Integration of spine research and clinical activities drives innovation, outcomes

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The integration of biomechanical spine research and clinical spine care has contributed to the Medical College of Wisconsin’s Department of Neurosurgery being a neurosciences innovator since the 1960s. Medical College faculty in today’s spine program, led by Chairman and Professor of Neurosurgery Dennis J. Maiman, MD, PhD, mine the synergy between colleagues and disciplines to translate clinical advances from scientific and medical discoveries.

Just as knowledge derived through research by the Medical College’s transdisciplinary neurosciences team has direct clinical applications, observations made in the clinic are taken immediately to the laboratory. Virtually all Medical College spine surgeons are involved in biomechanics and basic science laboratory projects while non-clinician faculty investigate clinical questions with an understanding and appreciation for the clinical coloring of a research problem. Such complete integration ensures the relevance and the quality of our activities.

Doctor Maiman’s research includes study of the material properties of spinal hardware. The use of titanium rods and screws for spinal fixation is very common. However, the metal can place stress on the spine due to its rigidity and corrupt MRI results. Doctor Maiman is investigating alternative non-metallic materials and techniques for fixing the spine that more closely mimic the material properties of bone, thus making them safer long term.

Experts in spinal pathology and spinal injury, Neurosurgery professors Narayan Yoganandan, PhD, and Frank A. Pintar, PhD, employ biomechanical research methods to assess occupant injury mechanisms and vehicle crash-worthiness. Notably, they are currently engaged with the US military to evaluate the mechanics of spine injuries sustained by soldiers whose vehicles are projected upward from the detonation of an improvised explosive device (IED). IED attacks are responsible for increasing numbers of spinal injuries in the Middle East. Drs Pintar and Yoganandan are focusing on developing instrumentation to test for these injuries with a long-term goal of designing vehicles that are resistant to them.

Advancing instrumentation—specifically, sophisticated test dummies—is a focus of the Medical College’s Neurosurgery laboratories. Although most spine injury research in the program is created from the cadaver model, developing scientifically accurate, reproducible dummies allows considerably more expansive research not possible in a cadaver. By placing transducers or pressure gauges within the discs of the spine and in the spinal cord, for example, our scientists can predict the forces that will occur there, which cannot be done as comprehensively or as accurately in a cadaver, as the constitution of the tissues and the compliances are different.

Drs Yoganandan and Pintar recently have expanded their biomechanics efforts to include study of the effect of side impact on pilots and passengers in airline crash landings or hard landings. This is being investigated in conjunction with the Federal Aviation Administration.

Mathematical modeling is the basis for translational research conducted by Brian D. Stemper, PhD, Associate Professor of Neurosurgery. He is using finite element analysis to study the subtle, anatomical differences between the spines of men and women, and the impact these dissimilarities have on the development of spinal disorders.

One of the clinical questions driving the research is the substantially higher incidence of scoliosis development among women as they age. By analyzing data from cadavers and from patients via his mathematical model, Dr Stemper has begun to discover the differences in how the spinal joints are aligned in women as opposed to men, which appears to contribute to the disorder. His research will eventually provide a more accurate basis for designing rehabilitation therapy based on the particular needs of women with different joint types and allow for better prediction of disease trajectory.

In conjunction with Jamie L. Baisden, MD, Associate Professor of Neurosurgery, Dr Stemper is now applying this science to whiplash injury, which also is more...
prevalent in women. The research is identifying differences in women’s joints that make them more prone to whiplash.

The epidemiological research of Marjorie Wang, MD, MPH, Assistant Professor of Neurosurgery, evaluates the impact of spine surgery on patients’ quality of life. Through a Robert Wood Johnson Foundation Physician Faculty Scholars Award, Dr. Wang is studying the risks of surgery for degenerative changes of the cervical spine through retrospective analysis of national database information, while also prospectively surveying patients on expectations and post-surgical outcomes. The evidence-based information developed for surgeons should enhance preoperative counseling and clarify indications for surgery.

Doctor Wang is among a select group of academic neurosurgeons to have completed a spine surgery fellowship at the Medical College. The fellowship program comprises a large and varied surgical experience including spine trauma, neoplasm, and degenerative diseases. Fellows also participate in ongoing research efforts or are able to design limited studies.

Expertise in neurosciences research and training is integral to our innovative diagnostic and treatment outpatient program for patients with acute and subacute spinal disorders. SpineCare, which Dr. Maiman helped create, is a fully integrative, interdisciplinary clinical program in which patients are treated on evidence-based pathways. SpineCare is a part of the Froedtert & The Medical College of Wisconsin Clinical Neurosciences Center. The program’s alignment with research initiatives enables faculty to rapidly convert clinical information into research data, which, in turn, speeds therapeutic enhancements.

Several clinical options have been altered as a result of biomechanical studies originating with clinical data accumulated through SpineCare. After tracking outcomes and examining for predictive factors in women with spondylolisthesis, for example, research indicated that spinal fusion, which was long assumed necessary for this degenerative disorder, is not always the favorable option.

The SpineCare program emphasizes functional outcomes with treatment plans individualized for each patient. Coordinated care is provided by specialists in Neurosurgery, Orthopaedic Surgery, Physical Medicine and Rehabilitation, Neurology, and Anesthesiology, as well as chiropractic physicians and therapists.

Collaborative expertise and leadership excellence are reflected in SpineCare’s outcomes. The expected surgical incidence in the clinic’s patient population is 11%, but at SpineCare, actual need for surgery is only 3%. In addition, 86% of patients return to work at their previous jobs. Returning patients to their families and workplaces with productive function underlies the objectives of the spine and neurosciences specialists at the Medical College and is fundamental to the health of our communities.
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