

Orthopaedic Connections

Beth Israel Lahey Health
Beth Israel Deaconess
Medical Center

The newsletter of the Carl J. Shapiro Department
SUMMER 2021 of Orthopaedics at Beth Israel Deaconess Medical Center

BIDMC research projects aim to optimize exosuits for improving work performance, preventing back injury

Researchers at Beth Israel Deaconess Medical Center are embarking on two projects to advance the development of wearable exosuits that could help individuals carry loads at work with greater ease and avoid back injury.

An exosuit is an artificial version of an exoskeleton—the organic, nearly rigid covering that protects arthropods like lobsters and helps them move. These wearable devices can be powered, with controls guided by sensors on the suit, or passive, with spring-like rods responding to the wearer's movements. Scientists have been developing exosuits with the goal of increasing the ability for workers to lift heavy loads more safely with less effort and for longer as well as helping individuals whose strength or mobility is impaired by medical conditions.

Recently, biomechanical researchers at BIDMC's Center for the Advancement of Orthopaedic Studies (CAOS) received government funding for research designed to expand knowledge in this evolving field. One study will look at how soft back exosuit could help soldiers as they lift and move heavy items, while the other will test the effectiveness of a novel

passive exosuit to aid older workers whose jobs entail lifting. Both projects will examine how effective the devices are at offloading weight to prevent back injury and lay the groundwork for better, more versatile versions.



The soft back exosuit by the Harvard Biodesign Lab is designed to relieve some of the strain of heavy lifting.

Soft, lightweight back exosuit

Conor Walsh, PhD, a professor at Harvard's School of Engineering and Applied Sciences, and his research group in the Harvard Biodesign Lab have made considerable progress on a back exosuit that provides support to help avoid back injury.

"We've been developing the back exosuit for about three years and now have a robust prototype that we are evaluating in human subjects studies,"

according to Walsh. The suit, which is light and doesn't restrict movement, straps on like a backpack. It applies forces via cables that work with the back and hip muscles to help with bending and lifting.

The U.S. Department of Defense recently awarded a three-year partner grant to Walsh and Dennis Anderson, PhD, research scientist at CAOS, to study the exosuit. "It's clear there are many DoD-related tasks and activities that cause injuries on the back, so we wanted to develop a solution that could reduce the strain. We are excited to leverage the generous support from this award to initiate a new collaboration where we can further the understanding of how exosuits interact with the body," Walsh stated.

The DoD study is a partnership, explained Anderson. "The Harvard Biodesign Lab brings the exosuit technology and an interest in developing it, and we bring the expertise in biomechanical modeling to evaluate spine and muscle loading."

Over the past 10 years, Anderson has been focused on taking biomechanical measurements of the spine as people move and stand, and creating sophisticated computational models that can provide insights into a range of orthopaedic issues—from vertebral fracture in older people to spinal stenosis—and areas for improving treatment outcomes. The exosuit study further expands the application of this work.

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Orthopaedic Connections

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In addition to phone and online requests, referring physicians can send an email including the patient's name, birth date or BIDMC medical record number, phone number and presenting problem, and we will contact the patient within one business day to schedule an appointment.

Dr. Edward Rodriguez named Chief of Orthopaedic Surgery

Edward K. Rodriguez, MD, PhD, was named Chief of the Department of Orthopaedic Surgery at Beth Israel Deaconess Medical Center (BIDMC) and took the helm in September. He succeeds Mark Gebhardt, MD, who continues his commitment to treating patients as well as his research, teaching and leadership activities at BIDMC.

"We are very pleased to welcome Dr. Rodriguez, an outstanding surgeon, researcher and educator, into his new role," said BIDMC President Pete Healy. "We are confident that his thoughtful leadership and commitment to his patients, colleagues and mentees will further enhance BIDMC's mission of extraordinary patient care supported by world class education and research."

Rodriguez began his training in bioengineering, receiving a PhD in that discipline from the University of California at San Diego before earning his medical degree from Harvard Medical School at the Harvard-MIT HST program. He completed his orthopaedic residency at the Harvard Combined Orthopaedic Residency Program followed by an orthopaedic trauma fellowship at the University of Maryland's R Adams Cowley Shock Trauma Center in Baltimore. Rodriguez is board-certified in orthopaedic surgery. He joined the orthopaedic department at BIDMC in 2004 as chief of orthopaedic trauma.

Six months into his role, Rodriguez shared his thoughts about his new position and plans for the future.

What do you envision accomplishing in the department?

I came into my new role putting forward a new vision for the way we should work and some new priorities we should embrace. Over the last 16 years under Mark Gebhardt's tenure, we have done an incredible job of building a department from essentially



nothing. We have built a strong, busy clinical group with over 28 physicians and 19 advanced practice providers and have succeeded at patient care and clinical excellence. For the next 10 or 15 years, hopefully, of my tenure, I would like to increase our focus on further improving the research and educational aspects of our mission. We need to improve the volume and quality of our clinical research, invest further in our basic science research, and develop a stronger national voice and presence. The plan is to create—in parallel to our clinical practice—a tripod consisting of a basic science and engineering laboratory, which we have had in place for many years; a clinical core research group to support our faculty, which we need to build from scratch; and a translational innovation initiative, which we recently launched in collaboration with Dr. Gyongyi Szabo, BIDMC's Chief Academic Officer.

