovery rate, patient satisfaction and costs.

0060

Symptomatic spinal metastasis: a systematic literature review of the preoperative prognostic factors for survival, neurological, functional and quality of life outcomes in surgically treated patients and methodological recommendations for prognostic studies. ***Anick Nater*[1], *Allan Martin*[1,2], *Arjun Sahgal*[3], *David Choi*[4], *Michael Fehlings*[1,2]. From the [1]University of Toronto, Toronto, Ont.; [2]Toronto Western Hospital, Toronto, Ont.; [3]Sunnybrook Hospital, Toronto, Ont.; and [4]The National Hospital for Neurology and Neurosurgery, London, UK.**

Background: Although several clinical prediction rules (CPRs) of survival exist for patients with symptomatic spinal metastasis (SSM), these have variable prognostic ability, and there is no recognized CPR for health-related quality of life (HRQoL). We undertook a critical appraisal of the literature to identify key preoperative prognostic factors of clinical outcomes in patients with SSM who were treated surgically. The results of this study could be used to modify existing or develop new CPRs. **Methods:** Seven electronic databases were searched (1990–2015) without language restriction to identify studies that performed multivariate analysis of preoperative predictors of survival, neurologic, functional and HRQoL outcomes in surgical patients with SSM. Individual studies were assessed for class of evidence. The strength of the overall body of evidence was evaluated using GRADE for each predictor. **Results:** Among 4818 unique citations, 17 were included; all were in English, rated class III and focused on survival, revealing a total of 46 predictors. The strength of the overall body of evidence was very low for 39 and low for 7 predictors. Owing to considerable heterogeneity in patient samples and prognostic factors investigated as well as several methodological issues, our results had a moderately high risk of bias and were difficult to interpret. **Conclusion:** The quality of evidence for predictors of survival was, at best, low. We failed to identify studies that evaluated preoperative prognostic factors for neurologic, functional or HRQoL outcomes in surgical patients with SSM. We formulated methodological recommendations for prognostic studies to promote acquiring high-quality evidence to better estimate predictor effect sizes to improve patient education, surgical decision-making and development of CPRs.

0061

Clinical guideline in managing perioperative spinal cord injury: results from a survey of the AOSpine International community. ***Anick Nater*[1,2], *Jean-Christophe Murray*[1,2], *Lindsay Tetreault*[2], *Aria Nouri*[1,2], *Allan Martin*[1,2], *Michael Fehlings*[1,2]. From the [1]University of Toronto, Toronto, Ont.; and [2]Toronto Western Hospital, Toronto, Ont.**

Background: This survey aimed to investigate the awareness and usage of clinical guideline(s), how spine surgeons feel about and manage perioperative spinal cord injury (SCI), how they perceive the value of developing a guideline for the management of perioperative SCI and their likelihood of using this guideline in their

clinical practice. **Methods:** The AOSpine International community was invited to participate in an electronic survey; staff surgeons and surgical residents performing spine surgery were presented with 2 clinical scenarios describing perioperative SCI. We analyzed results from the entire sample as well as differences among respondents, such as specialty, geographic regions, level of training and comfort. **Results:** Of the 770 respondents, whereas 85.6% are aware of guideline(s), 79.0% reported using them. Among 485 staff surgeons dedicating more than 50% of their practice to spine surgery, 1) 53.6% reported not feeling comfortable managing a patient who wakes up quadriplegic after a posterior cervical decompression, 22.3% would consider an immediate return to the operating room, whereas 77.7% would first obtain an MRI (67.6%) or administer high-dose steroids (40.2%); 2) 57.5% reported not feeling comfortable managing a patient with a complete loss of lower-extremity somatosensory and motor-evoked potentials after closing a T7 pedicle subtraction osteotomy; and 66.8% considered the release of the correction as the most important intervention to maximize recovery. Also, 90.3% believed that a guideline for the management of perioperative SCI would be useful, and 93.8% would be likely to use it. **Conclusion:** The majority of respondents are aware of and routinely use guideline(s) in their practice. Staff spine surgeons used various strategies, and despite considerable training and experience, most do not feel comfortable managing perioperative SCI. However, they highly value the creation and are likely to use a guideline for the management of perioperative SCI.

0065

Congenital cervical fusion as a risk factor for development of degenerative cervical myelopathy. ***Aria Nouri*[1,2], *Allan Martin*[1,2], *Stefan Lange*[1,2], *Mark Kotter*[1], *David Mikulis*[1], *Michael Feblings*[1,2]. From the [1]University of Toronto, Toronto, Ont.; and [2]Toronto Western Hospital, Toronto, Ont.**

