

16th Annual Spine Academic Day

# SPINEFEST

UNIVERSITY OF TORONTO SPINE PROGRAM

Monday June 10, 2024  
**Hybrid**



Surgery

UNIVERSITY OF TORONTO

Spine Program

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## About SpineFEST

This year SpineFEST marks its 16<sup>th</sup> anniversary. SpineFEST is our Annual Academic Spine Day and the key spine event at the University of Toronto (U of T). SpineFEST brings together the spine community to disseminate knowledge of advances in spine surgery, spine care management, and spine research. The day serves as a unique educational platform for clinicians and researchers from a broad spectrum of disciplines including neurosurgery, orthopaedic surgery, chiropractic, physiatry, physical therapy, nursing, family medicine, pain medicine, biomedical engineering, and basic/clinical translational science.

## Previous Visiting Professors

2023 Professor Shekar Kurpad, Medical College of Wisconsin, Milwaukee, Wisconsin

2022 Professor Lawrence Lenke, Colombia University, New York

2021 Professor Richard Fessler, Rush University Medical Center, Chicago, Illinois

2020 Professor Marcus Stoodley, Macquarie University, Sydney, Australia

2019 Professor Praveen Mummaneni, The University of California, San Francisco

2018 Professor Sanford Emery, West Virginia University

2017 Professor Zoher Ghogawala, Tufts University School of Medicine

2016 Professor Daniel Riew, Columbia University Medical Center

2015 Professor Wilco Peul, Leiden University Medical Centre

2014 Professor Kenneth Cheung, University of Hong Kong

2013 Professor Alexander Richard Vaccaro, Thomas Jefferson University

2012 Professor Jean Dubousset, The University of Paris

2011 Professor Jens Chapman, University of Washington

2010 Professor Edward Benzel, Cleveland Clinic

2009 Professor Jeffrey Wang, University of California

**Time and location:**

- Location: BMO Education & Conference Centre, 60 Leonard Avenue, Toronto, Ontario.
- Online log-in option:
- Time: 8:00 AM to 3:00 PM (EST)
- Day Program / agenda on page 11

**About the University of Toronto Spine Program**

**Vision**

Innovation and excellence in the delivery of spine care with a unique collaborative program of clinical expertise, research, teaching, and education.

**Integration**

The University of Toronto Spine Program is a multidisciplinary collaborative unit which combines neurosurgery and orthopaedic surgery and the broad spectrum of non-operative clinical and research disciplines which are engaged in spine. The U of T Spine Program is integrated across citywide clinical and research programs at the affiliated teaching hospitals; Toronto Western Hospital (TWH) at University Health Network (UHN), Sunnybrook Health Sciences Centre (SHSC), Hospital for Sick Children (HSC), St. Michael’s Hospital (SMH) at Unity Health Toronto (UHT), and Mount Sinai Hospital (MSH) at Sinai Health System.



## Faculty Members

<b>Toronto Western Hospital @ UHN</b>	<b>St. Michael's Hospital @ UHT</b>
Michael Fehlings MD PhD FRCSC <b>(Co-Chair)</b>	Henry Ahn MD PhD
Christopher Nielsen MD FRCSC	Howard Ginsberg MD PhD FRCSC
Stephen Lewis MD MSc FRCSC	Jefferson Wilson MD PhD FRCSC
Eric Massicotte MD MBA FRCSC	Christopher Witiw MD PhD FRCSC
Y Raja Rampersaud MD FRCSC	<b>Hospital for Sick Children</b>
Suganth Suppiah MD PhD	David Lebel MD PhD FRCSC
<b>Sunnybrook Health Sciences Centre</b>	Reinhard Zeller MD FRCSC
Jetan Badhiwala MD PhD FRCSC	<b>University of Toronto</b>
Leo da Costa MD	Margarete Akens Dr med vet PhD
Joel Finkelstein MD MSc FRCSC	Carlo Ammendolia DC PhD CCRF
Michael Hardisty PhD	Mark Erwin PhD DC
Jeremie Larouche MD MSc FRCSC	Sukhvinder Kalsi-Ryan PhD
Meaghan O'Reilly PhD	Cindi Morshead BSc PhD
Farhad Pirouzmand MD MSc FRCSC	Molly Shoichet PhD FRCS
Arjun Sahgal BSc MD FRCPC	Karl Zabjek BSc MSc PhD
Cari Whyne PhD	
Albert Yee MD MSc FRCSC <b>(Co-Chair)</b>	

## Message from the Co-Directors

Colleagues,

As we approach the end of our academic year, we would like to celebrate our successes for 2023/2024. The U of T Spine Program continues to foster city-wide collaborations within the University and the affiliated hospitals while taking the lead in several key initiatives and garnering a respected academic footprint locally, nationally, and globally. Collaboration and inter-professional multi-disciplinary knowledge exchange remain key elements to our success. The Program has continued to provide a full and rich calendar of academic activities in both online and in-person formats. This has enabled continued participation from alumni and the spinal community throughout Canada and across the globe.

On June 10<sup>th</sup> this year, our Program marks the 16th Annual Spine Academic Day “SpineFEST.” At this time of the year, we congregate to highlight our spinal community’s accomplishments and disseminate recent clinical, scientific and educational advances. We are pleased to host our SpineFEST keynote speaker for the Tator-Hall Lecture, Professor Serena Hu, MD, Chief of Spine Surgery Services, Department of Orthopaedic Surgery and (by courtesy) Neurosurgery at Stanford Medical School. In leadership, Dr. Hu has been the first woman president of several prestigious surgical organizations, namely, president of the American Orthopedic Association and the Scoliosis Research Society. She has been a leader in the field of Orthopaedic and Spine Surgery with a clinical interest in spinal deformity surgery. She has numerous clinically relevant research interests which has included, for example, work to reduce complications after spine surgery. We are excited about Dr. Hu’s keynote address titled “Standing on the Shoulders of Giants: Spine Deformity Treatment over the Ages”. Please join us in welcoming Dr. Serena Hu to SpineFEST 2024!

Following her keynote lecture, there will be a symposium focusing on Enhancing Perioperative Outcomes in Spine Deformity Surgery chaired by Dr. Stephen Lewis. A number of faculty will update us on their research work related to spinal disorders. The meeting will continue with invited trainee presentations to highlight outstanding clinical and basic science research.

Many thanks to our program judges (Drs. Jeff Wilson, Joel Finkelstein, Jeremie Larouche, Chris Nielsen, Meaghan O'Reilly, Karl Zabjek, Carlo Ammendolia, Michael Hardisty, David Lebel, Margarete Akens, Chris Witiw, Cari Whyne, and Arjun Sahgal) for reviewing numerous abstract submissions. We appreciate their time and expertise. Although many excellent submissions were received, we could only designate a few Best Abstracts for oral presentations. The remaining abstract submitters will present their work at the Elevator Pitch sessions in the morning and the afternoon.

The U of T Spine Program continues to leverage our foundational education platform to help create and support a national spine surgery fellowship training curriculum for cognitive and procedural competencies. Apart from tracking fellowship training experience, our efforts have enhanced cross-institutional and collaborative Neurosurgery and Orthopaedic Surgery spinal training across Toronto Academic Health Sciences Network (TAHSN) teaching hospitals, including Toronto Western Hospital (TWH-UHN), Sunnybrook Health Sciences Centre (SHSC), Unity Health Toronto (UHT), and the Hospital for Sick Children (HSC). We support an academic hub that competitively attracts around 18 national and international clinical fellows including many additional traveling surgeons each year. For several years now, our program continues to offer both a one-year core fellowship training experience as well as two-year fellowship opportunities with a more advanced second year focus on subspecialty exposure. While the fellowships remain primarily based at one of the TAHSN hospitals, opportunities exist and have been supported for city-wide experience. Many thanks to Drs. Albert Yee, Michael Fehlings, Stephen Lewis, Eric Massicotte, Jeremie Larouche, Chris Nielsen, Joel Finkelstein, Howard Ginsberg, Henry Ahn, and Reinhard Zeller for their valued help in shaping our citywide fellowship training opportunities. Building upon our Canadian Spine Society (CSS) national fellowship curriculum, our Program also continues with supporting and growing a surgical case log initiative for our citywide spine fellows. There are over 14,500 cases and procedures recorded since 2015/2016. We thank Drs. Jeremie Larouche, Tony Bateman, and Ms. Nadia Jaber for creating a successful foundational case log tracking program for our citywide fellows.

In recognizing Spine Surgery as a distinct formally designated discipline at the Royal College of Physicians and Surgeons of Canada (RCPSC) level, we have worked with national colleagues to develop an Area of Focused Competence (AFC) in spine surgery. The application for AFC diploma recognition was approved for national development in November 2021. A national Royal College working group with U of T representation and leadership has drafted 3 key documents (a trainee Portfolio highlighting minimal requirements in training, a Clinical Training Requirement CTR document which is an updated national trainee curriculum, and a Standards of Accreditation document for university training centres). Documents are currently being finalized and will soon be available to Canadian university Post Graduate Medical Education (PGME) Offices (PGME). University programs can then apply to become an accredited diploma training centre. There will be both adult and pediatric streams and an eventual stream also for staff surgeons already in established practice. We are well positioned organizationally within our program to apply and become an accredited training centre. Thanks to Drs. Albert Yee, Jeremie Larouche, Michael Fehlings, Scott Paquette, Hamilton Hall, and Ms. Nadia Jaber for taking the lead in engaging our national society, several university spine programs, and fellowship directors across Canada in this initiative. The diploma will provide a valued competency-based model for our surgical educators.

This also opens the door for new international collaborations. Several international specialty organizations have already inquired about our approach and plans.

This year, we launched our academic calendar of events on October 2<sup>nd</sup> with a welcome dinner for our incoming fellows and provided attendees with an updated on our citywide research opportunities. Many thanks to Drs. Carlo Ammendolia and Karl Zabjek who continue to lead this update and for keeping us informed on the progress of spine research in Toronto. We heard from numerous graduate students, residents, fellows, and faculty scientists.

On December 15<sup>th</sup>, Dr. Stephen Lewis continued an annual tradition of chairing a citywide fellow surgical skills course, introducing advanced anatomy of the spine with fellows performing both anterior and posterior surgical approaches, as well as spinal instrumentation. Over the past several years, Dr. Lewis has expanded this course to include advanced complex procedures including deformity osteotomy, minimally invasive surgery, and trauma techniques. The course encompasses a combination of wet lab with image guidance technology and faculty lectures with case-based discussions throughout the day. Many thanks to our industry partners: Medtronic, Stryker, DePuy Synthes, and Bioventus for their continued support of this integral training experience.

The Traumatic Spinal Cord Injury Course on Management and Classification also continued this year on January 22<sup>nd</sup> with a hybrid learning model. The program included pre-recorded lectures, online in-steps training, and in-person practicum followed by in-person case-based interactive discussions. Special thanks to Dr. Sukhvinder Kalsi-Ryan and Ms. Jaber for planning and organizing a successful hybrid training model, and many thanks to the course faculty Drs. Michael Fehlings, Jeremie Larouche, Jeff Wilson, and Julio Furlan, for their valued contributions.

On April 8<sup>th</sup>, we continued to complement the residents' surgical training with our Royal College Mock Oral course to prep senior residents in both neurosurgery and orthopedic surgery for their residency national exit examinations. We have had 3 neurosurgery and 9 orthopaedic surgery residents sit their Royal College examination this year. Drs. Jeremie Larouche and Jetan Badhiwala assumed co-chairing this established annual course. We appreciate their valued leadership in supporting and enhancing this course to meet the evolving and current format of the Royal College specialty examinations. Many thanks to Drs. Joel Finkelstein, Simon Harris and Colby Oitment for their continued support and teaching at this course. Sincere thanks to our fellow educators, Drs. Luke Reda and Colton Kennedy, for co-leading the teaching case scenarios and prepping the residents for their oral examination.

Over the past several years, our Program has been keen on bringing together citywide surgeons and trainees in multiple virtual events. The citywide Fellow Journal Club continues to be held several times a



year. On April 15th, we discussed the newly published Guidelines for the Management of Acute Spinal Cord Injury including additional related papers. Thanks to our citywide fellows Drs. Luke Reda, Colton Kennedy, and Rajesh Kumar, and our research fellow Dr. Mohammed Alvi for leading the article summaries and discussions.

We are pleased to have continued the annual Pediatric Spine Deformity Surgery course for the 2<sup>nd</sup> year on May 13<sup>th</sup>. Thanks to Dr. David Lebel for chairing and organizing this well received educational course. Many thanks also to SickKids faculty Dr. Samuel Strantzas, Ms. Jennifer Dermott, and Dr. Mark Camp for their outstanding teaching including case-based lectures.

Our academic calendar of events has continued to grow over the years with new educational initiatives being added regularly. A new course on non-operative spine treatment is under planning for introduction in our upcoming academic year. Thanks to Dr. Ammendolia for his leadership in establishing this course. We also would like to thank Dr. Chris Nielsen for taking the lead in planning and initiating a series of Clinical Case Reviews from across our city-wide hospitals with discussions framed around relevant and focused current literature. We look forward to launching these additional educational opportunities in the upcoming academic year.

Our Program continues to deliver a rich academic program leveraging several local, national, and international opportunities. We were delighted to collaborate with the U of T Dept of Neurosurgery to host and organize a resident cadaver course on Spine Peripheral Nerve Special Topics that was held May 22<sup>nd</sup> as part of the Canadian Neurological Sciences Federation (CNSF) Annual Meeting and the celebration of U of T Neurosurgery's 100<sup>th</sup> year Anniversary Event. Many thanks to Dr. Massicotte and Dr. Jetan Badhiwala for their exceptional efforts in planning and chairing this course. We have also collaborated with AO Spine North America to host an Advanced Concepts on Cervical Spine cadaver course on June 7<sup>th</sup> -8<sup>th</sup> in Toronto for attending spine surgeons and fellows from around the world. A heartfelt thank you to Dr. Fehlings and Dr. Richard Bransford for co-chairing and organizing a superb course.

