Complex Spine Fellowship

Curriculum

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Introduction

The neurosurgery section of the Neuroscience Institute at Virginia Mason™ is a high volume, state-of-the-art service using nationally- and internationally-recognized, system-based approaches to tertiary/complex spine surgery, including adolescent and adult spinal deformity, tumors, neglected trauma and a large volume of routine degenerative cervical and lumbar cases. In alignment with the Institute's vision to create a comprehensive multi-disciplinary team focused on quality, research, education and innovation, the goal of the Complex Spine Fellowship is to train spinal surgeons who possess a broad knowledge base in complex spinal surgery, an ability to generate relevant differential diagnosis based on history and physical examination, an understanding of indications and contraindications of therapeutic procedures, skill at performing these procedures safely and effectively, and an appreciation of the humanistic and ethical aspects of medicine.

Systems approaches to achieving safe outcomes and reducing complications are front and center to our approach to complex spine surgery. Virginia Mason is known nationally and internationally for its application of lean principles from the Virginia Mason Production System (VMPS) to increase patient safety and quality of care, while reducing costs. The spine fellow will be immersed in these principles throughout the fellowship, leading to deepened understanding of the broader healthcare context and how lean methodology can be applied in future practice settings.

Number of Positions

One fellow will be appointed each year.

Prerequisites for Training

Fellow must have completed an ACGME-accredited residency in neurosurgery or orthopaedic surgery with eligibility for Washington state licensure. In-folded fellowships during

neurosurgery residencies at other locations will also be considered.

Eligibility

Candidates' training director must provide a written attestation that the candidate is competent and qualified to perform and be credentialed in basic spinal procedures at an independent level. **We cannot consider applicants with J1 visa status.**

Duration of Training

The planned duration of training is one year.

Training Faculty

Training will be offered in complex spine surgery and system processes. The fellow will train with a minimum of four surgeons performing the bulk of complex spine procedures at our organization.

Oversight of the fellowship is provided by co-directors, Jean-Christophe Leveque, MD and Rajiv Sethi, MD. Support for the fellowship is provided by Kelsey Hanson, MBA, Academic Specialist.

JC Leveque, MD, *Program Co-Director*, graduated from Duke University Medical School prior to completing a neurosurgery residency and Complex Spine Fellowship at University of Michigan Medical Center. He is board certified by the American Board of Neurological Surgery and has served as the President and Treasurer of the Washington State Association of Neurological Surgeons. Dr. Leveque currently serves as the Neurosurgery Section Head at Virginia Mason.

Rajiv Sethi, MD, *Program Co-Director*, a graduate of Harvard Medical School, is a board-certified orthopaedic spine surgeon. He completed a Harvard Combined Orthopaedic Surgery Residency at Massachusetts General Hospital before completing a Complex Spine Surgery/Scoliosis and Deformity Fellowship at University of California, San Francisco. Dr. Sethi is the Medical Director of Neurosciences and Spine Service Line at Virginia Mason and serves on the Board of Directors for The National Spine Health Foundation.

Venu Nemani, MD, PhD, completed medical school and a PhD in Neuroscience at University of California, San Francisco. After completing an orthopaedic surgery residency at Hospital for Special Surgery in New York, Dr. Nemani completed a Spinal Deformity Surgery Traveling Fellowship in Japan as well as an Adult and Pediatric Spine Surgery Fellowship at Columbia University. Dr. Nemani is board certified by the American Board of Orthopaedic Surgery and is a fellow of the American Academy of Orthopaedic Surgeons and Scoliosis Research Society.

Farrokh Farrokhi, MD, attended Baylor College of Medicine prior to completing a residency in neurosurgery at University of Texas. He completed a fellowship in Pediatric Neurosurgery at Seattle Children's Hospital. In addition to being board certified by the American Board of Neurological Surgery, he serves as an examiner. Dr. Farrokhi was President of the Washington State Association of Neurological Surgeons for nearly a decade and is the past Section Head of Neurosurgery.

Philip Louie, MD, a graduate of University of Washington School of Medicine, he completed residency in orthopaedic surgery at Rush University prior to a Spine Surgery Fellowship at Hospital for Special Surgery in New York. Establishing himself as a remarkable researcher, Dr. Louie has published over 100 peer-reviewed articles in national and international journals and is set to serve as the Director of Research in the Neuroscience Institute at Virginia Mason.

Katie Krause, MD, PhD, earned her PhD in Neurophysiology prior to attending medical school, both at the Medical College of Wisconsin. She finished residency in Neurological Surgery at Oregon Health and Science University prior to her fellowship in Neurological Spine Surgery at the University of Washington. Dr. Krause recently completed a Leadership Fellowship with the Congress of Neurological Surgeons and holds board certification from the American Board of Neurological Surgeons.