So, basic research, clinical research and translational initiatives are the three legs, or cores, of the research tripod?

Yes. Our Center for Advanced Orthopaedic Studies will remain our engineering and basic science core. The expansion of the clinical research program involves hiring a clinical scientist to manage our clinical research activities and building up additional services for grant writing, manuscript development and statistical support. We're also

Dr. Edward Rodriguez

planning on having a total of three clinical research assistants who will be available to support all the clinicians. That will be the clinical core. And we now also have the newly formed Musculoskeletal Translational Innovation Initiative, headed by Ara Nazarian. I also named Dr. Nazarian our Vice Chair of Research Affairs, a position I created, to manage the interaction between these three entities and guide our entire research venture.

The whole idea behind uplifting our laboratory, creating a translational initiative and improving the resources for clinical research is to help us all be as productive in research as we possibly can for being one of the smaller departments at BIDMC.

How do you plan to enhance clinical research?

We have already interviewed a statistician and additional research assistants, and have added more resources for support, such as for grant writing and preliminary grant reviewing. We are also in the process of hiring a clinical scientist to become a primary administrative leader for the clinical research core. Many studies initiated by residents or fellows often die on the vine when the fellows and the residents move on. So, we need someone whose mission is to coordinate and move the clinical research forward and prevent the loss of momentum in any given study. One important point of the clinical research program is to facilitate the participation of all our divisions in multicenter studies that can potentially offer some kind of financial support.

Tell me a little more about the impetus for the Musculoskeletal Translational Innovation Initiative.

The initiative focuses on harnessing the innovative thinking of the faculty into projects that could potentially have not just a research, clinical or basic science benefit and interest, but also some commercial outcome that could be helpful to further support the departmental and institutional missions. Translational activities make

sense for an orthopaedic department because orthopaedics is often about engineering, surgical instrument and implant design, or therapeutics technology—endeavors that are amenable to industry support and collaboration.

We have had some experience in translational initiatives and have learned along the way how to take an idea from a concept to a patentable design, working with the BIDMC's technology ventures office to take that idea all the way to a small startup. We wanted to harness that experience and make it more accessible, not just to all the members of the department but to anyone in the greater musculoskeletal Beth Israel Lahey Health community. That is what the translational innovation initiative is about.

You mentioned the lab has been successful, but do you see areas where it could be even better?

Under the direction of Dr. Mary Bouxsein, the Center for Advanced Orthopaedic Studies has done remarkably well over the years. She has continued its long tradition of excellence going back to 1979, when it was established by Drs. Augustus White and Toby Hayes. The one thing we could do better is increase active collaborations with our clinicians. To achieve this we not only need to invest in upgrading the lab's resources but also boost the level of interaction by creating ongoing opportunities to exchange ideas and develop projects of mutual interest.

BIDMC has become part of the Beth Israel Lahey Health (BILH) system of academic medical centers and hospitals. How will that play into your plans for the department?

I expect our department to play a key role in our BILH orthopaedic community. We already have strong partners at Lahey Hospital and New England Baptist Hospital as well as in our affiliates at Needham and Milton. However, we have a unique position in the system given our academic and research role as well as our institutional capability to deal

with complex and high morbidity patients. I would like us to embrace that role fully within the system. For example, BIDMC has a full spectrum of orthopaedic specialties including oncology and trauma, and Lahey also has expertise in acute and complex care in these areas, so we could potentially work together to define combined or more integrated BILH-level services in subspecialties such as these.

I would also like all orthopaedic services to become more collaborative and integrated across the system in a way that is beneficial to everyone. This might include, for example, establishing common evidence-based performance and quality standards, streamlining inter-hospital credentialing to enable surgeons to practice at any BILH site, opening access to BIDMC research infrastructure to BILH partners, or creating systems that expedite referrals between orthopaedic practices anywhere in the system. I would like us to communicate that, here at BIDMC, we are ready to offer support when complexity and morbidity merit a transfer to improve a patient's outcome.

To help me improve our network-building with the other members of the musculoskeletal community within BILH, I promoted Dr. Arun Ramappa to be Vice Chair of Clinical Affairs. The mission of this position is to contribute to a more unified delivery of musculoskeletal care across the system, sharing leadership of the initiative with both New England Baptist Hospital and Lahey.

In addition to enhancing research, you mentioned advancing the department's educational mission.

There are a few educational goals I'm working on. One of the things the department has been highly successful at under Mark Gebhardt is becoming one of the preferred training sites for the Harvard Combined Orthopaedic Residency. The residents love us, in part because we have few fellows,

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Addition of total spine care makes orthopaedic services for Brockton area residents all-inclusive

With the expansion of the orthopaedic team at Signature Healthcare to include specialist physicians and other staff who treat neck and back pain, residents of the Brockton area now have access to a complete range of care for their spine health care needs close to home.