Over the academic year, the Program invites several world-renowned Professors as part of our well-established Hospital-Based Visiting Professorship series. On December 18<sup>th</sup>, we were thrilled to have Dr. Daniel Sciubba (the Senior Vice President of Neurosurgery at Northwell Health) visit with the event hosted by St. Michael's Hospital, Unity Health Toronto (UHT). We enjoyed Dr. Sciubba's morning Grand Rounds talk on Managing the Challenges of Spine Tumors. His evening talk during our Greater Toronto Area (GTA) Spine Rounds on Integrating Clinical Advancements, Technology and Humanity into Neurosurgery was also very well received. Thanks to Dr. Jeff Wilson and the UHT team for organizing and hosting a

successful visiting professorship event with Dr. Sciubba. On May 23<sup>rd</sup>, the Tator-Turnbull Spinal Cord Injury Symposium took part in the 100 years of Neurosurgery at the University of Toronto celebration and the CNSF annual meeting featuring our visiting professor Dr. James Guest, a Professor of Neurological Surgery from the University of Miami. The symposium also highlighted a number of excellent SCI research presented by faculty and trainees. This year, the symposium marks its 23<sup>rd</sup> anniversary. We appreciate the continued support of Dr. Fehlings and his relentless efforts in upholding this annual legacy recognizing the substantive contributions of Dr. Charles Tator and Barbara Turnbull to the field.

We are very thrilled to have Dr. Jetan Badhiwala join our Program as a new staff spine neurosurgeon at the Sunnybrook Health Sciences Centre and an Assistant Professor of Neurosurgery at the U of T. His academic program is focused on health outcomes research in traumatic and non-traumatic spinal cord injury. Dr. Badhiwala is a well-accomplished early career surgeon with over 125 peer-reviewed papers, 50 conference abstracts, and 15 book chapters. Please join us in welcoming Jetan to our Program.

At the provincial level, our program, led by Drs. Raj Rampersaud and Jeremie Larouche in collaboration with other city-wide surgeons is advocating for further enhancements in spinal care triage to address population needs and wait times to see a specialist. Central intake opportunities and further leverage of Advanced Practice Provider (APP) expertise is aimed to bridge current clinical care gaps complementing the important work conducted already to expand the provincial degenerative spine QBP program. The Provincial Neurosurgery Ontario Expert Panel has also secured additional funding to support enhanced urgent assessment for both cranial and spine conditions. The province continues to focus on regional, central intake, and long waiter efforts alongside initiatives directed at human resource recruitment/retention, capacity, and efficiency.

We want to take this moment and celebrate the graduation of our 2023/2024 citywide spine fellows, who will be completing their fellowship training in July or later in December this year. Congratulations to Drs. Maria Pia Monjardino, Motti Zucker, Rajesh Kumar, Luke Reda; Colton Kennedy Ariel Zohar, Prarthan Amin, Peyton Lawrence, Yousef Al-Jamaan, Francois Dantas, Karlo Pedro, Hiroyuki Kato, Fahad Alotaibi, Gianfranco Ligarotti, Ran Ankory, Zsolt Zador, and Shun Hayasaka. We wish them a successful and rewarding professional career. We look forward to their continued future engagement in our Program's activities as valued alumni members.

On a final note, we are pleased to announce that an external review will be conducted by the University Department of our Program at the end of this year or early next year. Opportunities for leadership and other collaborative roles will exist at the Program directorship level. In anticipation of the Royal College AFC diploma in spine surgery, a programmatic AFC committee will need to be established within the

university's existing Post Graduate Medical Education AFC structure. By way of this note, we want to extend our appreciation to the University of Toronto Department of Surgery Spine Program Council, Program educators, and trainees for their continued dedication and remarkable contribution over many years to the numerous successes of our Program. We are privileged to benefit from the specialized and diverse knowledge of our Program members. Notably, we wish to recognize the support from the U of T Department of Surgery and Divisions of Neurosurgery and Orthopedic Surgery. Special thanks to Dr. Carol Swallow (Chair of the Department of Surgery), Dr. Peter Ferguson (Chair of Orthopedic Surgery), and Dr. Gelerah Zadeh (Chair of Neurosurgery) for their longstanding and strong Departmental and Divisional support of our University-Wide Program. We also would like to thank all our industry partners (Medtronic, DePuy Synthes, and Stryker) who have stood steadfast along our side in support of our important academic endeavours even through recent challenging pandemic years. We extend thanks this year also to Bioventus for their educational support. Special thanks to Ms. Nadia Jaber, our Program Manager, for her outstanding expertise and valued information technology and communication skills. She remains invaluable towards moving forward our collaborative agenda and is integral to the continued development and growth of our Program. She has been instrumental in adapting innovative models for us to deliver our academic content and events which continues to evolve even during this post-pandemic time. A big thank you to our Program Volunteer Ms. Delphine Li for her great help in maintaining the fellow case log and her excellent assistance in organizing our Program activities. We wish her tremendous enjoyment and success as she embarks on the next phase of her professional life in the field of medicine.

In closing, we wish to celebrate another outstanding academic year in our U of T Spine Program. We wish everyone a safe, healthy, and enjoyable summer break followed by an exciting 2024-2025 academic calendar.

Sincerely,

Michael Fehlings & Albert Yee  
Co-Directors, U of T Spine Program

## Agenda

8:00 AM	Breakfast	
8:30 AM	Opening Remarks	Dr. Michael Fehlings & Dr. Albert Yee
	Greetings from U of T	Dr. Carol Swallow, Dr. Peter Ferguson, Dr. Gelareh Zadeh
Session I	Tator-Hall Lecture	Chair: Dr. Michael Fehlings
8:45 AM	Remarks	Dr. Charles Tator & Dr. Hamilton Hall
8:55 AM	Introduction to Keynote Speaker	Dr. Michael Fehlings
	Dr. Serena Hu	
9:00 AM	Keynote: <i>"Standing on the Shoulders of Giants: Spine Deformity Treatment over the Ages"</i>	Dr. Serena Hu, Stanford Medicine, Stanford, CA.
9:45 AM	Discussions	
10:00 AM	Elevator Pitch of Research Projects	Research Trainees
10:15 AM	Coffee Break	
Session II	Enhancement of Perioperative Outcomes in Spine Deformity Surgery	Chair: Dr. Stephen Lewis
<i>15 Min talk followed by 5 Min discussion</i>		
10:30 AM	<i>"Prevention, diagnosis and management of intraoperative spinal cord injury: A new guideline and care pathway"</i>	Dr. Michael Fehlings
10:50 AM	<i>"Planning and executing multicentre prospective studies. Can we get the answers we are looking for?"</i>	Dr. Stephen Lewis
11:10 AM	<i>"Enhancement of Perioperative Outcomes in Spine Deformity Surgery"</i>	Dr. Chris Nielsen
11:30 AM	New Faculty Talk   <i>"Surgical Timing for Spinal Cord Injury: the Contemporary Evidence"</i>	Dr. Jetan Badhiwala

11:50 AM	<i>"AI-enabled medical image analysis for the spine (oncology, MSK health, and image guided therapy)"</i>	Dr. Michael Hardisty
12:10 PM	<i>"Wellness in Spine Surgery: A Shared Goal for Patients &amp; Surgeons"</i>	Dr. Eric Crawford
12:30 PM	Elevator Pitch of Research Projects	Research Trainees
12:50 PM	<b>Lunch Break</b>	
<b>Session III</b>	<b>Research Trainee Presentations</b>	<b>Chair: Dr. Albert Yee</b>

*10 Min presentation followed by 5 Min discussion*

#### Invited Research Trainees

1:30 PM	<i>"Enabling Novel Paradigms: An Empirical Multidimensional Approach in Clinical Spine Research"</i>	Dr. Karlo Pedro
1:45 PM	<i>"Spinal Cord Injury Prediction Models with Application to Clinical Trials"</i>	Dr. Ali Moghaddamjou
2:00 PM	<i>"Long-Term Patient Reported Outcomes Following Perioperative Adverse Events in Osteoarthritic Orthopaedic Surgeries"</i>	Dr. Celina Nahanni

#### Best Abstracts / Oral Presentations

2:15 PM	Best Abstract, Basic Science Research (1 <sup>st</sup> Place) <i>"Assessing Sarcopenia and Treatment Effects in a Rat Model of Mixed Osteoblastic-Osteolytic Bone Metastasis with Imaging Biomarkers"</i>	Ms. Leanna Abraham
2:30 PM	Best Abstract, Clinical Research ( 1 <sup>st</sup> Place, tie) <i>"Saving spinal cord function by using intraoperative monitoring and rapid response during spinal deformity surgery"</i>	Dr. Ariel Zohar

2:45 PM	<b>Best Abstract, Clinical Research (1<sup>st</sup> Place, tie)</b> <i>“Days Alive and At Home After Treatment of Spinal Metastases: Measurement of a Patient Centered Outcome Using Population Health Data”</i>	Dr. Husain Shakil
3:00 PM	<b>Award Presentations and Closing Remarks</b>	

## Bios

### Tator & Hall



**Dr. Charles Tator** is a Professor in the Department of Surgery, at the University of Toronto, and a neurosurgeon at the Toronto Western Hospital. He is the former Chair of Neurosurgery at the University of Toronto. He started the first Acute Spinal Cord Injury Unit in Canada in 1974, and has reported on the epidemiology, prevention and treatment of spinal cord injury. He has undertaken seminal translational and clinical research in spinal cord injury. In 1992, he founded ThinkFirst, Canada, a national brain and spinal cord injury foundation whose mission is to reduce the incidence of catastrophic injuries in Canada. In 2012, ThinkFirst merged with three other charities to form Parachute Canada, the country's foremost injury prevention agency, of which he is a founding Director. In 2008, the University of Toronto Press published his book "Catastrophic Injuries in Sports and Recreation, Causes and Prevention-a Canadian Study." He has held two research chairs at the University of Toronto, the Dan Family Chair in Neurosurgery and the Campeau Family-Charles Tator Chair in Brain and Spinal Cord Research. In 2000, he received the Order of Canada, and in 2009 he was inducted into the Canadian Medical Hall of Fame. In 2017, he was promoted to Officer within the Order of Canada, and was also inducted into Canada's Sports Hall of Fame for his work on prevention of sports injuries.



**Dr. Hamilton Hall** is a Professor in the Department of Surgery at the University of Toronto and on the orthopaedic staff at the Sunnybrook Health Sciences Centre. He completed his medical degree at the University of Toronto then joined CARE and was stationed at a rural hospital in Malaysia. Dr. Hall returned to Toronto for his orthopaedic residency which concluded with a fellowship in medical education at the University of Dundee, Scotland. In 1974, because of his interest in patient education and rehabilitation, Dr. Hall founded the Canadian Back Institute which expanded into the CBI Health, now the largest home care and rehabilitation company in Canada. He is co-founder and Executive Director of the Canadian Spine Society and has served on the editorial boards of Spine, The Spine Journal and The BackLetter. Dr. Hamilton Hall has worked as a team physician for the NBA Toronto Raptors and doctor for the National Ballet of Canada.

Dr. Hall has received Outstanding Paper and Poster awards from the North American Spine Society and the International Society for the Study of the Lumbar Spine. He is a recipient of the Laurie Chute Award for Best Undergraduate Clinical Lecturer Award at the University of Toronto, the NASS Henry Farfan Award for outstanding contributions to the field of spine care and two Lifetime Achievement Awards, one from Stryker Spine and the other from the Canadian Spine Society. In 2019 he was inducted into the Toronto Orthopaedic Hall of Fame.

Dr. Hall's concept of a syndrome approach to classifying mechanical back pain is an essential component of several Canadian provincial initiatives to improve spine care. In addition to over 140 published articles and book chapters and over 1200 invited presentations, many as Visiting Professor, to universities in North America, Europe and Asia, he is author of the best-selling Back Doctor series of books for the lay public.

### U of T Spine Program | Co-Chairs



**Dr. Michael Fehlings** is the Vice Chair Research for the Department of Surgery at the University of Toronto and a Neurosurgeon at Toronto Western Hospital, University Health Network. Dr. Fehlings is a Professor of Neurosurgery at the University of Toronto, holds the Robert Campeau Family Foundation / Dr. C.H. Tator Chair in Brain and Spinal Cord Research at UHN, is a Senior Scientist at the Krembil Brain Institute and is Editor-in-Chief of Spinal Cord. In the fall of 2008,

Dr. Fehlings was appointed the inaugural Director of the University of Toronto Neuroscience Program (which he held until June 2012) and is currently Co-Director of the University of Toronto Spine Program. Dr. Fehlings combines an active clinical practice in complex spinal surgery with a translationally oriented research program focused on discovering novel treatments to improve functional outcomes following spinal cord injury (SCI). He has published over 1,100 peer-reviewed articles (h-index 124; cited over 49,000 times) chiefly in the area of central nervous system injury and complex spinal surgery. His seminal 1991 paper, cited over 2,000 times, outlined the severe and lasting consequences of SCI due to a cascade of secondary injury mechanisms following the initial trauma. His research on secondary injury mechanisms ultimately led to the commencement of the multicenter, international Surgical Timing in Acute Spinal Cord Injury Study (STASCIS), aimed at establishing the need for early surgical decompression to prevent the negative effects of the secondary injury cascade. His work examining the use of regenerative approaches including neural stem cells to repair the injured nervous system has led



to numerous international awards and has helped lead the field toward clinical translation in this area. Dr. Fehlings has published in prominent journals such as Nature, Nature Neuroscience, Lancet Neurology, and Science Translational Medicine.