Training Institution

Hands-on training occurs at Virginia Mason with the possibility of rotation to suburban satellite clinics. In rare circumstances, the fellow may observe procedures or patient care at other local institutions.

Salary

Salary and benefits are competitive at the regionally-determined PGY level.

Experience

The Complex Spine Fellowship provides a tertiary spine experience. The fellow is supported by a robust practice of seven physician assistants, who provide routine clinic and inpatient care, and will spend the majority of his/her time caring for patients before, during, and after spinal procedures, fully participating in the algorithm of surgery with the multidisciplinary care team in the evaluation and management of complex spine cases. Initially, fellows will observe faculty performing spine procedures, then transition to hands-on training. Hands-on experience will increase commensurate with the level of fellow skill and comfort level of individual faculty. The fellow may have one-half day of outpatient continuity clinic and spend significant time on system processes to improve patient safety. The fellow will also participate in weekly conferences and present to external audiences at least six times during the training period. The fellow's time is divided into three key areas:

Operative Care	65%
Non-Operative Care	15%
Research/Publication	20%

See surgical objectives (below) for detailed information about surgical skills training.

Didactics and Conferences

The fellow will attend and actively participate in spine surgery conferences and meetings at Virginia Mason, to include complex spine conference, neuroradiology conference, journal club, and other organizational meetings.

Call Schedule

Call responsibility is typically one weekend of four, for matters immediately related to spine care.

Program Goal

The goal of the fellowship is to teach requisite cognitive and technical aspects of complex spine surgery, including: understanding relevant disease processes, their presentation and management; analysis and interpretation of radiographic data; understanding the indications and contraindications for procedures; pre- and post-procedure care of the patient; surgical skills to perform three-column osteotomies and MIS approaches for spinal deformity correction; recognition and management of complications; appropriate documentation and reporting; appropriate communication with the patient and the multidisciplinary team; and most importantly research, presentation and publication. In addition, the Complex Spine Fellowship will provide the fellow with tools and skills to understand the broader industry context in which s/he works, with specific emphasis on making contributions that improve safety, appropriateness and cost effectiveness of complex spinal surgery.

Overview of Educational Objectives

The fellow will be mentored and directly supervised by neurosurgery and orthopaedic spine faculty toward achievement of goals in five areas: surgical skill, patient care, medical knowledge, research and teaching, and interpersonal skills and communication. Progress toward these objectives will be monitored on a daily basis and throughout the program.

Surgical Skill Objectives

The Complex Spine Fellow will be exposed to cases on the most complex end of the spine surgery spectrum. Fellows can expect to perform a minimum of 200 cases, with the approximate case breakdown:

Deformity	60%
Degenerative Spine	30%
Tumors	10%

At the end of the **first quarter**, the fellow will be able to:

1. Use Surgimap and present cases at spine conferences.

2. Plan for safe positioning, exposure and closure of the spine.

3. Assist in simple spine cases, beginning to take an active role in surgical care.

4. Assist in complex spine cases.

5. Begin exposure of the spinal column as well as the basics of spinal instrumentation.

6. Identify landmarks and anatomy in simple and complex cases.

At the end of the **second quarter**, the fellow will be able to:

Perform all of the previous quarters' specific learning objectives with increasing skill plus:

1. Assist in complex spinal cases, taking an active role in spinal instrumentation including thoracic/lumbar pedicle screws and interbody placement (posterior/ anterior/lateral).

2. Handle a drill and kerrison in a deformed spine.

3. Perform safe decompression.

4. Plan the step by step execution of the case.

5. Integrate the use of Physician Assistants in surgical procedures.

At the end of the **third quarter**, the fellow will be able to:

Perform all of the previous quarters' specific learning objectives with increasing skill plus:

1. Provide appropriate, safe, and skilled surgical treatment for patients having simple spine procedures, with attending observation but not necessarily direct involvement, including open laminectomy and discectomy.

2. Demonstrate skill in instrumentation, including cervical/thoracic/lumbar instrumentation.

3. Serve as the primary operator in performing anterior and lateral surgical approaches with direct attending involvement.

4. Demonstrate the physical steps and maneuvers necessary for more complex spinal deformity procedures such as PSO.

At the end of the **fourth quarter**, the fellow will be able to:

Perform all of the previous quarters' specific learning objectives with increasing skill plus:

1. Plan each case and identify specific patient factors that preclude a certain approach.

2. Perform basic lateral access surgery.

3. Perform anterior lumbar and lateral lumbar/thoracic approaches for spinal deformity correction with a skill level that ensures minimizing the risk of neurologic, vascular, or pulmonary complications.