Background: Congenital fusion of cervical vertebrae, including Klippel–Feil syndrome (KFS), is a suspected risk factor for the development of degenerative cervical myelopathy (DCM). This study aimed to establish prevalence and degenerative patterns of congenital cervical fusion (CCF) among a global cohort of patients undergoing surgical treatment for DCM. **Methods:** Data from 3 prospective DCM studies were merged, including clinical data for 813 patients and imaging for 592 patients. CCF was diagnosed by the presence of fused cervical vertebrae without signs of degenerative fusion, and a subgroup was defined by the presence of the characteristic wasp-waist sign seen in KFS. Clinical and imaging characteristics of patients with CCF and the KFS subgroup were compared with the remainder of DCM patients. **Results:** Twenty-three CCF patients (14 with KFS) were identified, resulting in a prevalence of 3.9% (2.4% KFS). Patients with CCF were older (p = 0.02), had more operated levels (p = 0.01), had greater rates of ossification of the posterior longitudinal ligament (p = 0.02) and demonstrated worse degenerative changes at C3–4, including spinal cord compression (p = 0.002) and T2WI signal hyperintensity (p = 0.04). Levels adjacent to fusions showed a trend toward increased spinal cord compression (p = 0.09), with fusions at C3–4 or above showing cord compression below in 9 of 10 patients, fusions at C5–6 or below having cord compression above in 8 of 8 patients and 2 of 2 patients with C4–5 fusion having cord compression both above and below. **Conclusion:** The prevalence of CCF and KFS is greater among our surgical DCM cohort than previously reported for the general population, suggesting that these patients are predisposed to developing DCM. CCF patients also have an altered pattern of degenerative changes, seemingly related to adjacent segment degeneration that preferentially affects the mid-cervical level.

0078

Cohort demographics and patient factors associated with interbody fusion in low grade lumbar degenerative versus isthmic spondylolisthesis: a CSORN study. ***Clayton Inculet*, *Jennifer Urquhart*, *Parham Rasoulinejad*, *Chris Bailey*. From Western University, London, Ont.; and London Health Sciences Centre, London, Ont.**

Background: Previous studies have commonly used a combined cohort of both degenerative spondylolisthesis (DSPL) and isthmic spondylolisthesis (ISPL). The aim of this study was to compare the characteristics of patients with DSPL or ISPL and to determine the patient factors that influenced utilization of an interbody device (ID). **Methods:** Patients undergoing interbody fusion or posterolateral fusion who were diagnosed with grade I or grade II ISPL or DSPL were retrospectively identified from the Canadian Spine Outcomes and Research Network (CSORN) study. Patients were excluded if they were younger than 18 years, lost to follow-up before 6 weeks, or had previous lumbar surgery. Comparison was performed between groups using descriptive analysis. Variables that were significant on univariate analysis or were considered clinically important for the determination of preoperative patient factors associated with ID were included in a multivariate backward stepwise logistic regression model. **Results:** A total of 119 patients had ISPL and 339 had DSPL. DSPL was more common in women, and patients with DSPL were older, less likely to smoke and more likely to have comorbidities ($p < 0.02$ for all comparisons). The majority of patients with DSPL presented with neurogenic claudication, whereas the majority of patients with ISPL had radicular pain ($p < 0.0001$). Patients in the latter group also had neurologic deficits (p = 0.0001) and worse back pain at baseline (7.3 ± 2.0 v. 6.7 ± 2.5, p = 0.033). Spondylolisthesis was more common at the L4–5 level in DSPL, whereas it was more common at the L5-S1 level in ISPL. More patients in the DSPL group had multilevel disease necessitating multilevel fusion (p = 0.011). A similar proportion of patients had ID in the 2 groups (79.8% DSPL v. 82.4% ISPL, p = 0.402). For ISPL the factors associated with ID utilization were higher grade of spondylolisthesis and radiculopathy as chief complaint. In contrast, the factors associated with ID utilization in DSPL were age younger than 65 years, single-level fusion, neurologic symptom as a chief complaint, and Oswestry Disability Index score greater than 56. **Conclusion:** DSPL and ISPL differ with respect to demographic and patient characteristics associated with utilization of ID.

0082

The effect of thoracolumbar anatomy on pedicle screw accuracy. ***Kyle Raasck*, *Ahmed Aoude*, *Alex Munteanu*, *Jeff Golan*, *Michael Weber*. From the McGill University Faculty of Medicine, Montreal, Que.**

Background: Pedicle screws have been used for posterior spinal fixation since the free-hand technique was first reported in 1959.

Multiple methods have since been developed to facilitate more accurate screw placement, such as stereotactic guiding and introperative fluoroscopy, though they also increase radiation exposure and operative interval. Pedicle screws remain technically demanding to place. We propose that a predominant factor of pedicle screw breach is due to the inherent vertebral anatomy involved at a given spinal level. The study aims to investigate the inverse correlation between breach incidence and vertebral isthmus width. **Methods:** We retrospectively reviewed the postoperative computed tomography (CT) scans of 91 patients who underwent thoracolumbar (T2–L5) surgery at the Jewish General Hospital. Breach incidence was computed and a Fisher exact test was performed. The average isthmus width by spinal level, reported by Zindrick in 1986 was then compared with the collected breach incidences by spinal level. A regression analysis and Pearson correlation was performed. **Results:** A total of 652 pedicle screws were analyzed, and 253 breaches were found. Breach incidence was higher in the thoracic than the lumbar spine (Fisher exact test, $p < 0.0001$) and medial breach was most common. The 2 spinal levels with the thinnest average isthmus width — T4 and T5 — had the highest breach incidence, whereas the 2 spinal levels with the thickest average isthmus width — L4 and L5 — had the lowest breach incidence. Breach incidence and isthmus width were shown to have a significant inverse correlation with an R^2 of 0.7 (Pearson correlation, $p < 0.0001$). **Conclusion:** A thinner vertebral isthmus width significantly increases the pedicle screw breach incidence. The smaller size and complex pedicle morphology of the thoracic spine was breached more than twice as frequently as the larger pedicles of the lumbar spine, which allow for more degrees of freedom. Image-guided assistance may be most useful where breach incidence is highest and isthmus width is lowest, particularly between T3 and T6.