Dr. Michael Fehlings has received numerous prestigious awards including the Gold Medal in Surgery from the Royal College of Physicians and Surgeons (1996), nomination to the Who's Who list of the 1000 most influential scientists of the 21st century (2001), the Lister Award in Surgical Research (2006), the Leon Wiltse Award from the North American Spine Society for excellence in leadership and/or clinical research in spine care (2009), the Olivecrona Award (2009) -- the top award internationally for neurosurgeons and neuroscientists awarded by the Nobel Institute at the Karolinska Institute in Stockholm for his important contributions in CNS injury repair and regeneration, the Reeve-Irvine Research Medal in Spinal Cord Injury (2012), the Golden Axon Leadership Award (2012), the Mac Keith Basic Science Lectureship Award for significant contributions to the basic science of cerebral palsy and childhood onset disabilities (2012), and was the Mayfield Lecturer (2012). In 2012, Dr. Fehlings served as the 40th President of the Cervical Spine Research Society (CSRS) -- the only Canadian to do so -- and was honoured with the CSRS Presidential Medallion for outstanding leadership and contributions to cervical spine research. In 2013, Dr. Fehlings was honoured with the Queen Elizabeth II Diamond Jubilee Medal presented to him by the Honourable Stephen Harper, the H. Richard Winn Prize from the Society of Neurological Surgeons, the Jonas Salk Award for Scientific Achievements from the March of Dimes Canada and the Henry Farfan Award from the North American Spine Society. In 2014, Dr. Fehlings was elected to the Fellowship of the Royal Society of Canada and to the Canadian Academy of Health Sciences, and in 2016 won the Royal College of Physicians and Surgeons Mentor of the Year Award. In 2019, the Right Honourable Jacinda Ardern, Prime Minister of New Zealand, presented him with the Ryman Prize for his work enhancing the quality of life for older people. He also received the Vilhelm Magnus Medal (2019) for his contributions to the neurosurgery field and the American Spinal Injury Association Apple Award (2016 & 2022) for excellence in spinal cord injury research publishing.



**Dr. Albert Yee** is the Holland Bone and Joint Program Chief and the Head of the Division of Orthopaedic Surgery at Sunnybrook Health Sciences Centre, where he holds the Marvin Tile Chair in Orthopaedic Surgery. Dr. Yee is an Orthopaedic Spine Surgeon at Sunnybrook Health Sciences Centre, an Associate Scientist (Physical Sciences Platform) at Sunnybrook Research Institute and a Consultant in Surgical Oncology, Bone Metastasis Clinic, Odette

Cancer Centre. He is a Full Professor at the University of Toronto in the Institute of Medical Sciences with a cross appointment in the Institute of Biomaterials and Biomedical Engineering. He is the Vice Chair of Research in the Division of Orthopaedic Surgery and Co-Director of the University of Toronto's Department of Surgery Spine Program. Dr. Yee is the Past President of the Canadian Orthopaedic Research Society, President of the Canadian Spine Society and Co-Chair of Bone & Joint Canada. He is the Canadian Lead for the Young Investigators Initiative (YII) of Bone & Joint Canada, and the US Bone & Joint Initiative, a grant mentorship and career development program. Dr. Yee has over 100 peer reviewed publications and has received academic honours including the American British Canadian (ABC) International Travelling Fellowship (American Orthopaedic Association / Canadian Orthopaedic Association, 2013), the Charles H. Tator Surgeon-Scientist Mentoring Award (2012), and the Canadian Orthopaedic Foundation J. Edouard Samson Award (2011). Dr. Yee's laboratory focuses on translational orthopaedic research utilizing pre-clinical surgical models to evaluate novel minimally invasive vertebral metastatic therapies (e.g., Photodynamic Therapy, Radiofrequency Ablation). His work has led to first in human clinical trials and FDA approval with commercialization of new minimally invasive spine technology. He has interest in understanding mechanisms of disease in cancer invasiveness to bone with an aim towards identifying potential new promising therapeutic targets.

**Keynote Speaker | Tator-Hall Lectureship**



**Dr. Serena Hu** is a professor and the Chief of the Spine Surgery Service in the Department of Orthopaedic Surgery and (by courtesy) Neurosurgery at Stanford University, School of Medicine. Dr. Hu was named president of the American Orthopedic Association (AOA) at the 2021 Virtual Annual Leadership Meetings. She was the first woman president of the AOA, the oldest orthopedic association in the world. In September of 2022, Dr. Hu became president of the Scoliosis Research Society, one of the oldest and most influential spinal societies in the world. She was also the first woman president of this prestigious organization.

Dr. Hu has been committed during her career to education, research, patient outcomes, and leadership in the field of Orthopaedic Surgery. Her clinical interest is in spinal deformity surgery and her research interests include decreasing complications after spine surgery, the effect of spine tumors on spinal stability and neurologic risk, disc degeneration and recovery and the cost effectiveness of spine treatment.

Dr. Hu received her medical degree from McGill University in Montreal, Quebec and was an intern at Beth Israel Medical Center in New York. She completed her residency at Hospital for Special Surgery, New York, NY and did a fellowship in Spine and Scoliosis surgery at Rancho Los Amigos Medical Center in Downey, CA. Prior to moving to Stanford in 2013, she was Chief of the Spine Service at UCSF.

## Invited Speakers



**Dr. Stephen Lewis** is a spine orthopaedic surgeon and the Spine Program Lead at the Toronto Western Hospital (TWH). He is Associate Professor of Orthopaedic Surgery at the University of Toronto (U of T) Department of Surgery. Dr. Lewis' clinical practice focused on spinal deformities at TWH. He has held a number of key leadership roles. He is the current Chairman of the AO Spine Knowledge Forum Deformity, and past Chair of the Scoliosis Research Society (SRS) Adult Deformity Committee and Awards committee. He is

also sitting on a numerous spine committee including Worldwide Course committee, and U of T Spine Program Council and education and research committee. Dr. Lewis serves as abstract reviewer for international meetings including SRS, IMAST, and NA Spine Society. Dr Lewis is a researcher and clinical investigator at the Krembil Research Institute with research focus on spine deformity. He has led several multi-centre international prospective studies through AO Spine, including the elderly spinal deformity surgery study, and the study of interpretation and management of intra-operative multi-modality neuromonitoring. Dr Lewis' has a longstanding and active leading role, locally and internationally, in education and teaching, particularly in spine deformity surgery. He has trained over 200 surgeons in-training and hosted a number of international surgeons in-practice. He is active in designing several complex spine surgery instrumentations, including osteotomy set. Dr Lewis is on editorial board and reviewing committee for the Spinal Deformity Journal and the Spine Journal. He has received numerous international awards for outstanding research papers including Whitecloud Award, Russell S. Hibbs Clinical Award, NASS Award, and CSS Deborah Scarlett Award. He also has received several awards for excellence in teaching including Best Teacher Award from U of T Spine Program, and Individual Teaching Excellence Award from the Department of Surgery, and the Centre of Excellence Award from the AO Spine.



**Dr. Christopher Nielsen** is a spine orthopaedic Surgeon at Toronto Western Hospital. His elective practice is in spine surgery where he sees a wide range of patients and treats all spinal pathologies in the cervical, thoracic, lumbar and sacral regions. His areas of interest are in adult spinal deformity and oncology. Dr. Nielsen also manages traumatic orthopaedic and spinal injuries.

Dr. Nielsen completed medical school and residency in Orthopaedic Surgery at the University of Calgary. He moved to Toronto after residency for a fellowship in complex

spine surgery at Toronto Western Hospital where he now works. Dr. Nielsen is currently finishing his Master's in Medical Education.



**Dr. Jetan Badhiwala** is a staff spinal neurosurgeon at Sunnybrook Health Sciences Centre and Assistant Professor within the Division of Neurosurgery, Department of Surgery at the University of Toronto. He completed medical school at McMaster University, neurosurgical residency at the University of Toronto, and a Fellowship in Complex Spine Surgery at the Cleveland Clinic. His clinical interests focus on spinal trauma and oncology. His academic program is focused on health outcomes research in traumatic and non-traumatic spinal cord injury. This includes harnessing big data to address clinical knowledge gaps and the application of artificial intelligence to healthcare data for 'personalized' or 'precision' medicine. He has published over 125 peer-reviewed papers, 50 conference abstracts, and 15 book chapters to date. Many of these have been published in high impact general medical journals, such as *The Lancet*, *JAMA*, *BMJ*, *The Lancet Neurology*, and *Annals of Internal Medicine*, as well as subspecialty journals, such as *Neurosurgery*, *Journal of Neurosurgery*, *Journal of Neurotrauma*, *The Spine Journal*, and *Spine*. Jetan has been the recipient of a number of honors and awards, including the CIHR Fellowship, the AANS/CNS Spine Section Research Grant, First Place Resident/Fellow Paper (CSRS), and the Stewart B. Dunsker Award (AANS/CNS).



**Michael Hardisty PhD** is a Junior Scientist at the Sunnybrook Research Institute. His current research is translational and interdisciplinary with a focus on the spine, orthopaedics, cancer, and the use of artificial intelligence for medical image analysis and biomechanics. Michael Hardisty earned his PhD in Biomedical Engineering at the University of California, Davis. He has extensive experience creating and translating medical image analysis tools for clinical applications; specifically, he is focused on using imaging biomarkers and deep learning to aid in clinical decision making, predict patient outcomes and guide therapy.



**Dr. Eric Crawford** is completed medical school, orthopaedic residency training and spine fellowships at the University of Toronto and currently works at Sunnybrook Health Sciences Centre. Eric is emerging as a physician wellness advocate and champions ‘vulnerability is strength.’ He has openly shared his battle with depression and burnout to help normalize the mental health conversation amongst physicians, and to facilitate changes to medical education and practice that promote physician wellness, sustainability, and a culture of inclusivity. Eric is grateful for the support he received from his colleagues and mentors and therefore promotes peer-support as a powerful tool to help mitigate against and prevent burnout. Eric is a member of the Peer Support Champion Program at Sunnybrook and recently started ‘Wellness Rounds’ with the orthopaedic residents. He advocates for wellness initiatives, as a member of the University of Toronto Division of Orthopaedic Surgery Wellness Committee and speaks regularly about the topic at healthcare centres, universities, and conferences. Eric enjoys trail running and reports that the rhythm of movement and being in nature is ‘his meditation’ and one of the best things he does to support both his physical and mental health.

### Invited Research Trainees Presentations



**Dr. Karlo Pedro** currently serves as a clinical and research fellow at Toronto Western Hospital. Following his medical degree (cum laude) and neurosurgery training at the University of the Philippines, he pursued a spine fellowship at Toronto Western Hospital in 2021. He then further specialized in neurotrauma and critical care at Montreal General Hospital & Montreal Neurological Institute -McGill University. Karlo has garnered multiple research awards including the best paper at the Fraser Gurd surgical research forum and the Teuber Graduate Award from McGill University. He aspires to make significant contributions as an academic spinal neurosurgeon and is currently pursuing a PhD degree from University of Toronto through the Surgeon-Scientist Training Program under the mentorship of Dr. Michael Fehlings. Karlo’s research interest focuses on the application of innovative statistical and modeling techniques to comprehensively analyze the multidimensional clinical signatures and outcomes of spine patients.





**Dr. Ali Moghaddamjou** is a neurosurgery resident at the University of Toronto who is concurrently pursuing a PhD under the guidance of Dr. Fehlings. Dr. Moghaddamjou completed his medical school and undergraduate studies at the University of British Columbia. He has a passion in combining technology with medicine to improve patient outcomes. His research is centered on the development of predictive models for spinal cord injury, with an aim to create more personalized treatment approaches by leveraging big data and machine learning techniques.



**Dr. Celina Nahann** is a graduating fifth year Orthopaedic Surgery resident at the University of Toronto. She obtained her MD from the University of Toronto concurrent with an MSc in System Leadership and Innovation through the Dalla Lana School of Public Health. She holds Hon BSc in Physics from the University of Waterloo and a PhD from Queen's University. Celina will be continuing her training in Toronto this year, completing a research and clinical fellowship in the Spine program at Toronto Western Hospital.

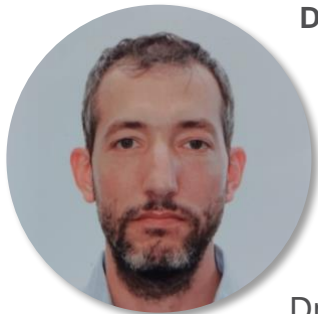
## Best Abstracts | Oral Presentations

### Best Abstract in Basic Science Research Projects



**Leanna Abraham** is a student at the University of Toronto supervised by Dr. Margarete Akens. She completed an Honours Bachelor of Science at the University of Toronto in Human Biology in 2022. She is currently completing an MSc in the Department of Medical Biophysics at the Princess Margaret Cancer Research Tower. Her work is focused on investigating the co-existence of osteopenia and sarcopenia in the context of cancer metastasis into the vertebrae. She aims to explore this relationship using preclinical animal models and medical imaging techniques.

**Best Abstract (tie) in Clinical Research Projects**



**Dr. Ariel Zohar** is an orthopedic surgeon currently participating in a Spine Surgery Fellowship at Toronto Western Hospital as part of the University of Toronto's Spine Program. Dr. Zohar holds an M.D. from the Ruth and Bruce Rappaport Faculty of Medicine at the Technion Israel Institute of Technology. His residency training took place at Lady Davis Carmel Medical Center in Haifa, Israel.

Dr. Zohar is passionate about medical education and has served as a Clinical Instructor and Head Tutor for medical student rotations at the Ruth and Bruce Rappaport School of Medicine, Technion-IIT, Haifa. Additionally, He contributed to the field through research, acting as a sub-investigator in various clinical trials related to orthopedics and musculoskeletal health.



**Dr. Husain Shakil** is a neurosurgery resident and surgeon scientist trainee at the University of Toronto. He is currently completing a PhD in Clinical Epidemiology and Health Care Research at the Institute of Health Policy, Management and Evaluation. His research interests include health outcome evaluation and prediction using big data, and health process and delivery optimization using a combination of economic and statistical methods. His clinical interests are in the treatment and care of patients with spine pathology requiring surgery, including oncologic, traumatic, and degenerative spine disease.



Organizing Team



**Nadia Jaber** is the Manger of the University of Toronto Spine Program. She manages the Program’s operations, communications, and fundraise. She plans and organizes the Program’s education and knowledge translations platforms. Nadia completed her Master of Information Studies at the University of Toronto, and obtained trainings in Entrepreneurship Essentials and in Leadership Principles from Harvard Business School – Online. She continues to integrate her education, knowledge and expertise in information, communication and technology to enhance the Program’s experience in collaboration, education, teaching, and community outreach and advocacy.