4. Earn the respect of the OR team and perform complex spinal deformity procedures, still with attending physician oversight, but at a skill level that demonstrates the capability for performance independently as a new attending surgeon after completion of fellowship.

At the conclusion of the fellowship, the fellow will have obtained the knowledge and experience necessary to diagnose, evaluate, and surgically treat spine patients, including the use of three column osteotomies, MIS lateral and anterior approaches for spinal deformity correction, and MIS for decompression in basic lumbar and cervical surgery.

Patient Care Objectives

Virginia Mason Neuroscience Institute patients include the spectrum of adult patients with medical, surgical, and neurological illnesses managed in an outpatient and inpatient setting. Patients originate from tertiary care referrals, the emergency room, and from community-based physicians. The fellow will encounter patients from each of these groups and in all stages of illness, ensuring experience with a comprehensive range of conditions managed by tertiary complex spine expertise. In this context, the fellow will apply clinical, epidemiologic and surgical knowledge to the care of complex patients, demonstrate analytical thinking approach to clinical situations, consistently teach and support team members, and provide compassionate, appropriate, and effective care of patients with spinal disease:

1. Develop, communicate, and implement treatment plans, discuss new cases and clinical problems with an attending physician within an appropriate time interval, formalize a management strategy and use it to help manage spine patients.

2. Provide sophisticated, concise and well-referenced written consultations of acutely and chronically ill adult patients with spine conditions, including history and physical exam and interpretation of lab and radiologic data.

3. Demonstrate effective oral communication with the patient and his/her family, and oral and written communication with other health care providers.

4. Advocate for quality patient care, assist patients in dealing with health care complexity, and recognize patient preferences when selecting diagnostic and therapeutic options.

5. Use systematic approaches to reduce errors, practice effective health care allocation that does not compromise quality of care, and apply knowledge of types of medical practices and health care delivery systems.

6. Demonstrate humanistic treatment of patients in the context of cultural, socioeconomic, ethical, environmental, and behavioral factors affecting their care.

7. Participate in the evaluation and management of inpatients who require any advanced spinal intervention, including post-procedure follow-up and management of complications.

At the end of the **first quarter**, the fellow will be able to:

1. Evaluate patients in clinic and provide a concise summary to the attending physician with appropriate understanding of physical examination and radiographic findings.

2. Provide a rough outline of the proposed surgical or nonsurgical plan, including radiographic assessment and clinical presentation that are the indications for the surgical procedure.

3. Discuss the Seattle Spine Team Approach, including the role that anesthesiology and non-operative providers play in the workup and management of complex spine patients.

At the end of the **second quarter**, the fellow will be able to:

Perform all of the previous quarters' specific learning objectives with increasing skill plus:

1. Evaluate patients independently in clinic. Develop and present to an attending physician a surgical or nonsurgical management plan supported by medical/surgical literature.

2. Work as an integral part of the surgical team managing the postoperative care for patients during their hospital stay.

3. Independently manage the monthly multidisciplinary spine conference including presentation with history, imaging, proposed surgical plan, and "red flags" requiring more evaluation.

At the end of the **third quarter**, the fellow will be able to:

Perform all of the previous quarters' specific learning objectives with increasing skill plus:

1. Independently evaluate simple and complex spine patients in clinic.
2. Develop and provide an appropriate surgical plan, including the "order set" necessary with table, instrumentation, monitoring, etc.

At the end of the **fourth quarter**, the fellow will be able to:

Perform all of the previous quarters' specific learning objectives with increasing skill plus:

1. Demonstrate capability to manage the complications of spine surgery – infection, potential vascular injury, neuromonitoring changes, dural tear, pneumothorax, pseudoarthrosis, etc.
2. Engage meaningfully with perioperative providers, primarily Anesthesia, including in appropriate pre-operative discussions regarding blood transfusion, anesthetic choice, expectation for wake-up, and post-operative triaging of patients.
3. Summarize the characteristics necessary for implementation of the Seattle Spine Team Approach in the fellow's next center of employment and have developed a plan for such implementation.

Research & Teaching Objectives

The fellow will demonstrate ongoing commitment to self-directed learning and choose an independent research project relevant to complex spine surgery by the end of the first month of fellowship training. By the end of the fellowship year, the fellow will complete and submit a minimum of three abstracts to the Scoliosis Research Society or similar forums, and author at least three peer-reviewed publications. The fellow will have one day per week dedicated to research. If deemed necessary, the Program Director will allow extra time for research in order to help expedite the fellow's research projects and publication.