0083

The impact of mean arterial pressure on functional outcome post–acute spinal cord injury: a scoping systematic review of animal models. ***Frederick Zeiler, Behzad Sabit, Neil Berrington*. From the Universty of Manitoba, Winnipeg, Man.**

Background: The purpose of this study was to perform a scoping systematic review on the animal literature surrounding mean arterial blood pressure (MAP) and functional outcomes post–acute spinal cord injury (ASCI). **Methods:** We performed a systematic review of the literature, searching MEDLINE, BIOSIS, EMBASE, Global Health, SCOPUS and the Cochrane Library from inception to January 2015. We also performed a hand search of various published meeting proceedings. Through a 2-step review process involving 2 independent reviewers, we selected articles for the final review based on predefined inclusion criteria. Ten studies were included within the final systematic review. A variety of animal models were used within these studies. All included studies had some objective means of documenting functional outcome postmanipulation of the MAP. **Results:** Four studies could be considered to be "positive studies," showing some neurologic improvement or beneficial effect to having the blood pressure manipulated. Two studies showed worse functional outcomes secondary to episodes of hypotension. Four studies failed to show an association between MAP and functional outcome within the animal models. **Conclusion:** This review concludes that within the animal literature, there is insufficient evidence to draw a conclusion about the effect of MAP on neurologic outcome in animal models of ASCI.

0094

An expert nonphysician back pain screening program — 7-year, 4000-patient experience. ***Brett Dunlop*. From McMaster University, Hamilton, Ont.**

Background: The purpose of this study was to report on the 7-year experience of an innovative back pain screening program. **Methods:** The 4000+ patient experience was reviewed with specific interest in diagnosis, surgical referral rate and patient disposition. **Results:** In total, 66% of those screened were felt to have benign nonsurgical back pain, and conservative care was facilitated or a care plan communicated to the referring physician. A total of 23% had features consistent with a surgical diagnosis, and surgical care was expedited. The remaining 11% had back pain from a nonspinal pathology, mild symptoms, or for other reasons were poor surgical candidates. It was worrisome that this group included patients with hip arthritis, aortic aneurysm, impending bisphosphonate fracture and other serious medical conditions presenting as back or leg pain. **Conclusion:** The screening program has been well used. The program has helped expedite surgical care and reduce the number of patients waiting for surgical consultation. Screening has identified many back pain symptoms of a nonspinal origin, some indicating serious medical conditions, in patients who were otherwise languishing on waiting lists.

0096

Preoperative characteristics of elderly patients undergoing multilevel spinal fusion surgery — a preliminary report from prospective evaluation of elderly deformity surgery: PEEDS. ***So Kato*[1], *Stephen Lewis*[1], *Sigurd Berven*[2], *Lawrence Lenke*[3], *Christopher Shaffrey*[4], *David Polly*[5]. From the [1]University Health Network, Toronto, Ont.; [2]University of California, San Francisco, San Francisco, Calif.; [3]Columbia University Medical Center, New York, NY; [4]University of Virginia, Charlottesville, Va.; and [5]University of Minnesota, Minneapolis, Minn.**

Background: The objective of this preliminary report is to describe the baseline characteristics of the patients enrolled in the study and to capture the trends in patient selection. **Methods:** We undertook a prospective observational study with 12 international sites of patients older than 60 years with no previous fusion surgery who underwent a minimum 5-level lumbar spinal fusion. The demographic data obtained included age, sex, work status, body mass index (BMI), comorbidities, animal fluency test result, smoking history and bone mineral density. We compared them with the data in the general population available in the literature or national surveys in North America. **Results:** A total of 220 patients were included (45.0% in North America, 38.6% in Asia and 16.4% in Europe). In total, 65.0% of patients were in their sixties, 34.1% in their seventies and 0.9% in their eighties. Women accounted for 80.0% of the cohort. Employment rate was 15.0% and comparable to the general elderly population in Canada (12.8%). Median BMI was 25.4, whereas 78% of elderly Canadians have a BMI above 25. Smoking rate was lower than

the national survey result (4.5% v. 8.5%). Diabetes (11.4% v. 25.9%), chronic pulmonary disease (8.2% v. 12.1%) and moderate to severe renal disease (4.1% v. 26.0%) were less frequent than the survey results. Mean animal fluency test result was 20.4 ± 6.8, which corresponds to that of individuals in their forties and fifties in the general population. The mean spine T-score was 0.0 ± 2.2, which is equivalent to that of a healthy 30-year-old adult. **Conclusion:** The present multicentre prospective study revealed that the baseline characteristics of the enrolled patients were different from the population norms, and they tended to be healthier. There is a considerable selection process for the elderly population to be candidates for major spine surgeries.