**Delphine Li** is the inaugural volunteer at the University of Toronto Spine Program. Delphine completed her Honours Bachelor of Science in Neuroscience and English at the University of Toronto in 2024. She will be commencing her medical education at the Michael G. DeGroote School of Medicine, McMaster University in the fall. Delphine started volunteering in 2023 to gain exposure to spine care and learn more about research and education initiatives in the Program. Delphine has enjoyed her time helping Nadia plan and organize activities and events, and she is grateful for the knowledge and experience she gained.

## Scientific Abstracts

#	Author	Title
1	<b>Ahmad Essa</b> , Husain Shakil, Armaan K. Malhotra, James P. Byrne, Jetan Badhiwala, Eva Y. Yuan, Yingshi He, Andrew S. Jack, Francois Mathieu, Jefferson R. Wilson, Christopher D. Witiw	Quantifying the Association between Surgical Spine Approach and Tracheostomy Timing after Traumatic Cervical Spinal Cord Injury
2	<b>Ahmad Essa</b> , Armaan K. Malhotra, Husain Shakil, James P. Byrne, Jetan Badhiwala, Avery B. Nathens, Tej D. Azad, Eva Y. Yuan, Yingshi He, Andrew S. Jack, Francois Mathieu, Jefferson R. Wilson, Christopher D. Witiw	Trends and Impact of Pharmacological Venous Thromboembolism Prophylaxis Timing for Complete Traumatic Cervical Spinal Cord Injury Across North American Trauma Centers from 2013 to 2020
3	<b>Ahmad Essa</b> , Armaan K. Malhotra, Husain Shakil, Avery B. Nathens, Eva Y. Yuan, Yingshi He, Andrew S. Jack, Francois Mathieu, Jefferson R. Wilson, Christopher D. Witiw	Disparities in Surgical Timing Following Traumatic Complete Spinal Cord Injury: The Role of Insurance Coverage and Race
4	<b>Ahmad Essa</b> , Husain Shakil, Armaan K. Malhotra, Jetan Badhiwala, Eva Y. Yuan, Yingshi He, Andrew S. Jack, Francois Mathieu, Avery B. Nathens, Jefferson R. Wilson, Christopher D. Witiw	Time to Surgery Following Complete Cervical Spinal Cord Injury: Evolution of Clinical Practice Patterns over a Decade from 2010 – 2020 Across North American Trauma Centers
5	<b>Armaan K Malhotra</b> , Nathan Evaniew, Nicolas Dea, Charles G Fisher, John T Street, David W Cadotte, W Bradley Jacobs, Kenneth Thomas, Najmedden Attabib, Neil Manson, Hamilton Hall, Christopher S Bailey, Andrew Nataraj, Philippe Phan, Yoga R Rampersaud, Jerome Paquet, Michael H Weber, Sean D Christie, Greg McIntosh, Jefferson R Wilson	The effects of peri-operative adverse events on clinical and patient-reported outcomes after surgery for degenerative cervical myelopathy: an observational cohort study from the Canadian Spine Outcomes and Research Network
6	<b>Dorothy J. Kim</b> ; Ayesha Hadi; Jennifer A. Dermott; Aya A. Mitani; Andrea S. Doria; Andrew W. Howard; David E. Lebel	Assessing Cobb angle agreement in community spine radiographs: Clinical significance in Adolescent Idiopathic Scoliosis patients
7	<b>Jennifer A. Dermott</b> , Teresa To, Liisa Jaakkimainen, Maryse Bouchard, Andrew Howard, David E. Lebel	Socioeconomic disparity limits opportunity for conservative management of idiopathic adolescent scoliosis
8	<b>Joshua Plener</b> , Akram Alayed, Mette Jensen Stochkendahl, Corey Hofkirchner, Aksa Ahmed, James Young, Michael Schneider, Paul Taenzer, John Flannery, Mohammad Movahedi, Carlo Ammendolia	Development and usability testing of the Spinemobility smartphone app to increase physical activity in older adults with lumbar spinal stenosis: An intervention mapping approach
9	<b>Prarthan Amin</b> , Aditya Raj, Greg McIntosh, Raja Rampersaud [On Behalf of CSORN Investigators]	Impact of 1-2 level MIS vs. Open interbody fusion on post-operative opioid use.
10	<b>Prarthan Amin</b> , Aditya Raj, Greg McIntosh, Ganesh Swamy, Christopher Nielsen, Raja Rampersaud [On Behalf of CSORN Investigators]	The impact of concurrent deformity on patient reported outcome following 1-3 level lumbar surgery not aimed at deformity correction.
11	<b>Tetsuhiko Mimura</b> , Ali Moghaddamjou, Jetan H. Badhiwala, Michael G. Fehlings	Steroids are Associated with Improved Neurological Recovery and Reduced Complications in Severe Cervical Spinal Cord Injury: A Pooled Analysis of Individual Patient Data in 1071 Cases
12	<b>Yousef Aljamaan</b> , Stephen Lewis, Aditya Raj, Christippher Nielsen, Larry Lenke and the AO knowledge forum deformity	A Prospective, Observational, Multicenter Study Assessing Functional Improvements After Multilevel Fusion for Adult Spinal Deformity (ASD): 5-Year Follow-Up Results

13	<b>Husain Shakil</b> , CSORN Investigators, Nathan Evaniew, Nicolas Dea, Jefferson R. Wilson	Who Gets Better after Surgery for Degenerative Cervical Myelopathy? A Machine Learning Responder Analysis from the Multicenter Canadian Spine Outcomes and Research Network
14	<b>Husain Shakil</b> , Alex Kiss, Christopher D. Witiw, Donald A. Redelmeier, Jefferson R. Wilson	Days Alive and At Home After Treatment of Spinal Metastases: Measurement of a Patient Centred Outcome Using Population Health Data
15	<b>Laura Burgess</b> , Matthew Rezkalla, Geoffrey Klein, Batuhan Karagoz, Gonzalo Martinez Santos, Mobin Malmirian, Cari Whyne, Arjun Sahgal, Michael Hardisty	A Machine Learning Tool for Prediction of Vertebral Compression Fracture Following Stereotactic Body Radiation Therapy for Spinal Metastases
16	<b>Jin Tong Du</b> , Ahmed Cherry, Rajesh Kumar, Nadia Jaber, Michael Fehlings, Albert Yee	Integration of a self-evaluation tool into surgical case logs for tracking spine fellow progress
17	<b>Aazad Abbas</b> , Dusan Kovacevic, Gurjovan Sahi, Johnathan R. Lex, Jay Toor, Firoz Miyanji	Artificial Intelligence to Predict Postoperative Health-Related Quality of Life for Adolescent Idiopathic Scoliosis Patients
18	<b>Maria Pia Monjardino</b> , Robert Kouckeki, David Lebel, Mark Camp	Learning curve of pedicle screw placement assisted by machine vision technology in neuromuscular scoliosis patients undergoing posterior spinal fusion by a single surgeon
19	<b>Adrian Wai Chan</b> , K Liang Zeng, Daniel Moore-Palhares, Eshetu G. Atenafu, Hanbo Chen, Sten Myrehaug, Mark Ruschin, Hany Soliman, Chia-Lin Tseng, Bei-Bei Zhang, Cari Whyne, Pejman Maralani, Arjun Sahgal, Jay Detsky	Spine Stereotactic Body Radiotherapy in Geriatric Patients: Implications of Age and Dose on Iatrogenic Vertebral Compression Fracture Risk
20	<b>Leanna Abraham</b> , Christine Huang, Michael Hardisty, Cari Whyne, Margarete K. Akens	Assessing Sarcopenia and Treatment Effects in a Rat Model of Mixed Osteoblastic-Osteolytic Bone Metastasis with Imaging Biomarkers
21	<b>Zohar A</b> , Loomans J, Pellise F, Smith JS, Kato S, Sardar ZM, Gupta M, Lenke LG, Lewis SJ	How reliable are intraoperative neuromonitoring alerts during non-cord level spinal deformity surgery? Results from the Spinal Deformity Intraoperative Monitoring (SDIM) study
22	<b>Zohar A</b> , Loomans J, Pellise F, Smith JS, Kato S, Sardar ZM, Gupta M, Lenke LG, Lewis SJ	Saving spinal cord function by using intraoperative monitoring and rapid response during spinal deformity surgery
23	<b>Omar I. Hassan</b> , Soichiro Takamiya, Azam Asgarihafshejani, Mohammad Zavvarian, Akshat Modi, Tetsuhiko Mimura, James Hong, Michael G. Fehlings	Assessing 'LDX' Induced Restoration of Inhibitory Signaling after Traumatic Spinal Cord Injury
24	<b>François Dantas</b> , Stephen J. Lewis, Janneke Loomans, Ferran Pellisé Urquiza, Justin S. Smith, So Kato, Zeeshan M. Sardar, Munish C. Gupta, Lawrence G. Lenke	What events are associated with intraoperative neuromonitoring alerts in deformity surgeries? Results from the multicenter prospective Spinal Deformity Intraoperative Monitoring (SDIM) study
25	<b>PL Lawrence</b> , H Ota, C Lee, S Russo, I Crandon	Circumferential cervical spinal fixation a single centre experience
26	<b>Peyton Lloyd Lawrence RCS Ed</b> , Salvatore Russo FRCS, Kevin Tsang FRCS, Professor Ivor Crandon FRCS	Waiting times for operative management of degenerative cervical myelopathy (DCM) and the impact on outcome
27	<b>Sydney Brockie</b> , Noah Poulin, Cindy Zhou, Mandana Movahed, James Hong, Michael G. Fehlings	An examination of the roles of Cx3cr1 and microglia in degenerative cervical myelopathy

## Abstract # 1

**Title:** Quantifying the Association between Surgical Spine Approach and Tracheostomy Timing after Traumatic Cervical Spinal Cord Injury

**Authors and Affiliations:** Ahmad Essa, MD, MPH<sup>1,2,3</sup>, Husain Shakil, MD, MSc<sup>1,4</sup>, Armaan K. Malhotra, MD<sup>1,4</sup>, James P. Byrne, MD, PhD<sup>5</sup>, Jetan Badhiwala, MD, PhD<sup>1,6</sup>, Eva Y. Yuan, MSc<sup>1</sup>, Yingshi He, BSc<sup>1</sup>, Andrew S. Jack MD, MSc<sup>7</sup>, Francois Mathieu MD, MSc<sup>8</sup>, Jefferson R. Wilson, MD, PhD<sup>1,4,9</sup>, Christopher D. Witiw, MD, MSc<sup>1,4,9</sup>

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**Purpose:** Recent evidence suggests earlier tracheostomy is associated with fewer complications in complete cervical spinal cord injury (SCI) patients. This study aims to evaluate the influence of spine surgical approach on the association between tracheostomy timing and in-hospital adverse events treating complete cervical SCI patients.

**Methods:** This retrospective cohort study was performed using Trauma Quality Improvement Program data from 2017 to 2020. All patients with acute complete (ASIA-A) cervical SCI who underwent tracheostomy and spine surgery were included. Tracheostomy timing was dichotomized to early (within 1-week after surgery) and delayed (more than 1-week after surgery). Primary outcome was the occurrence of major in-hospital complication. Secondary outcomes included occurrences of immobility-related complications, surgical-site infection, hospital, and intensive care unit (ICU) length of stay (LOS), and time on mechanical ventilation.

**Results:** The study included 1592 patients across 358 trauma centers. Mean time to tracheostomy from surgery was 8.6 days. 495 patients underwent anterior approach, 670 by posterior approach, and 427 by combined anterior and posterior approach. Patients underwent anterior approach were significantly more likely to have delayed tracheostomy compared to posterior approach (53% versus 40%,  $p < 0.001$ ). Early tracheostomy significantly reduced major in-hospital complications (OR 0.67, 95% CI 0.53-0.84) and immobility complications (OR= 0.78, 95% CI 0.6-1.0). Those undergoing early tracheostomy spent 6.0

(95% CI -8.47 to -3.43) fewer days in hospital, 5.7 (95% CI -7.8 to -3.7) fewer days in the ICU and 5.9 (95% CI -8.2 to -3.7) fewer days ventilated. Surgical approach had no significant negative effect on the association between tracheostomy timing and the outcomes of interest.

**Conclusions:** Earlier tracheostomy for patients with cervical SCI is associated with reduced complications, LOS, and ventilation time. This relationship appears independent of the surgical approach. These findings emphasize that tracheostomy need not be delayed due to the SCI treatment approach.

## Abstract # 2

**Title:** Trends and Impact of Pharmacological Venous Thromboembolism Prophylaxis Timing for Complete Traumatic Cervical Spinal Cord Injury Across North American Trauma Centers from 2013 to 2020

**Authors and Affiliations:** Ahmad Essa, MD, MPH<sup>1,2,3</sup>, Armaan K. Malhotra, MD<sup>1,4</sup>, Husain Shakil, MD, MSc<sup>1,4</sup>, James P. Byrne, MD, PhD<sup>5</sup>, Jetan Badhiwala, MD, PhD<sup>1,6</sup>, Avery B. Nathens, MD, PhD<sup>4,8</sup>, Tej D. Azad, MD, MS<sup>8</sup>, MS Eva Y. Yuan, MSc<sup>1</sup>, Yingshi He, BSc<sup>1</sup>, Andrew S. Jack MD, MSc<sup>10</sup>, Francois Mathieu MD, MSc<sup>10</sup>, Jefferson R. Wilson, MD, PhD<sup>1,4,11</sup>, Christopher D. Witiw, MD, MSc<sup>1,4,11</sup>

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<sup>11</sup>Division of Neurosurgery, Department of Surgery, St. Michael's Hospital, Toronto, Ontario, Canada

**Purpose:** This study aims to evaluate the timing and trend of venous thromboembolism (VTE) prophylaxis initiation following surgical intervention and its impact on the occurrence of VTE complications across North American trauma centers following complete traumatic cervical spinal cord injury (SCI).

**Methods:** This retrospective observational cohort study utilized data from the Trauma Quality Improvement Program (TQIP) from 2013 to 2020. We identified surgically treated patients with complete traumatic cervical SCI. Outcomes of interest included time to VTE prophylaxis following surgery, the occurrence of VTE complications, and rates of unplanned return to the operating room. Mixed-effects

regression models were constructed to evaluate the adjusted estimate for each outcome accounting for patient-, injury-, and hospital-level covariates.