Objectives include:

1. Review evidence-based literature to answer specific clinical questions arising from patient care.

2. Review and present current literature including medical trial data.

3. Organize clinical data of complicated spine patients, compare personal practice patterns to larger populations, and analyze personal practice patterns systematically for possible means of improvement.

4. Develop research skills, including generating study designs, including hypotheses and methods suitable for IRB and grant applications, basic and advanced data acquisition, statistical analysis, and manuscript preparation suitable for publication.

5. Develop and submit a minimum of three manuscripts, book chapters, or review articles.

6. Develop teaching skills in the education of medical and surgical residents, nurse practitioners, physician assistants, and medical students.

At the end of the **first quarter**, the fellow will:

1. Complete CITI GCP/Ethics training.

2. Complete free online refresher courses on statistical analysis.

3. Complete a literature review on topics of potential research interest and identify knowledge gaps in Complex Spine peer-reviewed literature.

4. Based on the literature review, propose study objectives with well-defined aims.

5. With assistance from the research program manager, develop study methodology, data collection tool, IRB applications for proposed studies.

6. Submit IRB application and complete initial data abstraction for a minimum of one IRB-approved research project.

7. Give a 30-minute presentation to the NSI research team.

At the end of the **second quarter**, the fellow will:

1. Following approval of co-authors, submit abstracts to the Scoliosis Research Society for the next IMAST meeting.

2. Identify and receive IRB approval for one to two additional, feasible research studies.

3. Finalize data collection and analysis for study/studies developed in the first quarter.

4. Write and distribute manuscript(s) to co-authors for revision.

5. Give a 30-minute presentation to the NSI research team.

At the end of the **third quarter**, the fellow will:

1. Finalize all data collection and analysis for new studies developed in the second quarter.

2. Obtain final approval of manuscripts and complete tables, figures from all co-authors.

3. Submit two to three manuscripts to peer-reviewed journals, listing self as corresponding author.

4. Give a 30-minute presentation to the NSI research team.

At the end of the **fourth quarter**, the fellow will:

1. Complete all manuscript preparation, including revisions with co-author feedback.

2. Provided written summary for all existing IRB-studies.

3. Present research at the IMAST meeting.

4. Give final 30-minute presentation to the NSI research team.

All research data must be stored on a secured, shared drive. No PHI may be placed on a flash drive or moved from the secured, shared drive in any manner.

If the fellow is unable to complete a manuscript prior to completion of program appointment, authorship may change. Access to Virginia Mason's electronic medical record, including for the purpose of research, concludes when the appointment ends.

Complex Spine Fellowship Research Timeline
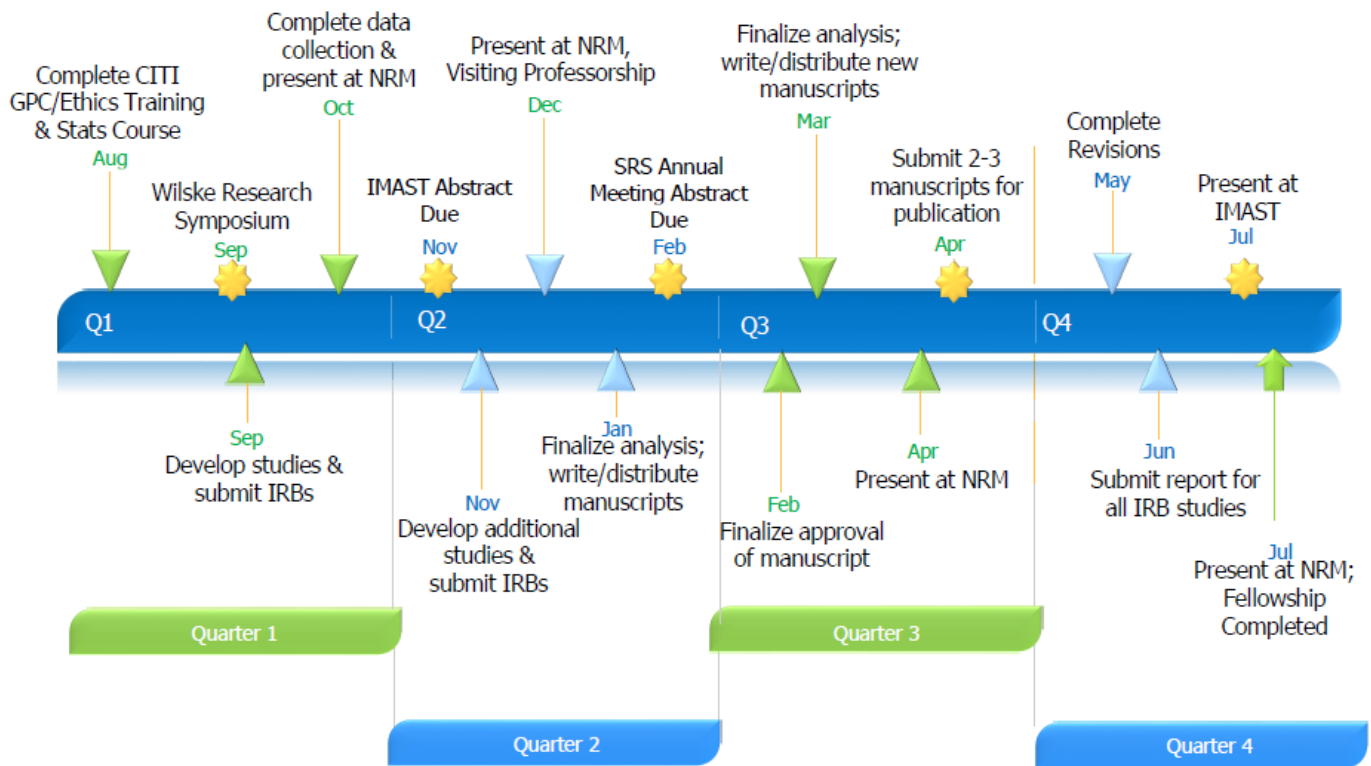
*NRM Neuroscience Institute Research Meeting