0110

Neurotrauma after jumping over the United States–Mexico border wall: case series and cost analysis. ***Wyatt Ramey, R. John Hurlbert.*** **From Banner University of Arizona Medical Center, Tucson, Ariz.**

Background: While attempting to immigrate, nearly 400 000 Mexican citizens unlawfully cross the United States–Mexico border annually. This imparts well-known economic challenges to border states, but there is also substantial impact on the health care system. Of particular relevance is the incidence of neurotrauma after falling from the border wall, which can reach a height of 21 feet. We report an analysis of patient presentation, treatment and associated costs in this patient population over a 4-year period. **Methods:** The medical records of patients diagnosed with spine and/or intracranial trauma were retrospectively reviewed at 1 institution. Basic demographics, diagnoses, types of surgery, month of presentation and hospital cost were analyzed. **Results:** Between 2012 and 2016, 63 patients were diagnosed with neurotrauma after falling from the border wall. Thirty-five patients were male, and average age was 34 years. Average length of stay was 5.9 days. Forty-nine patients (78%) suffered spine fractures, and 18 required fusion with or without decompression. Fourteen patients (22%) experienced intracranial injury, with 3 of them requiring surgery. Injuries more commonly presented in the spring (44%), followed by summer (24%), with an overall downward annual trend in the number of injuries. Traumatic brain injury was associated with longer and more expensive hospital stays, whereas spine injuries occurred more frequently and often required costly surgeries with instrumentation. **Conclusion:** Neurotrauma represents a major reason for admission following injury when falling from the United States–Mexico border wall. In the current political and economic climate, this patient population is exceedingly relevant and requires ongoing efforts on both sides of the border to minimize both socioeconomic and health care impacts.

0125

Spinal intraoperative 3D navigation: correlation between clinical and absolute engineering accuracy. ***Daipayan Guha*[1]**, ***Raphael Jakubovic*[2]**, ***Shaurya Gupta*[1]**, ***Naif Alotaibi*[1]**, ***Albert Yee*[1,3]**, ***Victor Yang*[1,3]**. **From the [1]University of Toronto, Toronto, Ont.; [2]Ryerson University, Toronto, Ont.; and [3]Sunnybrook Health Sciences Centre, Toronto, Ont.**

Background: Spinal computer-assisted navigation (CAN) may guide instrumentation placement, reliably reducing screw breach rates. Definitions of screw breach, if reported, vary widely across studies. Absolute quantitative error is theoretically a more precise and generalizable metric of navigation accuracy. It has also been computed variably and reported in less than one-quarter of clinical studies of CAN-guided pedicle screw accuracy. Here, we characterize the correlation between clinical pedicle screw accuracy based on postoperative imaging and absolute quantitative navigation accuracy. **Methods:** We reviewed a prospectively collected series of 209 pedicle screws placed with CAN guidance in 30 patients undergoing open posterior thoracolumbar instrumentation. All patients underwent postoperative computed tomography (CT). Screws were graded clinically by multiple independent raters using the Heary and 2 mm classifications. Absolute screw accuracies were quantified by the translational and angular error in each of the axial and sagittal planes. **Results:** Acceptable screw accuracy was achieved for significantly fewer screws based on 2 mm grade versus Heary grade (92.6% v. 95.1%, $p = 0.036$), particularly in the lumbar spine. Interrater agreement was good for the Heary classification and moderate for the 2 mm grade, significantly greater among radiologists than surgeon raters. Mean absolute translational/angular accuracies were 1.75 mm/3.13° and 1.20 mm/3.64° in the axial and sagittal planes, respectively. There was no correlation between clinical and absolute navigation accuracy. Surgeons appear to compensate for perceived translational navigation error by adjusting screw medialization angle. **Conclusion:** Radiographic classifications of pedicle screw accuracy vary in sensitivity across spinal levels as well as in interrater reliability. Correlation between clinical screw grade and absolute navigation accuracy is poor, as surgeons appear to compensate for perceived navigation registration error. Future studies of navigation accuracy should report absolute translational and angular errors. Clinical screw grades based on postoperative imaging may be more reliable if performed in multiple by radiologist raters.

0126

Optical topographic imaging for spinal intraoperative 3D navigation in minimally invasive approaches: initial preclinical experience. ***Daipayan Guha*[1]**, ***Raphael Jakubovic*[2]**, ***Shaurya Gupta*[1]**, ***Albert Yee*[1,3]**, ***Victor Yang*[1,3]**. **From the [1]University of Toronto, Toronto, Ont.; [2]Ryerson University, Toronto, Ont.; and [3]Sunnybrook Health Sciences Centre, Toronto, Ont.**

Background: Computer-assisted 3D navigation may guide spinal instrumentation. A novel optical topographic imaging (OTI) system for spinal navigation has been developed and described separately. Although it offers comparable accuracy and significantly faster registration relative to current navigation systems, OTI to date has been applied only to open posterior exposures. Here, we explore the utility of OTI in minimally invasive (MIS) approaches. **Methods:** Mini-open midline posterior exposures were performed in 5 human cadavers. The spinous process and medial half of the bilateral laminae were exposed at T2, T6, T10 and L3. The retractor width was increased serially to create exposures of 25, 30, 35 and 40 mm^2. The exposed anatomy at each size was then registered to a preoperative thin-slice computed tomography (CT) scan. Using the second-smallest exposure resulting in successful registration,

screw tracts were created using a tracked awl and gearshift probe, and an appropriately sized screw was placed. Navigation data were compared with screw positions on postoperative CT imaging, and the absolute translational and angular deviations were computed. **Results:** Thirty-seven cadaveric screws were analyzed: 8 pedicle screws at T2, 10 pedicle screws at T6, 9 pedicle screws at T10, and 4 pedicle and 6 cortical screws at L3. Overall absolute translational errors were 1.79 mm ± 1.43 mm and 1.81 mm ± 1.51 mm in the axial and sagittal planes, respectively. Absolute angular deviations were 3.81° ± 2.91° and 3.45° ± 2.82°, respectively. There were no differences in errors between levels, nor between L3 cortical and pedicle screws. The number of surface points registered by the navigation system correlated positively with the likelihood of successful registration (odds ratio 1.02, 95% CI 1.009–1.024, $p < 0.0001$), but not with any absolute navigation error, independent of the size of the exposure. **Conclusion:** Optical machine vision is a novel navigation technique previously validated for open posterior exposures. OTI has comparable accuracy for mini-open MIS exposures, with the likelihood of successful registration affected more by the geometry of the exposure than its size.