**Results:** The study included 5,325 patients treated across 463 trauma centers. The mean time to VTE prophylaxis administration was 3.4 ( $\pm 4.6$ ) days. The annualized trend of VTE prophylaxis administration after surgery decreased by 0.2 days (4.8 hours) per year over the 8-year study interval. This was associated with a decreasing VTE complication rate of 0.9% per annum. Multi-variable mixed effects regression models demonstrated significant reduction in time to VTE prophylaxis (MD = -0.13, 95% CI; -0.22 to -0.04) and VTE complications (OR = 0.93, 95% CI; 0.88 to 0.99) over the study period after adjustment. There was no significant difference in the rate of unplanned return to the operating room during the study period (OR = 1.15, 95% CI; 0.96 to 1.35)

**Conclusions:** This analysis provides insight into VTE prophylaxis practice patterns following surgery for complete cervical SCI across North American trauma centers from 2013 to 2020. The trend in VTE prophylaxis administration timing has been consistently decreasing which appears to be associated with a significant reduction in VTE related complications with no change in unplanned return to the operating room.

### Abstract # 3

**Title:** Disparities in Surgical Timing Following Traumatic Complete Spinal Cord Injury: The Role of Insurance Coverage and Race

**Authors and Affiliations:** Ahmad Essa, MD, MPH<sup>1,2,3</sup>, Armaan K. Malhotra, MD<sup>1,4</sup>, Husain Shakil, MD, MSc<sup>1,4</sup>, Avery B. Nathens, MD, PhD<sup>4,5</sup>, Eva Y. Yuan, MSc<sup>1</sup>, Yingshi He, BSc<sup>1</sup>, Andrew S. Jack MD, MSc<sup>6</sup>, Francois Mathieu MD, MSc<sup>6,7</sup>, Jefferson R. Wilson, MD, PhD<sup>1,4,7</sup>, Christopher D. Witiw, MD, MS<sup>1,4,7</sup>

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<sup>7</sup>Division of Neurosurgery, Department of Surgery, St. Michael's Hospital, Toronto, Ontario, Canada

**Purpose:** To quantify the influence of insurance coverage and race on time to surgery in patients with traumatic complete spinal cord injury (SCI).

**Methods:** This multi-center retrospective observational study was performed using data obtained from the American College of Surgeons Trauma Quality Improvement Program (TQIP) database from 2010-2020. We evaluated the impact of insurance coverage and race on surgical timing using a multivariable Poisson regression model, adjusted for clinically important covariates. We also performed secondary analyses to assess the influence of these factors on access to surgery within 24 hours of injury as recommended by recent practice guidelines and consensus statements.

**Results:** The study included 8,222 patients with traumatic complete spinal cord injury treated across 429 trauma centers. Among these, 4,095 (49.8%) were privately insured, 3,239 (39.4%) were publicly insured, and 888 (10.8%) were uninsured. A total of 5,597 (68.1%) patients identified as White, and 2,625 (31.9%) patients identified as non-White. The mean time to surgery was 28.9 ( $\pm 32.8$ ) hours. Both publicly insured and uninsured patients experienced a significant mean delay to surgery of 3.5 and 5.6 hours, respectively, when compared to privately insured patients (95%CI; -5.3 to -1.7, and 95%CI; -8.4 to -2.7). Similarly, non-white patients had longer mean wait time of 4.3 hours longer to surgery compared to white patients (95%CI; -5.9 to -2.7). These differences remained significant after adjusting for potential confounders. Lack of insurance was associated with a 16% (95%CI; 1.05 to 1.28) increase, public insurance with an 8% (95%CI; 1.03 to 1.14) increase, and non-white race with a 14% (95%CI; 1.07 to 1.21) increase in time to surgery respectively. Secondary analysis showed a 30% increased odds of delayed surgery for non-white and uninsured patients. Likewise, publicly insured patients had an 18% increased odds of delayed surgery, thus challenging adherence to the 24 hours surgical guideline.

**Conclusions:** This study demonstrates significant disparities in time to surgery following complete SCI associated with insurance coverage and race. Non-white, publicly insured and uninsured patients were more likely to experience delay to surgery compared to white and privately insured patients.

#### Abstract # 4

**Title:** Time to Surgery Following Complete Cervical Spinal Cord Injury: Evolution of Clinical Practice Patterns over a Decade from 2010 – 2020 Across North American Trauma Centers

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**Purpose:** This study aims to quantify the change in time to surgery for treatment of complete traumatic cervical spinal cord injury (SCI) patients in American College of Surgeons (ACS) accredited trauma centers across North America over the last decade (2010 to 2020).

**Methods:** This multi-center retrospective observational cohort study employed data from the Trauma Quality Improvement Program (TQIP) from 2010 to 2020. All surgically treated patients with complete traumatic cervical SCI were included. Primary outcome was time to spine surgery from treating hospital arrival in hours. Both descriptive statistics and a multivariable Poisson regression model clustering standard of errors by each included trauma center were employed to evaluate and quantify the annual change in time to surgical intervention. Moreover, secondary analysis using a multivariable logistic model to evaluate the change in the proportion of patients who underwent early surgery ( $\leq 24$  hours) over the last decade was performed.

**Results:** The study included 6855 complete traumatic cervical SCI patients managed across 484 trauma centers in North America. Mean time to spine surgery was 26.6 hours (median of 14.6 hours). A total of 4618 patients (67.3%) underwent surgical intervention within 24 hours from hospital arrival. From 2010 to 2020, time to surgery decreased by an average 0.8 hours ( $\pm 0.15$ ) per year. A multivariable adjusted model for time to surgery demonstrated a significant downward annual reduction of 5% in time to surgery between the years 2010 and 2020 (Incidence rate ratio = 0.95; 95% Confidence Interval; 0.93 to 0.96). In the secondary analysis, a significant increased annual proportion in SCI patients who underwent early surgical intervention ( $\leq 24$  hours) was demonstrated with OR of 1.09 (95% CI; 1.05 to 1.12).

**Conclusions:** This study provides compelling real-world based quantification of the change in time to surgical intervention following traumatic cervical SCI. A significant decreasing annual trend pertaining to surgical timing, across trauma centers in North America over the past decade was demonstrated.



## Abstract # 5

**Title:** The effects of peri-operative adverse events on clinical and patient-reported outcomes after surgery for degenerative cervical myelopathy: an observational cohort study from the Canadian Spine Outcomes and Research Network

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**Purpose:** There is a lack of data examining the effects of peri-operative adverse events (AEs) on long-term outcomes for patients undergoing surgery for degenerative cervical myelopathy (DCM). We aimed to investigate associations between the occurrence of perioperative AEs and co-primary outcomes: 1) modified Japanese Orthopedic Association (mJOA) score and 2) neck disability index (NDI) score.

**Methods:** We analyzed data from 800 patients prospectively enrolled in the Canadian Spine Outcomes and Research Network multicenter observational study. The Spine AdVerse Events Severity system was used to collect intra- and post-operative AEs. Patients were assessed at up to 2 years post-surgery using the NDI and the mJOA scale. We used a linear mixed effect regression to assess the influence of AEs on longitudinal outcome measures as well as multivariable logistic regression to assess factors associated with meeting minimal clinically important difference (MCID) thresholds at 1 year.

**Results:** There were 167 (20.9%) patients with minor AEs and 36 (4.5%) patients with major AEs. The occurrence of major AEs was associated with an average increase in NDI of 6.8 points (95% CI: 1.1 – 12.4,  $p=0.019$ ) and reduction of 1.5 points for mJOA scores (95% CI: -2.3 to -0.8,  $p<0.001$ ) up to 2 years after surgery. Occurrence of major AEs reduced the odds of patients achieving MCID targets at 1-year post-surgery for mJOA (OR 0.23, 95% CI: 0.086 - 0.53,  $p=0.001$ ) and for NDI (OR 0.34, 95% CI: 0.11 – 0.84,  $p=0.032$ ). Length of stay was reduced in the groups with no AEs compared to minor and major AE groups respectively.

**Conclusions:** Major AEs were associated with reduced functional gains and worse recovery trajectories for patients undergoing surgery for DCM. Occurrence of major AEs reduced the probability of achieving mJOA and NDI MCID thresholds at 1 year. Both minor and major AEs significantly increased health resource utilization by reducing the proportion of discharges home and increasing length of stay.

## Abstract # 6

**Title:** Assessing Cobb angle agreement in community spine radiographs: Clinical significance in Adolescent Idiopathic Scoliosis patients

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**Purpose:** The study objectives were 1) to determine the agreement of Cobb angle measurement between community radiologist and spine specialist evaluating the same community acquired spine radiograph and 2) to determine if inaccurate measurements were associated with late adolescent idiopathic scoliosis (AIS) referrals.

**Methods:** A review of AIS patients seen for initial visit at a tertiary care paediatric hospital between January-September 2021 was conducted. Community index spine x-rays available on the institution's PACS ( $n=119$ ) were independently measured by two blinded raters. The agreement in Cobb angle readings and corresponding management categories between community radiology and tertiary care clinicians was determined. Agreement in readings of the reference standard 3-foot standing spine x-ray

was compared. Logistic regression was used to estimate the odds of late referrals from the discrepancy in Cobb angle readings between community radiology and reference standard when images were within 90 days (n=111). Discrepancies were defined as differences in Cobb angle measurements  $>5^\circ$ . Late referrals were defined as AIS patients who present as likely surgical candidates on initial presentation.

**Results:** The agreement in Cobb angle on the index x-ray between community radiologist and spine specialist was moderate (ICC=0.78 95% CI 0.66-0.86, SEM=6.14°) with moderate agreement in corresponding management ( $\kappa$  =0.58). On the same image, the agreement between community radiologist and pediatric radiologist remained moderate (ICC=0.74 95% CI 0.65-0.81, SEM=6.73°), although the agreement in corresponding management was higher ( $\kappa$ =0.65). Comparatively, the agreement between spine specialist and pediatric radiologist on both index and reference standard was excellent (ICC=0.96, 95% CI 0.89-0.98, SEM=2.57°; ICC=0.97, 95% CI 0.95-0.98, SEM=2.86°) with substantial agreement in corresponding management ( $\kappa$ =0.73;  $\kappa$ =0.71). The proportion of AIS patients who presented late was 34.2%. The odds of late referral increased significantly with inaccuracies in community measurements (OR = 3.55 95% CI 1.91-6.59).

**Conclusions:** Inaccuracies in measurement of Cobb angle by community radiology impact timely AIS referrals, potentially contributing to an increased number of avoidable spine surgeries due to missed opportunities for non-operative treatment.

## Abstract # 7

**Title:** Socioeconomic disparity limits opportunity for conservative management of idiopathic adolescent scoliosis

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**Purpose:** Brace treatment minimizes risk of scoliosis curve progression to surgical range; however, many adolescent idiopathic scoliosis (AIS) patients present too late to be considered an ideal brace candidate, contributing to a higher than necessary surgical burden. The purpose of this study was to evaluate the

association of SES and public healthcare utilization with late AIS presentation to a spine specialist. Late presentation is defined as a Cobb angle  $\geq 50^\circ$  or  $>40^\circ$  and  $\leq$  Risser 2.

**Methods:** Case-control; All AIS patients aged 10-18 years, seen for initial consultation in a single tertiary care spine program between 2014-21 were linked to provincial health administrative databases. Linked data included: age, sex, body mass index (BMI), Cobb angle, and Risser score. Material deprivation, an area-level poverty index, and individual-level immigration data were proxies for SES. Utilization of health services in the 5 years before presentation was represented by physician outpatient visit rate stratified by specialty, annual health exams, and emergency department use. A comparative analysis was conducted between youth presenting late/not late. Variables that increased the probability of late presentation and adjusted odds ratios (OR) were considered significant at  $p < 0.001$ .

**Results:** In total 2732 AIS patients (2236 female, 82%) were included, average age 14.1 ( $\pm 1.7$ , range: 10.0-17.9), mean Cobb angle  $37.7^\circ$  ( $\pm 14.4$ , range: 10-95) and BMI  $20.4 \text{ kg/m}^2$  ( $\pm 5.2$ , range: 12.2-54.5). The volume of late referrals was 27% ( $n=727$ ). Youth referred late were younger, had fewer physician outpatient visits, and were overrepresented in the group that had no annual exams, was  $<$  Risser 2, and in the most deprived quintile (Q5). The probability of being referred late increased with higher deprivation ( $Q1=0.22$  vs  $Q5=0.34$ ) and decreased when a pediatrician versus family/general practitioner was the primary care provider (0.13 vs 0.35), and with regular versus no annual health exams (0.11 vs 0.32).

**Conclusions:** Lower SES and healthcare utilization both increase the probability of late AIS presentation, particularly when primary care is not provided by a pediatrician. Those that had regular annual health exams were least likely to present late, suggesting there may be a role for routine screening for scoliosis within a public health care system.

## Abstract # 8

**Title:** Development and usability testing of the Spinemobility smartphone app to increase physical activity in older adults with lumbar spinal stenosis: An intervention mapping approach

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**Purpose:** Only 4% of people with symptomatic lumbar spinal stenosis (LSS) meet the recommended minimum daily requirement for physical activity (PA). Limited PA greatly increase the risk for further disability and premature death in this population. The Spinemobility Program for LSS is a 6-week comprehensive program, shown in trials to improve pain, function, and walking distance. However, it is uncertain whether this program can improve daily PA. Smartphone apps have shown promise in their ability to increase PA in older adults. The objectives of this study are to i) use intervention mapping to develop a Spinemobility smartphone app aimed to increase PA in this population and ii) assess the usability of the app in conjunction with the in-clinic Spinemobility program and as a standalone intervention.

**Methods:** Intervention mapping was used to systematically develop a smartphone app using best available evidence and stakeholder consensus meetings with clinicians, researchers, and end-user consumers. The prototype app was pretested for usability with 10 eligible patients with LSS, alongside the in-clinic LSS program and as a standalone intervention. Six weekly semi-structured interviews were conducted with participants to assess ease of use, compliance and to provide feedback on each of the key features of the app. The interviews were transcribed and summarized using a thematic approach. Through consensus with the intervention mapping team and in consultation with the app developer, modifications to the app were made.