Interpersonal and Communication Objectives

1. Communicate effectively with patients and families in a compassionate, culturally and gender sensitive manner, including diagnosis, treatment plan, and follow-up care.

2. Appropriately notify supervising attending physicians of changes in the clinical status of patients and request consultations appropriately.

3. Effectively discuss end of life care with patients and their families and the importance of "saying no" to expensive procedures with no proven track record regarding cost effectiveness or improvement of quality of life.

4. Maintain communication with the neurosurgery charge nurse, inpatient schedulers, spine attending physicians, nurses, techs and all team members regarding patients and the procedure schedule.

5. Supervise and lead the team appropriately, demonstrating commitment to ethical principles pertaining to the provision or withholding of care, patient confidentiality, and informed consent.

Teaching Methods

The principal teaching methods of the Complex Spine Fellowship program are case- and/or procedural-based discussions and instruction led by the attending physician. A majority of teaching will involve direct instruction in the performance of spine procedures under supervision of attending physicians and may also include:

1. Modeling by attending physician
2. Direct 1:1 instruction by attending physician
3. Hands-on spine training supervised by attending physician
4. Participation in regularly scheduled clinical conferences
5. Attendance at annual, scheduled, and small conferences and meetings
6. Use of scientific literature and information technology
7. Preparation and delivery of Virginia Mason Grand Rounds presentations
8. Recommended reading

Teaching will be supplemented by multidisciplinary conferences, journal club, neurology tumor board meetings, and events specific to neurosurgery spine. Teaching will also take place during daily management of patients on the service. The fellow will organize four spine journal club sessions per year with the University of Washington orthopaedic spine service and take part in teaching activities of the service.

Evaluation and Feedback

The fellow will meet with the Program Director and will receive verbal and written evaluations at least quarterly. Quarterly evaluations will be used to assess progress on learning objectives outlined above. The fellow will be expected to provide confidential assessment and feedback about the program and faculty. Evaluative content will be received from:

1. Direct observation during procedures, rounds, clinics, and conferences
2. Attending physician evaluation of fellow
3. Semi-annual evaluation by Program Director

Competency Assessment

Currently, there is no ACGME accreditation for advanced complex spine surgery and system improvement learning. The fellow's competence is typically assessed by the program director and neurosurgery chief. The fellow will keep a procedure log for advanced spine procedures. This log will allow the Program Director to provide specific volumes of procedures the fellow performs when recommending privileges at different institutions.

Appendix A: Complex Spine Fellowship Alumni

Year	Fellow	Medical School	Residency	Current Position
2021-22	Jesse Shen, MD, MS	University of Montreal, Quebec, CA	University of Montreal, Quebec, CA	Virginia Mason Medical Center, WA
2018-19	Michael Bohl, MD	University of Michigan Medical School, MI	Barrow Neurological Institute, AZ	Carolina Neurosurgery & Spine Associates, NC
2017-18	Louis Nkrumah, MD, PhD	Albert Einstein College of Medicine, NY	Emory University, GA	Mariwalla Neurosurgery, NY
2016-17	Vijay Yanamadala, MD, MBA	Harvard Medical School, MA	Massachusetts General Hospital, MA	Ayer Neuroscience Institute, CT