0127

Optical topographic imaging for intraoperative 3D navigation in the cervical spine: accuracy validation and initial clinical feasibility. ***Daipayan Guha*[1], *Raphael Jakubovic*[2], *Shaurya Gupta*[1], *Michael Fehlings*[1,3], *Albert Yee*[1,4], *Victor Yang*[1,4]. From the [1]University of Toronto, Toronto, Ont.; [2]Ryerson University, Toronto, Ont.; [3]Toronto Western Hospital, Toronto, Ont.; and [4]Sunnybrook Health Sciences Centre, Toronto, Ont.**

Background: Computer-assisted 3D navigation may guide spinal instrumentation. Current systems are hampered by cumbersome registration and inability to account for intraoperative tissue movement. A novel optical topographic imaging (OTI) system was developed for craniospinal neuronavigation and has been described previously in the thoracolumbar spine. Here, we validate its accuracy in the mobile cervical spine **Methods:** Initial validation was performed in 4 human cadavers. Intraoperative registration was performed to thin-slice preoperative computed tomography (CT). A tracked drill guide was used to navigate screw tracts at all levels. Lateral mass screws were placed at C1 and C3–6, pars screws at C2 and pedicle screws at C7. Navigation data were compared with screw positions on postoperative CT scans, and the absolute translational and angular deviations were computed. Clinical validation was subsequently performed in 6 patients undergoing open posterior cervical instrumentation. **Results:** Fifty-three cadaveric screws were analyzed: 5 lateral mass screws at C1, 32 at C3–6, 8 pars screws at C2 and 8 pedicle screws at C7. Absolute translational errors were 1.66 mm ± 1.18 mm and 2.08 mm ± 2.21 mm in the axial and sagittal planes, respectively. Absolute angular deviations were 4.11° ± 3.79° and 6.96° ± 5.40°, respectively. In hierarchical linear modelling, adjusting for differences between cadavers, C7 pedicle screws demonstrated decreased axial translational error relative to all other screws (0.51 mm ± 0.36 mm, $p = 0.001$). Twenty-two clinical screws were analyzed: 2 pars screws at C2, 14 lateral mass screws at C3–5 and 6 pedicle screws at C7. Absolute translational errors were 1.52 mm ± 1.32 mm and 1.06 mm ± 0.97 mm in the axial and sagittal planes, respectively. Absolute angular deviations were 3.69° ± 2.63° and 2.83° ± 2.65°, respectively. There were no differences in errors between levels. There were no facet, canal or foraminal violations and no neurovascular injuries. **Conclusion:** OTI is a novel navigation technique allowing efficient initial and repeat registration. Accuracy, even in the more mobile cervical spine, is comparable to current spinal neuronavigation systems.

0129

Computer-assisted intraoperative 3D navigation: trends and outcomes among Ontario spinal surgeons. ***Daipayan Guha*[1], *Ali Moghaddamjou*[1], *Albert Yee*[1,2], *Victor Yang*[1,2]. From the [1]University of Toronto, Toronto, Ont.; and [2]Sunnybrook Health Sciences Centre, Toronto, Ont.**

Background: Computer-assisted navigation (CAN) has become the standard of care in cranial neurosurgery for the localization of subsurface structures. In spinal procedures, CAN guidance has been proven to increase the accuracy of instrumentation. However, adoption remains limited owing to workflow restrictions, steep learning curves and high costs. Here, we aim to assess the usage of spinal CAN among Ontario surgeons to identify potential gaps in application and impact on patient outcomes. **Methods:** A prospectively collected database of billed provincial health insurance fee codes and corresponding diagnostic codes was reviewed retrospectively from 2002 to 2014. Patients undergoing instrumented spinal fusions or percutaneous vertebroplasty/kyphoplasty were identified. A combination of fee codes and ICD-9 codes were applied to distinguish the surgical approach, spinal level and indication for surgery (i.e., trauma, degenerative, deformity, infection, tumour). The use of intraoperative navigation was determined for each identified case. **Results:** A total of 4607 cases of instrumented spinal fusion were identified, with more than half performed between 2010 and 2014. A total of 35.3% of patients were older than 65 years, with no sex predilection. Most (63.2%) procedures were performed by orthopedic surgeons, with the remainder by neurosurgeons. Most (86.0%) identified cases occurred in an academic institution. Of 2239 cases with identifiable etiology, CAN was used in 8.8%. In univariate analyses, CAN was used more often by neurosurgeons than orthopedic surgeons (20.9% v. 12.4%, $p = 0.002$) and in academic institutions than in community hospitals (15.9% v. 12.3%, $p = 0.008$), and it was performed more often in/after 2010 than earlier (18.9% v. 8.9%, $p < 0.001$). Differences in CAN usage by specialty and year remained significant in multiple logistic regression modelling. **Conclusion:** Intraoperative navigation for spinal procedures has proven benefit for instrumentation accuracy, but is used preferentially by neurosurgeons at large academic institutions. The substantial increase in CAN usage after 2010 may reflect improvements in available technologies; however, significant gains must be made in cost and usability to improve access among all surgical disciplines and in smaller institutions. This is a preliminary analysis, with results forthcoming on the impact of CAN usage on surgical revision rates.