**Results:** Key app features include user risk profiling with tailored daily education, motivational messaging and resources, goal setting and feedback/reminders. The app provides a daily exercise schedule with videos, an activity/inactivity tracker, gamification features, and opportunities for peer-to-peer interactions. Participants reported they felt the app was individualized to their needs and found the education provided to be beneficial. Some participants appreciated the motivational messaging, daily reminders, and gamification, while others felt their motivation was intrinsically driven. Participants indicated they did not

utilize the peer forum, desired an improved layout of the app with larger font size, and wanted improved clarity on exercise progression.

**Conclusions:** Overall, participants feel the app addresses their needs and recommended only minor changes. Next steps include evaluating the feasibility of conducting an RCT assessing the ability of the app to increase PA among people with LSS attending an in-clinic LSS program or using the app as a standalone intervention. Our app has the potential to increase access to an evidence-based intervention for LSS, including in remote, rural, under-serviced and low socioeconomic status communities.

## Abstract # 9

**Title:** Impact of 1-2 level MIS vs. Open interbody fusion on post-operative opioid use.

**Authors and Affiliations:** Prarthan Amin<sup>1</sup>, Aditya Raj<sup>1</sup>, Greg McIntosh<sup>2</sup>, Raja Rampersaud<sup>1,2</sup> [On Behalf of CSORN Investigators]

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**Purpose:** One of the reported benefits of MIS fusion is reduced pain and need for use of post-operative opioids. The aim of this study was to investigate potential differences in patterns of pre-to-post surgery opioid utilization changes among patients undergoing open vs MIS lumbar fusion.

**Methods:** A retrospective review of CSORN registry data. Surgical patients (n=511) with degenerative lumbar disorders undergoing posterior decompression and interbody instrumented fusion (one/two levels) and available data on baseline opioid use, were categorized into open (n= 307) and MIS (n=204) groups. Changes in opioid use from pre-operative status to 3- and 12-months post-surgery were compared between both groups.

**Results:** There was no significant difference in baseline opioid use between groups (48.5% and 45.6% respectively). Baseline patient reported outcomes (PROs), demographic and pre-surgical characteristics were comparable between groups except the MIS group had slightly lower reported leg pain rating (6.94 vs 7.56, p<0.001) and number of comorbidities (2.7 vs 3.0, p<0.0028). Post-surgically, the MIS group had significantly less OR time (164 vs 208 mins), mean blood loss (159 vs 450 ml) and length of stay

(3.1 vs 4.6 days),  $p < 0.001$ . There were no significant differences in change in PROs between the two groups at both follow ups.

There were no significant differences in the patterns of opioid utilization changes from pre-surgery to 12 months post between groups ( $p > 0.05$ ): non-users who stayed non-users (open=47.9%, MIS=50.5%); users who stayed users (open=18.9%, MIS 19.1%); non-users who became users (open=3.6%, MIS=3.9%); and users who became non-users (open=29.6%, MIS=26.5%).

**Conclusions:** Compared to open 1-2 level interbody fusion, use of a MIS technique does not differentially impact 3- and 12-month opioid utilization. Approximately 1 in 5 patients were still using opioids at 12 months post-surgery irrespective of MIS or Open fusion technique.

## Abstract # 10

**Title:** The impact of concurrent deformity on patient reported outcome following 1-3 level lumbar surgery not aimed at deformity correction.

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**Purpose:** This study aimed to compare patient-reported outcomes (PROs) at 3 and 12 months after short segment lumbar surgery (1-3 levels) for patients with and without spinal deformity.

**Methods:** From the CSORN registry, there were 438 patients included who had degenerative diagnoses and underwent 1-3 levels of lumbar decompression alone or with fusion not aimed at overall lumbar/global realignment. All cases were prospectively categorized into two groups: no-deformity (n=311) or presence of lumbar deformity (n=127), defined as sagittal (neutral or kyphosis) and/or coronal ( $<10^\circ$ ,  $10-20^\circ$ ,  $>20^\circ$ ). Differences in 3 and 12-month PROs were compared overall, stratified by surgery type and for specific diagnosis.

**Results:** There was no difference in the distribution of decompression alone/fusion between deformity (52%/48%) and no-deformity (54%/46%) groups. Overall, the deformity group showed statistically



significantly longer operative time (161 vs 135 mins), length of hospital stay (3.3 vs 2.2 days) and adverse events (30% vs 19%) ( $p < 0.05$ ).

Adjusted for baseline differences in individual PRO scores and demographic differences (age, tobacco use and symptom duration) there were no statistically significant differences in PROs at 3 and 12 months by group. There was a trend for less improvement in EQ5D ( $\Delta 0.23$  vs.  $0.18$ ) and SF-12PCS ( $\Delta 12.4$  vs.  $9.3$ ) at 12-months in the deformity group. For stenosis and spondylolisthesis patients there was a significant difference in ODI improvement for those in the no-deformity vs. deformity group ( $\Delta -21.6$  vs.  $-16.2$ ,  $p = 0.05$ ) at 12 months.

When stratified by surgery type (decompression alone; decompression and fusion) there were no significant differences in PROs at 3 months and 12 months between both groups. Decompression alone for deformity had the worse ODI outcome at 12 months ( $\Delta -20.7$  vs  $-12.5$ ,  $p = 0.16$ ).

**Conclusions:** Patients with concurrent deformity had worse perioperative outcomes with short-segment lumbar spinal surgery. There was no overall statistical difference in PROs at 3 and 12 months, however, trends in differential outcomes exist in subgroup analyses and require further exploration with a larger sample size.

## Abstract # 11

**Title:** Steroids are Associated with Improved Neurological Recovery and Reduced Complications in Severe Cervical Spinal Cord Injury: A Pooled Analysis of Individual Patient Data in 1071 Cases

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**Purpose:** The current evidence presents the use of steroids as an option in acute spinal cord injury (SCI), but also shows the importance of identifying subpopulations of patients with SCI, especially those with the most favorable risk-benefit ratio for steroid use. The objective of this study is to clarify the effect of steroids and their impact on complications in patients with cervical SCI, stratified by baseline neurological status.



**Methods:** We did a pooled analysis of individual patient data derived from three independent large prospective multicenter datasets of patients with SCI (NACTN, STASCIS, NASCIS II). The cervical SCI patients who had a documented baseline neurologic examination were included. The primary outcome was upper extremity motor scores (UEMS) and lower extremity motor scores (LEMS) at 1 year. The patients were grouped by the baseline American Spinal Injury Association Impairment Scale (AIS) grade, and differences in outcomes by treatment were analyzed using inverse probability treatment weighting. The secondary outcomes included in-hospital complications.

**Results:** We identified 1071 eligible patients. Of these, 380 patients of AIS grade A, 100 patients of AIS grade B, 153 patients of AIS grade C, and 305 patients of AIS grade D with follow-up data were analyzed. In AIS grade A patients, the use of steroids resulted in significantly higher weighted LEMS (5.7 vs. 2.4;  $p<0.01$ ), but not UEMS (23.0 vs. 22.1;  $p=0.58$ ) at 1 year. On the other hand, there were no significant effects of steroids in AIS grade B, grade C, and grade D patients. In AIS grade A, the steroid group had a lower incidence of cardiopulmonary complications (43.1% vs. 64.1%;  $p<0.001$ ) and gastrointestinal/genitourinary (GI/GU) complications (13.1% vs. 22.4%;  $p=0.02$ ). In AIS grade C, the steroid group had a lower incidence of cardiopulmonary complications (14.9% vs. 37.3%;  $p<0.01$ ) and urinary tract infections (9.0% vs. 22.0%;  $p=0.04$ ).

**Conclusions:** In patients with AIS grade A, steroids were associated with improved lower extremity motor function; in patients with AIS grades B, C, and D, there was no significant effect on functional recovery. Of note, steroids had a favorable safety profile with reduced cardiopulmonary and GI/GU complications in cervical SCI cases.

## Abstract # 12

**Title:** A Prospective, Observational, Multicenter Study Assessing Functional Improvements After Multilevel Fusion for Adult Spinal Deformity (ASD): 5-Year Follow-Up Results

**Authors and Affiliations:** Yousef Aljamaan<sup>1</sup>, Stephen Lewis<sup>1</sup>, Aditya Raj<sup>1</sup>, Christippher Nielsen<sup>1</sup>, Larry lenke<sup>2</sup> and the AO knowledge forum deformity.

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**Purpose:** To assess which key functional outcomes including standing, walking and sitting, were most impacted by multilevel fusion surgery for ASD. also, to assess if these functional improvements were maintained over the follow-up period.

**Methods:** Patients  $\geq 60$  years of age from 12 international centers undergoing spinal fusion of  $>5$  levels were included. Follow-up visits were performed at 10 weeks, 12 months, 24 months and 60 months. Function was assessed using the Scoliosis Research Society 22r (SRS22r) function domain, and with the personal care, walking, sitting and standing sections from the Oswestry Disability Index (ODI) and EQ-5D-3L scores.

**Results:** A total of 219 patients (80.4% females) were included with a mean age of 67.5 years. The mean preoperative SRS-22r function scores were 2.71 (95% CI: 2.61; 2.80) which improved to 3.46 (3.35; 3.57) by 2 years post-surgery and were sustained at 5 years (3.40 [3.27; 3.53]). 44.9% of patients were either bedbound or had primarily no activity before the surgery which reduced to 18.1% at 2 years and 17.1% at 5-year follow-up. Similarly, the percentage of patients that could stand  $>30$  minutes improved from 24.3% to 67.8% at 2 years and was 59.0% at 5 years. 25.7% of patients could walk for a mile or more before surgery, which improved to 62.7% at 2 years and was 57.3% at 5 years. 42.6 % had unlimited sitting pre-operatively, that improved to 65.0% at 2 years and 64.2% at 5 years. Normal social life was seen in 18.8% of patients at baseline compared to 56.0% at 2 years and 50.4% at 5 years.

**Conclusions:** This study provides quantifiable information regarding practical functional improvements seen in patients  $\geq 60$  years of age undergoing multilevel spinal fusions for ASD. Specifically, at 5 years post-op, about 60% of patients can expect to stand more than 30 minutes, walk more than a mile and enjoy unlimited sitting, while 50% can enjoy a normal social life.

## Abstract # 13

**Title:** Who Gets Better after Surgery for Degenerative Cervical Myelopathy? A Machine Learning Responder Analysis from the Multicenter Canadian Spine Outcomes and Research Network

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**Purpose:** Outcomes after surgery for degenerative cervical myelopathy (DCM) vary. To inform preoperative education and counseling, we performed a responder analysis to identify factors associated with treatment response measured using patient-reported outcomes (PROs) such as Neck Disability Index (NDI) and EuroQol-5D (EQ-5D) at 12 months post-surgery.

**Methods:** A retrospective cohort study was conducted utilizing prospectively collected data from the Canadian Spine Outcomes Research Network (CSORN) registry collected between 2015-2022. We included all surgically treated DCM patients with complete follow-up and PROs available at 1-year. Multivariable LASSO regression was used to identify significant associations with likelihood of treatment response measured through NDI, and EQ-5D. Variable importance was measured using standardized coefficients. To test robustness of findings we trained a separate XGBOOST machine learning model which patients would respond to treatment based on each PRO. Variable importance for the XGBoost model was measured using SHAP values.

**Results:** Among the 554 DCM patients included, 41.3% responded to treatment with respect to NDI, and 59.6% for EQ-5D. LASSO regression for likelihood of treatment response measured through NDI found the variable importance rank order to be baseline NDI, then symptom duration. For EQ-5D, the variable importance rank order was baseline EQ-5D, living arrangement, then symptom duration. A separate XGBoost model of treatment response measured through NDI, corroborated findings that patients with higher baseline NDI, and shorter symptom duration were more likely to respond to treatment, and additionally found older patients, and those with kyphosis on baseline upright x-ray were less likely to respond. Similarly, an XGBoost model for treatment response measured through EQ-5D corroborated findings that patients with higher baseline EQ-5D, shorter symptom duration, and living alone were more likely to respond to treatment, and additionally found older patients were less likely to respond.

**Conclusions:** Our findings suggest patients with higher baseline patient NDI, lower EQ-5D, shorter symptom duration, younger age, living alone, and without kyphosis on pre-operative x-ray are more likely to respond to treatment. Timing of surgery with respect to patient symptoms is underscored as a crucial, and modifiable patient factor, that is associated with an increased likelihood of achieving clinically meaningful outcomes for patients with DCM.

**Abstract # 14**

**Title:** Days Alive and At Home After Treatment of Spinal Metastases: Measurement of a Patient Centred Outcome Using Population Health Data

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**Purpose:** Days spent alive and at home (DAH) is a patient-centred outcome that has not been described for patients with spinal metastases. In this study, we measure DAH after initial treatment of spinal metastasis, investigate the optimal follow-up period for measurement, assess the validity of DAH as an outcome measure, and estimate the minimal important difference (MID) in the outcome.

**Methods:** A retrospective analysis was conducted of population based administrative health data from 2007 to 2019 in Ontario, Canada, including 36,233 patients treated for spine metastases. Primary study outcomes include DAH and survival at 30-days, 90-days, 180-days, 365-days, and 730 days after first treatment of a spinal metastasis.

**Results:** The 180-day follow-up period most closely corresponded with the 152 day (95% CI 148 to 155 day) median survival for patients. Median DAH-180 was 114 days (95% CI 112 to 117), and closely approximated DAH-365 (median 120; 95% CI 117 to 123), and DAH-730 (median 121; 95% CI 118 to 125). Older age, frailty, prior ICU admission, increased baseline health resource utilization, metastasis secondary to melanoma, hepatobiliary or lung cancer, and increased distance from a treating cancer centre were associated with decreased median DAH-180. These findings support construct validity of DAH-180 at the patient health, social, and cancer level. The estimated minimally important difference (MID) in DAH-180 was 14 days.

**Conclusions:** DAH-180 has construct and predictive validity as a patient-centred outcome measure among patients treated for spinal metastases, with a MID of approximately 14 days. Future research is required to consider patient perspectives and compare DAH to validated patient reported outcomes.