0007

Spontaneous spinal epidural hematoma management: a case series and literature review. ***Kyle Raasck*[1], *Ahmed Habis*[1], *Ahmed Aoude*[1], *Leonardo Simões*[1], *Fernando Barros*[2], *Rudy Reindl*[1], *Peter Jarzem*[1]. From the [1]McGill University**

Faculty of Medicine, Montreal, Que.; and [2]Oeste D'Or Hospital, Campo Grande, Rio de Janeiro, Brazil.

Background: Spontaneous spinal epidural hematoma (SSEH) manifests from blood accumulating in the epidural space, compressing the spinal cord and leading to acute neurologic deficits. Suboptimal therapeutic principles contribute to SSEH's 5.7% mortality and a morbidity rate 10 times as high. Standard therapy is decompressive laminectomy, though spontaneous recoveries have been reported. Nonsurgical management is a viable course of action that is often overlooked in current literature, although which patients will benefit from surgery remains unclear. This study aims to investigate parameters that affect SSEH's progression, outlining a best practice therapeutic approach. **Methods:** A literature review yielded 65 cases from 12 studies. Furthermore, 6 cases were presented from our institution. All data were analyzed under the American Spinal Injury Association (ASIA) guidelines. **Results:** More than 50% of SSEH patients do not fully recover. In total, 30% of patients who presented with an ASIA score of A did not improve with surgery, though every SSEH patient who presented with an ASIA score of C or D improved. Spontaneous recovery is rare — only 23% of patients were treated nonsurgically. Patients managed nonsurgically were 3 times as likely to have an initial ASIA score of D — the least severe score before full recovery — than their surgically managed counterparts. This indicates that nonsurgical management tends toward low-risk patient presentations. However, not all patients treated nonsurgically present with minimal neural deficit. In total, 33% of patients managed nonsurgically had an initial ASIA score of A or B, all improving to a score of D or E without surgery. Furthermore, 73% of the nonsurgically managed patients made a full recovery, as opposed to the 48% of patients managed surgically who fully recovered. **Conclusion:** The degree of preoperative neural deficit is a major prognostic factor. If spontaneous recovery is manifested, the nonsurgical approach is feasible, overlooked and 25% more effective. Decompressive laminectomy should continue to remain readily available should the patient's impaired neurologic status stagnate or worsen, supported by the inverse correlation between operative interval and extent of recovery.

0008

Description and results of a comprehensive care protocol for overnight stay spine surgery in adults. ***Drew Bednar.*** **From McMaster University, Hamilton, Ont.**

Background: The purpose of this study was to define the probability of successful morning-after discharge after adult spine surgery achieved with a standard care protocol as applied to patients with a large variety of common degenerative spine disorders. **Methods:** A standardized protocol of patient preparation, preoperative comorbidities optimization and perioperative care was applied in a prospective cohort of 126 patients. Office and hospital chart records were reviewed for relevant outcomes. **Results:** Fully 122 of 124 appropriately selected cases were able to successfully achieve uneventful same-day discharge without any need for readmission, unscheduled early emergency department or clinic visits, or other major complications. **Conclusions:** A wide variety of common degenerative spinal pathology in adults can be routinely managed on an overnight stay basis without requirement for formal hospital inpatient admission.

0029

Sacral osteotomy to decrease pelvic incidence in patients with sagittal malalignment in the setting of normal lumbar lordosis. ***So Kato, Stephen Lewis, Sam Kesben, Nasir Quraishi.*** **From the Hospital for Sick Children, Toronto, Ont.**

Background: We describe a technique of lumbosacral osteotomy to address sagittal malalignment with associated coronal imbalance and pelvic incidence (PI)–lumbar lordosis (LL) mismatch. **Methods:** A 16-year-old girl presented with low back pain and right leg pain. Standing anteroposterior radiograph showed scoliosis with a Cobb angle of 34º and 5.7 cm of coronal imbalance. A lateral radiograph showed a sacralized L5 with a PI of 85º and LL of 47º. Pedicle subtraction osteotomy through the sacralized L5 addressed the malalignment secondary to a high PI-LL mismatch of 38º. **Results:** Following alar resection, an osteotomy was performed below the L5 pedicles. The cranial parts, including the superior end plate and intervertebral disc, were removed. Osteotomy closure was achieved using the central rod technique. L5 incidence was reduced from 59º to 33º with reduced coronal malalignment. Back pain was significantly improved, and PI-LL mismatch was improved to 10º 2 years postoperatively, with no local loss of sagittal correction. **Conclusion:** In this case presenting with significant PI-LL mismatch with a lumbar lordosis in the normal range, a lumbosacral osteotomy to correct the abnormally high incidence was effective in achieving correction of both the coronal and sagittal malalignments.

0051

A clinical practice guideline for the management of patients with acute spinal cord injury and central cord syndrome: recommendations on the timing (≤ 24 hours versus > 24 hours) of decompressive surgery. ***Jefferson Wilson[1], Bizhan Aarabi[2], James Harrop[3], Brian Kwon[4], Allan Martin[1,5], Geno Merli[3], James Middleton[6], Mohammed Shamji[1], Lindsay Tetreault[1], Michael Fehlings[1,5].*** **From the [1]University of Toronto, Toronto, Ont.; [2]University of Maryland, Baltimore, Md.; [3]Thomas Jefferson University, Philadelphia, Pa.; [4]University of British Columbia, Vancouver, BC; [5]Toronto Western Hospital, Toronto, Ont.; and [6]University of Syndey, Sydney, Australia.**

Background: Preclinical evidence suggests that persistent compression of the spinal cord after a primary injury represents a reversible form of secondary injury that, if ameliorated in an expeditious fashion, may lead to reduced neural tissue injury and improved outcomes. This guideline aims to discuss the timing of surgical decompression in patients with traumatic spinal cord injury (tSCI) and central cord syndrome. **Methods:** A systematic review of the literature was conducted to address the following key questions. 1) What is the efficacy and effectiveness of early decompression (≤ 24 hours) compared with late decompression (> 24 hours) or conservative therapy based on clinically important change in neurologic status? 2) Does timing of decompression influence functional or administrative outcomes? 3) What is the safety profile of early decompression compared with late decompression or conservative therapy? 4) What is the evidence that early decompression has differential efficacy or safety in subpopulations?

5) What is the comparative cost-effectiveness of early versus late decompression? A multidisciplinary guideline development group used this information, in combination with clinical expertise, to develop recommendations for the timing of surgical decompression in patients with tSCI and central cord syndrome. The benefits and harms, financial impact, acceptability, feasibility and patient preferences of each recommendation were carefully considered. **Results:** We suggest that early surgery be considered as a treatment option in adult patients with traumatic central cord syndrome, and we suggest that early surgery be offered as an option for adult acute SCI patients regardless of level Quality of evidence for both recommendations was considered low. **Conclusion:** These guidelines should be implemented into clinical practice to improve outcomes and reduce morbidity in patients with acute SCI and central cord syndrome by promoting standardization of care, decreasing the heterogeneity of management strategies and encouraging clinicians to make evidence-based decisions.

0052

A clinical practice guideline for the management of patients with acute spinal cord injury: recommendations on the use of methylprednisolone sodium succinate. ***Michael Fehlings[1,2], Bizhan Aarabi[3], James Harrop[4], Gregory Hawryluk[5], Brian Kwon[6], Allan Martin[1,2], Geno Merli[4], James Middleton[7], Mohammed Shamji[2], Lindsay Tetreault[2], Jefferson Wilson[1].*** **From the [1]University of Toronto, Toronto, Ont.; [2]Toronto Western Hospital, Toronto, Ont.; [3]University of Maryland, Baltimore, Md.; [4]Thomas Jefferson University, Philadelphia, Pa.; [5]University of Utah, Salt Lake City, Utah; [6]University of British Columbia, Vancouver, BC; and [7]University of Syndey, Sydney, Australia.**

Background: Given its potent anti-inflammatory actions, methylprednisolone sodium succinate (MPSS) may have potential neuroprotective effects in patients with spinal cord injury (SCI) when administered at high doses. The objective of this guideline is to outline the appropriate use of MPSS in patients with traumatic SCI. **Methods:** A systematic review of the literature was conducted to address the following key questions: 1) What is the efficacy, effectiveness and safety of MPSS compared with no pharmacologic treatment, and 2) What is the evidence that MPSS has differential efficacy or safety in subpopulations? A multidisciplinary guideline development group used this information, in combination with their clinical expertise, to develop recommendations for the use of MPSS. The benefits and harms, financial impact, acceptability, feasibility and patient preferences of each recommendation were carefully considered. Based on GRADE, a strong recommendation is worded as "we recommend," whereas a weaker recommendation is indicated by "we suggest." **Results:** We suggest not offering a 24-hour infusion of high-dose MPSS to adult patients who present after 8 hours of acute SCI (moderate evidence). When started within 8 hours of injury, we suggest that a 24-hour infusion of high-dose MPSS be offered to adult patients with acute SCI as a treatment option (moderate evidence). We suggest not offering a 48-hour infusion of high-dose MPSS for adult patients with acute SCI (no included studies, expert opinion). **Conclusion:** These guidelines should be implemented into clinical practice to improve outcomes and reduce morbidity in patients with SCI by promoting standardization of care, decreasing the heterogeneity of management strategies and encouraging clinicians to make evidence-based decisions.