**Abstract # 15**

**Title:** A Machine Learning Tool for Prediction of Vertebral Compression Fracture Following Stereotactic Body Radiation Therapy for Spinal Metastases

**Authors and Affiliations:** Stereotactic Body Radiation Therapy for Spinal Metastases

Laura Burgess<sup>1</sup>, Matthew Rezkalla<sup>2</sup>, Geoffrey Klein<sup>3</sup>, Batuhan Karagoz<sup>4</sup>, Gonzalo Martinez Santos<sup>4</sup>, Mobin Malmirian<sup>4</sup>, Cari Whyne<sup>2,5</sup>, Arjun Sahgal<sup>1</sup>, Michael Hardisty<sup>2,5</sup>

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**Purpose:** Spine stereotactic body radiotherapy (SBRT) achieves impressive rates of overall pain response and local control. The most common complication following spine SBRT is vertebral compression fracture (VCF), this occurs at an estimated rate of 9% in a recent meta-analysis. Many clinical, radiographic and dosimetric factors have been found to be predictive of VCF including age, lytic disease, pre-existing fracture, spinal deformity, histology and radiation dose. There is interest in the development of a tool capable of predicting those at high risk for developing this potentially destabilizing condition, which may allow for prophylactic interventions. We aimed to develop a machine learning (ML) tool able to predict the development of VCF following spine SBRT.

**Methods:** A retrospective review of a prospectively maintained database of spinal segments treated with SBRT was conducted. The database includes clinical, tumor and treatment information. ML models were compared to spine instability neoplastic scores (SINS), the current clinical standard for predicting spinal instability. Clinical, tumor and treatment factors were used as inputs in 4 ML models: logistic regression, neural network/multi-layer perceptron (MLP), support vector machine (SVM) and random forest (RF). Models were evaluated with respect to accuracy, precision, sensitivity and specificity in predicting VCF, and relative feature importance determined.

**Results:** Between 2008 and 2021, 1406 spinal segments were included within the database. Patients were followed by institutional protocol with clinical assessment and full spine magnetic resonance imaging every 2 to 3 months. The median age of patients was 63.8 years. The most common histologies were breast and non-small cell lung cancer. The most common dose fractionation was 24Gy in 2 fractions

(47.1%). The majority of spines were SINS stable (53.2%). Most patients did not have a baseline VCF (81.1%); 7.4% of vertebrae went on to experience a VCF and 3.9% had progression of a VCF.

In predicting VCF, all machine learning models were more precise than SINS. Compared to SINS, RF, SVM and logistic regression models had improved sensitivity and MLP and RF models had improved specificity. Overall, the RF model outperformed SINS in all performance metrics. Based on the RF model, important factors increasing the risk of VCF were age at the time of treatment, extent of vertebral body collapse, performance status, pain, and spinal alignment.

**Conclusions:** Simple machine learning models using clinical, tumor and treatment specific data outperform SINS alone in the prediction of VCF following spine SBRT.

## Abstract # 16

**Title:** Integration of a self-evaluation tool into surgical case logs for tracking spine fellow progress

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**Purpose:** Spine Surgery training requires an Orthopedic or Neurosurgery residency and a subspecialty fellowship. Unlike residencies, most spine fellowship curricula are not formalized and evaluated. Our institution uses a nationally based curriculum and has implemented standardized surgical case logs to evaluate procedural competencies. Through this study, we aim to assess the confidence and competence of spine fellows using case logs and demonstrate its utility as an evaluation tool.

**Methods:** Data was extracted from fellow-reported surgical case logs from 2015 to 2023. A Likert-scale survey assessed personal learning, confidence, and competence on a scale of 1-5. Lower scores indicated less personal learning, lower confidence, and lower ability to complete the task adequately.

**Results:** Surgical case logs from 39 fellows were collected from 2015 to 2023 with a total of 6971 cases logged. Mean cases logged per fellow was 178 cases (SD=74). The average self-reported confidence was 3.74 (SD=0.99), and the average competence was 3.61 (SD=1.17). A positive correlation exists

between confidence and competence with Spearman's rank correlation = 0.93. The most common primary surgical approach used was posterior with 5301 cases with average reported confidence of 3.71 (SD=1.01) and competence of 3.73 (SD=1.02). Conversely, a lesser-used lateral approach with only 24 logged cases, had an average confidence of 2.88 (SD=0.90) and competence of 2.79 (SD=0.88). The most common class of diagnoses was degenerative/inflammatory with 4272 cases with average reported confidence of 3.80 (SD=0.98) and competence of 3.81 (SD=0.99). The least common diagnosis was infectious with 261 cases. The average confidence was 4.03 (SD=0.93), and competence was 3.99 (SD=0.94).

**Conclusions:** A standardized surgical case log is an effective and accepted way to document surgical exposure that can be leveraged in credentialing and accreditation processes. The self-evaluation survey gives administrators insight into the fellow's confidence and perceived competence in various surgical cases. This allows the program to adapt according to each fellow's needs while still operating within the competencies set out by the program.

#### Abstract # 17

**Title:** Artificial Intelligence to Predict Postoperative Health-Related Quality of Life for Adolescent Idiopathic Scoliosis Patients

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**Purpose:** Adolescent idiopathic scoliosis (AIS) has a large impact on health-related quality of life (HRQoL) for patients including poor psychosocial functioning, psychological distress, and pain. Surgical management for AIS is common; however, there is limited consensus on preoperative and intraoperative strategies to optimize HRQoL outcomes following surgery. Accurate prediction of postoperative outcomes can guide operative planning, ultimately leading to improved HRQoL. This feasibility study aimed to generate machine learning models (MLMs) using preoperative and intraoperative variables to accurately predict postoperative HRQoL outcomes following AIS surgery.



**Methods:** A prospective, longitudinal, multicenter database was queried for AIS patients of Lenke 1 or 5 classification with minimum two-year follow-up. MLMs were generated using various preoperative and intraoperative factors to predict the difference in Scoliosis Research Society-22 (SRS-22) questionnaire scores from preoperative assessment to two-year follow-up. MLMs were compared to a model that estimates the mean score by evaluating the coefficient of determination ( $R^2$ ) and the number of times the prediction was within a predesignated value of the actual score (i.e. buffer accuracy).

**Results:** A total of 1,417 patients were included. The stochastic gradient descent (SGD) model had the highest  $R^2$  for all SRS-22 scores (0.31–0.64). For 0.5-buffer accuracy, the linear regression model performed best for the satisfaction (66.2%), self-image (70.1%), pain (65.7%), and total SRS-22 scores (80.9%), while the SGD model performed best for the mental health (54.9%) and general function SRS-22 scores (79.9%). The SGD model had the highest 1-buffer accuracy across all SRS-22 scores (87.4%–97.2%). All MLMs, except for the AdaBoost model, outperformed the mean estimates on all accuracy metrics across each outcome.

**Conclusions:** MLMs accurately predicted the difference in HRQoL outcomes for AIS patients using preoperative and intraoperative factors. Findings provide key insights into the feasibility of implementing MLMs to guide operative planning and counsel patients on expected outcomes of surgical management. Future work should aim to optimize these factors to ultimately maximize patient outcomes.

## Abstract # 18

**Title:** Learning curve of pedicle screw placement assisted by machine vision technology in neuromuscular scoliosis patients undergoing posterior spinal fusion by a single surgeon

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**Purpose:** To study a single surgeon's machine vision technology (7D Surgical Inc., Toronto, Canada) learning curve based on navigation time per screw in a pediatric neuromuscular population who underwent posterior spinal fusion (PSF)

**Methods:** A retrospective study of clinical and radiographic records of pediatric patients with neuromuscular scoliosis who underwent PSF and instrumentation with pedicle screws placed with the assistance of machine vision technology. All surgeries were performed by a single surgeon. Demographic

data, scoliosis etiology, radiographic data, surgical outcomes (EBL, transfusion and LOS), intra-operative radiation exposure, and complications were collected.

**Results:** A total of 32 patients were included, 18 (56%) female, with a mean  $\pm$  standard deviation (SD) of  $14 \pm 3$  years old and a mean  $\pm$  SD body mass index of  $17.0 \pm 3.1$  kg/m<sup>2</sup>. The majority of the patients (17 (53%)) had a diagnosis of cerebral palsy. Other diagnoses included Duchenne muscular dystrophy, congenital myopathy, encephalopathy and Rett syndrome. C-shaped with lumbar apex was the most common curve pattern (17 patients (53%)). The majority (28 (88%)) of the surgeries were assisted by trainees (fellow and/or resident). Per case, an average  $\pm$  SD of  $25 \pm 6$  screws/  $15 \pm 4$  levels were navigated; in 16 of the 26 patients (62%) where S2 alar-iliac screws (S2AI) were inserted, navigation was used. Mean  $\pm$  SD operative and navigation time was, respectively,  $585 \pm 130$  minutes (min) and  $147 \pm 57$  min, corresponding to a navigation time per screw of 5 min 56 seconds  $\pm$  1 min 53 seconds.

Navigation assisted S2AI screws allowed to reduce operative time in 30 min ( $p=0.559$ ).

In a preliminary analysis, a trend of decreasing navigation time per screw was observed according to the accumulation of cases, as well as total operative time, LOS and intra-operative radiation exposure.

**Conclusions:** Although preliminary, machine vision technology seems to contribute to a reduction in operative time, LOS and intra-operative radiation exposure. Navigation time per screw decreases based on the accumulation of cases and navigation assisted S2AI screws allows 30 minutes reduction in operative time.

## Abstract # 19

**Title:** Spine Stereotactic Body Radiotherapy in Geriatric Patients: Implications of Age and Dose on Iatrogenic Vertebral Compression Fracture Risk

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**Purpose:** Stereotactic body radiotherapy (SBRT) is an effective treatment for spinal metastases, however, outcomes specific to a geriatric population have not been described. Our study aimed to investigate the efficacy and safety of spine SBRT, in particular the rate of vertebral compression fracture (VCF), in patients aged 70 and older.

**Methods:** Consecutive patients aged  $\geq 70$  from a prospectively maintained database of 976 patients and 2407 segments treated with SBRT spine in a single quaternary oncology center between 2008-2021 were retrospectively reviewed. The primary outcome is the risk of VCF, with secondary outcomes including MRI-based local control (LC) and overall survival (OS).

**Results:** 252 patients with 580 spinal segments treated with spine SBRT were reviewed. The median age was 75.8 (range: 70-90.3) years and the median (interquartile range) follow-up duration was 16.9 (6.4-41.3) months. The median OS of the entire cohort was 20.3 months and the 2-year local failure rate was 14.3%. The cumulative risk of VCF at 12 and 24-months were 8.4% and 12.3%, respectively. Significant predictors of VCF on multivariable analyses included greater biologically equivalent dose, baseline fracture and increasing age. In particular, the 2-year VCF rate and median time to VCF were 30.3% and 3.4 months for those 86 and older, compared to 11.2% and 12.8 months for those younger than 86, respectively ( $p=0.0011$ ).

**Conclusions:** Spine SBRT should be considered in a geriatric population, however, for those 86 and older we suggest caution due to the significant risk of VCF.

## Abstract # 20

**Title:** Assessing Sarcopenia and Treatment Effects in a Rat Model of Mixed Osteoblastic-Osteolytic Bone Metastasis with Imaging Biomarkers

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**Purpose:** Growing evidence shows a link between sarcopenia and osteopenia in many diseases, including cancer. Common systemic treatments with docetaxel (DTX) and bisphosphonates [zoledronic acid (ZA)] in metastatic prostate cancer may have an impact on muscle and bone. The study aims to quantify early changes to the psoas muscle secondary to prostate cancer and its treatment. Muscle volume, attenuation, and function are hypothesized to correlate with tumor presence.

**Methods:** Athymic, 6-week-old male rats (n=15) received intra-cardiac ACE-1 prostate cancer cell injections (control n=9). Grip strength, Gd-contrast in-vivo  $\mu$ MR, and  $\mu$ CT were performed on days (d) - 1, 13, and 20 post-tumor-cell injection to assess muscle function, psoas muscle volume, and attenuation. Tumor presence was confirmed with bioluminescence imaging (BLI), histology, and ex-vivo  $\mu$ CT imaging. Rats were randomized into DTX (5 mg/kg, i.v.) (n=12), ZA (Zometa; 60 $\mu$ g/kg, s.c.) (n=6), or untreated (n=6) groups on d 9 and sacrificed on d 21.

**Results:** BLI, histology, and ex-vivo  $\mu$ CT images confirmed bone metastases in 9 rats. Tumor-cell injected rats displayed significantly smaller increases in psoas volume and a greater negative change in muscle attenuation over time (two-factor ANOVA,  $p < 0.05$ ), confirming the presence of sarcopenia. ZA treatment significantly increased BMD (two-factor ANOVA,  $p < 0.005$ ) and decreased muscle attenuation (two-factor ANOVA,  $p < 0.05$ ). Docetaxel treatments showed a smaller negative change in muscle attenuation over time compared to the ZA-treated rats, or controls ( $p < 0.002$ ). No significant differences in grip strength were found between healthy and tumor-injected rats. DTX-treated rats had a significantly weaker grip strength 3 days post-treatment than non-treated and ZA-treated animals (t-test,  $p < 0.01$ ).

**Conclusions:** Sarcopenia is observed in rats with tumors, and psoas muscle attenuation and volume loss are measurable in this preclinical model of bone metastases. These imaging biomarkers regarding changes in muscle volume and attenuation can potentially be used to detect disease progression earlier in patients with metastatic prostate cancer.

## Abstract # 21

**Title:** How reliable are intraoperative neuromonitoring alerts during non-cord level spinal deformity surgery? Results from the Spinal Deformity Intraoperative Monitoring (SDIM) study

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**Purpose:** To assess the utility of IONM in patients undergoing non-cord level spinal deformity surgery.

**Methods:** Twenty international centers prospectively documented IONM, demographics, radiographic findings, and surgical events of patients undergoing spinal deformity correction. Inclusion criteria were: ages 10-80 years, neurologically intact, major Cobb>80° or undergoing any spinal osteotomy with EMG, SSEP, and MEP monitoring. Detailed neurological examination was performed at baseline, immediately post-op and prior to discharge from hospital. IONM change was defined as amplitude loss of >50% in SSEP or MEP from baseline or sustained EMG activity that lasts > 10 seconds.