0054

A clinical practice guideline for the management of patients with acute spinal cord injury: recommendations on the role of baseline magnetic resonance imaging in clinical decision making and outcome prediction. ***Allan Martin[1,2], Bizhan Aarabi[3], Anthony Burns[4], James Harrop[5], Shekar Kurpad[6], Brian Kwon[7], Mohammed Shamji[2], Lindsay Tetreault[2], Jefferson Wilson[1], Albert Yee[8], Michael Fehlings[1,2].*** **From the [1]University of Toronto, Toronto, Ont.; [2]Toronto Western Hospital, Toronto, Ont.; [3]University of Maryland, Baltimore, Md.; [4]Toronto Rehabilitation Institute, Toronto, Ont.; [5]Thomas Jefferson University, Philadelphia, Pa.; [6]Medical College of Wisconsin, Milwaukee, Wis.; [7]University of British Columbia, Vancouver, BC; and [8]Sunnybrook Hospital, Toronto, Ont.**

Background: Magnetic resonance imaging (MRI) is the gold standard for imaging the spinal cord and related soft tissues; however, there remains debate about the appropriate use of MRI in patients with acute spinal cord injury (SCI), as it requires considerable resources and may be risky in trauma patients with respiratory difficulties or hemodynamic instability. This guideline aims to outline the role of MRI in clinical decision-making and outcome prediction in patients with traumatic SCI. **Methods:** A systematic review of the literature was conducted to address the following key questions and inform guideline development: 1) How does the acquisition of a baseline MRI influence management strategy(ies) and, consequently, neurologic, functional, patient-reported and safety outcomes? 2) Do spinal cord lesion characteristics, pattern and length identified on baseline MRI predict neurologic, functional, patient-reported and safety outcomes? 3) Do spinal cord characteristics identified on diffusion tensor imaging (DTI) predict neurologic, functional, patient-reported and safety outcomes? 4) Is there evidence to suggest that baseline MRI is cost-effective in patients with acute SCI? A multidisciplinary guideline development group (GDG) used this information, in combination with clinical expertise and patient input, to develop recommendations on the use of MRI in the evaluation and treatment of patients with SCI. **Results:** Based on the limited available evidence and the clinical expertise of the GDG, we suggest that MRI be performed in adult patients with acute spinal cord injury prior to surgical intervention, when feasible, to facilitate improved clinical decision-making. We suggest that MRI should be performed in adult patients in the acute period following SCI, before or after surgical intervention, to improve prediction of neurologic outcome. **Conclusion:** These guidelines should be implemented into clinical practice to improve outcomes and prognostication for patients with SCI.

0087

The impact of mean arterial pressure on functional outcome post-trauma-related acute spinal cord injury: a scoping systematic review of the human literature. ***Frederick Zeiler, Behzad Sabit, Neil Berrington.*** **From the University of Manitoba, Winnipeg, Man.**

Background: The purpose of this study was to perform a scoping systematic review on the literature surrounding mean arterial pressure (MAP) and functional outcomes following traumatic acute spinal cord injury (ASCI). **Methods:** We performed a

systematic review of the literature, searching MEDLINE, BIOSIS, EMBASE, Global Health, SCOPUS and the Cochrane Library from inception to January 2015. We also performed a hand-search of various published meeting proceedings. Through a 2-step review process involving 2 independent reviewers, we selected articles for the final review based on predefined inclusion criteria. **Results:** Nine studies were included in the final review. Only 2 were prospective studies. All studies documented some degree of objective functional outcome in relation to MAP following traumatic ASCI. Four studies documented as association between higher MAP and improved functional outcome. Five studies failed to show any association between MAP and functional outcome. **Conclusion:** Although no definitive conclusions could be reached based on the data collected, this study does give valuable insight into future avenues of research on the topic of hemodynamic management in traumatic ASCI and provides guidelines for refinement of future study design.

0124

Targeting spine surgical care to patient need for optimized outcome with the Solution-Focused Spine Patient Outcomes Questionnaire — A solution-focused survey looking into patient outcome expectations in adult reconstructive surgical spine care. ***Drew Bednar*[1], *Dina Bednar*[2]. From [1]McMaster University, Hamilton, Ont.; and [2]Canadian Solution-Focused Brief Therapy Centre, Hamilton, Ont.**

Background: There is a growing literature identifying discrepancies in how patients and surgeons perceive their spine care outcomes. Interventions strategically targeted to patient needs have the potential to improve those outcomes. This is a pilot trial testing the applicability of a simple office-based preoperative questionnaire (the Solution-Focused Spine Patient Outcomes Questionnaire, SFSPOQ) using the patient-positive principles of Solution-Focused Brief Therapy to optimally identify patients' perceived needs in approaching surgical spine care with a view to optimizing eventual long-term outcomess. **Methods:** Patients scheduled for elective surgical spine care in Dr. Bednar's practice routinely have to wait many months and so are invited to an office preoperative visit shortly before the scheduled surgery during which the care plan, risk–benefit and timelines to recovery are reviewed. In the effort to optimally understand how the patients expect to benefit from their surgery and thus to potentially optimize the perioperative and late rehabilitaion care plan, the SFSPOQ was developed as a 4-item questionnaire and completed interactively by surgeon and patient at that office visit. **Results:** We present the results of the first 30 such surveys, which reveal significant differences between surgeon-perceived issues in surgical care planning and what the patients see as their needs and hoped-for outcomes. **Conclusion:** Elective surgical spine care is an intervention largely targeted to quality of life issues and a service business where the wants and needs of the consumer are often ignored or trivialized, as surgeons make decisions that are musculoskeletally or neurologically based. Current quality of life outcomes tools are cumbersome and do not easily lend themselves to application in the clinical office setting. The SFSPOQ presents a quickly and easily applied intervention that identifies issues easily missed by the surgeon and thus brings opportunity to optimize the patient's perioperative experience.