**Results:** Out of the 197, neuromonitoring alerts were observed in 22 (11.2%) out of the 197. No significant differences were found between the alert and no alert groups in terms of age, sex, Cobb angles, DAR, C7 plumb line, osteotomy, number of osteotomies, or levels fused. A higher percentage of patients with a recorded alert were undergoing revision surgery compared to those with no alert (40.9% vs. 18.9% p = 0.026). 18 patients (81.8%) had one alert and 4 patients (18.2%) had two. MEP alerts were the most common, observed in 21 out of 26 alerts (80.8%), with 76.2% being unilateral and 23.8% being bilateral. In 61.5% of alerts, only MEP changes were seen. SSEPs were affected in 30.8% of alerts, and only SSEP changes were seen in 11.5% of alerts. EMGs were affected in only 7.7% of alerts. 71.4% of MEP changes fully recovered intraoperatively. Out of 197 patients, 33 (16.8%) developed new postoperative neurological deficits. Of these, 24 were not detected by IONM events during surgery.

**Conclusion:** 16.8% of patients developed a new neurological deficit postoperatively. MEP alerts were most common, whereas EMG was found unreliable. IONM alerts had high specificity (93.1%) and negative predictive value (86.1%). However, the sensitivity of IONM alerts was less than 50% for non-cord level surgery.

## Abstract # 22

**Title:** Saving spinal cord function by using intraoperative monitoring and rapid response during spinal deformity surgery

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**Purpose:** To evaluate the effectiveness of IONM in preventing neurologic deficits during complex cord-level deformity operations

**Methods:** Twenty international centers prospectively documented IONM, demographics, radiographic findings, and surgical events of patients undergoing spinal deformity correction. Inclusion criteria were: ages 10-80 years, neurologically intact, major Cobb>80° or undergoing any spinal osteotomy with EMG, SSEP, and MEP monitoring. Detailed neurological examination was performed at baseline, immediately post-op and prior to discharge from hospital. IONM change was defined as amplitude loss of >50% in SSEP or MEP from baseline or sustained EMG activity that lasts > 10 seconds.

**Results:** Of 349 patients with cord-level deformity correction, 16.3% had at least one IONM alert. Alerts were seen in patients with significantly larger coronal Cobb angles (73.4° v. 61.3°; p=0.008) and higher coronal deformity angular ratios (DAR) (11.0 vs. 8.3; p<0.001).

There were 81 IONM alerts in total. A single IONM alert was most common (71.9%) followed by 2 alerts (19.3%) and 3 alerts (7.0%). Changes in MEPs without SSEP or EMG were most common (76.5%; unilateral-53.2%; bilateral-46.8%). Combined MEP and SSEP alerts occurred in 13.6% of all alerts. Most events prior to the MEP alert were surgical (80.8%) and involved release/osteotomy (41.3%), correction/rod placement (38.1%), and instrumentation placement (17.5%). Osteotomy/release was the most common cause of unilateral MEP alerts, whereas rod placement/correction was the most common cause of bilateral MEP alerts. Rapid corrective actions (i.e. elevating blood pressure, transfusion, anaesthesia adjustments, rod or implant removal, steroid administration, correction attenuation and decompression) reversed 80% of the MEP changes. 25% of patients with IONM alert had new

neurological deficits, 21.4% had motor dysfunction, and 5.8% had sensory dysfunction. False negatives occurred in 4.9% of patients without IONM alerts.

**Conclusions:** IONM alerts are more common in complex spinal operations with larger Cobb angles and DARs, usually manifested in MEPs changes. IONM is valuable but has a 4.9% false negative rate, which highlights the need for more sensitive detection modalities.

## Abstract # 23

**Title:** Assessing 'LDX' Induced Restoration of Inhibitory Signaling after Traumatic Spinal Cord Injury

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**Purpose:** To study Traumatic spinal cord injury (SCI) has devastating impacts on the physical, social, and vocational well-being of patients. The primary injury involves the mechanical disruption of neural tissue and is followed by secondary injury. This entails functional losses around and extending beyond the lesioned area, disrupted synapses in anatomically preserved tissue, and worsened SCI symptoms and recovery. 'LDX', a pharmacological inhibitor of Na-K-Cl2 cotransporter 1 (NKCC1), is proposed to cross the blood spinal cord barrier (BSCB) and enhance functional recovery during task-specific rehabilitation following traumatic SCI, while also concomitantly restoring inhibitory signaling in the perilesional area and enhancing new synapse integration. This builds off principles of voluntary movement requiring a concert of both inhibitory and excitatory signaling. Prior studies have used different NKCC1 inhibitors with lower BSCB penetrance in a prophylactic single dose before SCI and little has been explored in functional movement recovery. Addressing this gap is imperative for clinical applicability as pre-SCI pharmacological treatment is difficult to justify given the sporadic initiation of the disease. In a more translatable manner, this study focuses on treatment after SCI with a novel repurposed drug, 'LDX', that has prior Food and Drug Administration approval. The objective is to assess the efficacy of 'LDX' in treating SCI through neuromodulation coupled with rehabilitation.



**Methods:** Female Wistar rats received a clip compression-contusion injury at the C6/C7 level of the spinal cord to model SCI in patients. Rats were randomized into 8 groups (n=12/group) with sham and SCI animals receiving either vehicle or 'LDX', with and without rehabilitation. Bi-daily intraperitoneal 'LDX' and vehicle treatments were administered for 12 weeks, beginning 1-week post-SCI.

**Results:** It is anticipated that the greatest functional recovery in neurobehavioral assays and synapse restoration will be from the concomitant therapy of 'LDX' and rehabilitation. Preliminary results have shown 'LDX' to be safe for administration in rats with spinal cord injury even at concentrations 4 times above the recommended dosage and for long treatment regimens.

**Conclusions:** 'LDX' presents a hopeful new therapy for SCI and when used concomitant to rehabilitation therapy, a highly translatable treatment.

#### Abstract # 24

**Title:** What events are associated with intraoperative neuromonitoring alerts in deformity surgeries? Results from the multicenter prospective Spinal Deformity Intraoperative Monitoring (SDIM) study

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**Purpose:** Multimodality intraoperative electrophysiological monitoring aids in safely performing spinal deformity surgery. Changes in intraoperative potentials alert the team of potential spinal cord ischemia or injury, and certain interventions can decrease the chances of poor neurological outcomes after an alert. The purpose of this research is to describe the events prior to intraoperative neuromonitoring (IONM) alerts during deformity surgeries.

**Methods:** A multicenter prospective study was conducted. Patients aged between 10 and 80 with a minimum Cobb angle of 80° and/or requiring a posterior column or 3-column osteotomy using multimodal

neuromonitoring with EMG, SSEP, and MEP were analyzed. Patient demographics, radiographic parameters, IONM alert types, and triggering events were recorded. An alert was defined as SSEP amplitude loss > 50%; MEP amplitude loss > 50% in two of three muscle groups and/or EMG sustained activity for > 10 seconds. Patients were divided into cord level surgery if the curve correction was at or above the conus medullaris, and non-cord level if the correction was below the conus.

**Results:** 556 patients were included in primary analyses, of which 349 were classified as cord level, and 197 as non-cord level. Overall, IONM alerts were recorded in 79 patients (14.5%), of which 81 alerts occurred in 57 patients (16.3%) at cord level, and 26 alerts occurred in 22 patients (11.2%) at non-cord level. For cord-level surgeries, 78 out of the 81 alerts had MEP changes, of which 44 were unilateral and 34 were bilateral MEP changes. The most common surgical event prior to a unilateral MEP change was an osteotomy/release (57.9%) whereas for a bilateral MEP change, it was correction/rod placement (64%). Unilateral changes were associated mostly with a type 2 osteotomy (68.2%) whereas bilateral changes were associated more with a type 5 or 6 osteotomy (66.7%). MEP alert occurred more frequently during decompression on the concave side (76.5%) in unilateral MEP changes. For non-cord level surgeries, 21 out of the 26 alerts had MEP changes, of which 16 were unilateral and 5 were bilateral MEP changes. The most frequent event was an osteotomy/release prior to both unilateral (50%) and bilateral (66.7%) MEP changes, and types 2, and 3,4 osteotomies had similar rates of IOMN alerts. For non-surgical events that preceded any alert in cord-level surgeries, technical was most frequent (9.1%) in unilateral changes, whereas anesthesia (26.5%) and technical (23.5%) were most frequent in bilateral MEP changes. For non-cord level surgeries, technical (25%) was most frequent in unilateral changes, whereas systemic events such as low blood pressure or anemia (20%) and technical (20%) were found in bilateral MEP changes.

**Conclusions:** Osteotomy/release most frequently occurred prior to a unilateral MEP change whereas correction/rod placement was more frequently observed in bilateral MEP changes in cord-level deformity surgeries. For non-cord level surgeries, osteotomy/release was the most frequent surgical maneuver that triggered an IONM alert. These are the critical steps that require meticulous handling and attention to prevent neurologic injuries.

## Abstract # 25

**Title:** Circumferential cervical spinal fixation a single centre experience

**Authors and Affiliations:** PL Lawrence<sup>1,2</sup>; H Ota<sup>1</sup>; C Lee<sup>1</sup>; S Russo<sup>1</sup>; and I Crandon<sup>2</sup>

**Purpose:** To assess morbidity and mortality amongst same day and staged circumferential (360 degree) cervical spinal fixation at Imperial College NHS Trust (ICNHST) and audit those results against existing international literature.

**Methods:** Analysis of medical records of all 360 degree cervical spinal fixations at ICNHST between 2016 and 2017 was done. Central tendency trends as well as outcome comparisons between one (1) stage and two (2) stage subgroups with respect to: age, injury severity score (ISS), Acute Spinal Cord Injury (ASIA) score, Rockwood Frailty Scale (RFS), length of stay (LOS), spinal and extra spinal morbidity such as, respiratory tract infections and venous thromboembolism (VTE) and mortality were assessed and then audited against the current.

**Results:** Ankylosing Spondylitis (AS) 'chalk stick' fractures and bi-facet dislocation were the majority cases warranting consideration of 360-degree fixation in the Imperial population. The only mortalities were frail elderly patients subjected to a two-stage fixation. The incomplete two-stage though associated with prolonged LOS displayed no and the average Length of stay (LOS) was significantly longer in this group as well. Advanced age and premorbid frailty were associated with extra-spinal morbidity, preoperative ASIA score correlated with long-term ambulatory function.

**Conclusions:** The ICNHST data on one versus two stage 360-degree fixation mirrors the world literature. One-stage is ideal but sometimes unachievable, it is perhaps wise to not expose the frailer (Rockwood Frailty score .4) patients to a two-stage fixation due to potential mortality risk. The mortality risk is possibly attenuated by doing one side and accepting sub-optimal surgical stability.

## Abstract # 26

**Title:** Waiting times for operative management of degenerative cervical myelopathy (DCM) and the impact on outcome

**Authors and Affiliations:** Peyton Lloyd Lawrence RCS Ed, Salvatore Russo FRCS, Kevin Tsang FRCS, Professor Ivor Crandon FRCS

**Purpose:** To audit the waiting time as well as operative approach for patients with degenerative cervical myelopathy (DCM) and its impact on outcome in the Imperial College NHS Trust (ICNHST) against the latest AO standard.

**Methods:** The medical records of 107 patients who had undergone surgery for DCM at ICNHST in 2016 to 2017 was reviewed. Central tendency analysis of nominal and ordinal variables such as surgery waiting time and demographics were assessed using Microsoft excel. **RESULTS:**

**Results:** The mean age reviewed was 58.2 years. Male to female ration was 1:1. The mean wait time was 10.22 weeks overall. However, 58% of cases were moderate with mean wait time in that stratum at 4 weeks. Most patients improved at 3- 6 months by 2 points on the mJOA regardless of approach done although 63% of cases were anterior. The results were compatible with the latest AO recommendations except for mild patients where it seemed more efficient to converse about morbidity of surgery vs myelopathy in the first instance, since disease burden is tolerable and plated in most hence risk may outweigh benefit. The approach chosen should be individually chosen based on a gestalt of patient and disease factors since results are equivocal.

**Conclusion:** The management of cervical myelopathy must be taken at the merit of each patient based on a gestalt of the individual clinical factors involved. However, a default rule of limiting wait to under 4 weeks is effective despite the surgical approach employed.

## Abstract # 27

**Title:** An examination of the roles of Cx3cr1 and microglia in degenerative cervical myelopathy

**Authors and Affiliations:** Sydney Brockie, Noah Poulin, Cindy Zhou, Mandana Movahed, James Hong, Michael G. Fehlings

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**Purpose:** The purpose of this study is to examine the roles of fractalkine and microglial signaling in DCM progression and secondary injury following surgery. We hypothesize that inhibiting microglial

CX3CR1 signaling drives inflammatory responses after decompression and inhibiting this may attenuate secondary injury.

**Methods:** In this study, we utilized existing  $Cx3cr1^{egfp/egfp}$  knock-out mice, as well as novel transgenic strains to model DCM in the absence of the CX3CR1 receptor and  $Cx3cr1^+$  microglia.

**Results:** We developed a novel  $Tmem119-Cre^{ERT2}::Cx3cr1-DTR$  mouse strain to target  $Cx3cr1^+$  microglia after decompression. The parallel use of knock-out and inducible cell ablation models allowed us to establish the primary functions of microglial CX3CR1 signaling in an inflammatory context. We demonstrate that the absence of CX3CR1-signaling and  $Cx3cr1^+$  microglia drive chronic hypersensitivity after decompression. Additionally, we observed enhanced neuronal and synaptic preservation in ablated animals, coupled with reduced synaptic engulfment and phagocytic activity. Further, we observed reduced vascular association of  $Cx3cr1^+$  microglia in ablated animals, which contributed to reduced acute vascular leakage. Finally, we found  $CX3CR1^{egfp/egfp}$  and  $Cre/lox$  animals display similar cytokine regulation, suggesting the critical role of CX3CR1 in this context.

**Conclusions:** By increasing understanding of DCM pathobiology, this work highlights potential therapeutic targets and may aid in the surgical and peri-operative management of DCM.

## Acknowledgement

Thank you!

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