Signature Healthcare, which includes Brockton Hospital and Signature Medical Group, is clinically affiliated with Beth Israel Deaconess Medical Center (BIDMC) for orthopaedic services, cancer care and other specialties. With the two entities working together, Brockton and nearby communities can get the quality of care available in an academic medical center without traveling to Boston.

The BIDMC Department of Orthopaedics and Signature Healthcare, a not-for-profit, community-based hospital, first linked forces in 2014, when they embarked on establishing state-of-the-art orthopaedics care at Signature. Part of that vision included a robust spine service with diagnostics, non-operative care and surgical care, which hadn't been available in the Signature network for more than 15 years.

In just a few years, Richard Mulroy, MD, FACS, a joint replacement specialist and BIDMC faculty member who heads the orthopaedic service at Signature Healthcare, succeeded in bringing all the subspecialties live—except spine care. Then in 2018, he started to establish the hospital's first comprehensive spine program, naming Andrew White, MD, Chief of the Spine Division at BIDMC Orthopaedics, to lead it. With the guidance of White and others at BIDMC, Mulroy brought in non-surgical orthopaedic specialists, or physiatrists, to meet the outpatient needs of the community and a spine surgeon for patients who could benefit from surgical interventions.

Now, in addition to orthopaedic procedures that were already available

at Signature Healthcare—such as rotator cuff repair, hip replacement, carpal tunnel release, ACL repair, and arthroscopy—patients can receive the entire menu of treatment options for their spine care, according to Mulroy. That menu includes injections, physical therapy, bracing, medications and, when needed, surgery.



Spine specialists at Signature Healthcare Spine Center offer individuals in the Brockton area care close to home.

New faces, new skills

As chief of the new spine service, White brought expertise, support and cutting-edge thinking in this specialty. He has been instrumental in recruiting providers, mentoring and training staff, and putting processes and outcome measures in place.

“Besides recruiting for the specialty of spine physiatry, we were also able to train midlevel providers—we now have three physician assistants with good spine experience,” said White. “The last piece of the puzzle was to introduce spine surgery to Brockton Hospital. We ultimately recruited Sapan Gandhi for that role”

Primary care physicians can refer patients with back or neck pain to the

non-surgical spine physician without prior imaging or physical therapy, which some centers require. That physician assesses patients, learns what their goals are, and then helps them to avoid spine surgery for as long as possible or prevent the need for it altogether. They often work in conjunction with physical therapists and use other modalities such as

injections and ultrasound treatments. Importantly, the non-surgical spine physician knows when a patient may benefit from surgery, and quickly refer them to a surgeon if needed.

Orthopaedic surgeon Sapan Gandhi, MD, takes a conservative approach with his patients. “I treat people the way I would want care for myself or one of my family members, which is to only recommend surgery when it's needed,” he said. “When surgery is indicated, we do the least amount that will help the patient get better.”

The surgeries Gandhi most commonly performs are to alleviate arthritis, ruptured (herniated) disc, pinched nerve and spinal stenosis of the neck

or back. More complex procedures, such as those for back trauma, scoliosis and tumors, are available at BIDMC Boston by Gandhi and White, providing seamless continuity of care.

When a patient's issues are more complex, such as those for back trauma, scoliosis or tumors, Gandhi and White operate at BIDMC Boston. "I see myself as a link between the care that can be provided locally in Brockton and care that requires more specialized infrastructure in Boston," Gandhi said.

Gandhi often consults with the non-surgical spine physicians at Signature Healthcare or the surgeons at BIDMC's Spine Center when a patient's diagnosis or treatment plan is not clear cut. And he is transparent about it. "I will tell a patient, 'You have kind of an unusual case. I'm going to show this to my partners at our Monday morning meeting and let's have you come back in a couple of weeks and we can talk about what they said.' Patients seem to like that openness," Gandhi related.



Surgeon Sapan Gandhi, MD, performs spine surgery at Brockton Hospital.

In addition to hiring an excellent care team, implementing the spine program required giving Signature Healthcare providers in affiliated services the tools specific to spine care. "For example, there are terrific radiology techs, radiologists, and anesthesiologists at Signature, but many had not worked with spine patients," said White.

"Over several years, I held a series of calls, meetings and training programs to familiarize them and other care providers to advance their knowledge of our spine program."

Close to home

For many patients, convenience is a key factor in their decisions about healthcare.

"Many patients don't want to leave their community to be treated; they find it disconcerting," White said. There are different reasons for that. Sometimes it's about their identity—they were born in a community and they want all their treatment there, from cradle to grave.

Another often-cited reason people prefer local care is the impracticality of going into Boston. Although the Brockton area is just 25 miles south of the city, traveling is wrought with challenges. "Many people find the trip to be daunting, with traffic, parking and not being familiar with where they're going on a day that's already ridden with anxiety because they're having an operation," added White. "Part of the goal is to keep people in their community where they might be most comfortable."

That goal is now being met. The spine team sees patients at Signature Healthcare's multispecialty site on Liberty Street near Rt. 24, and performs interventions and surgery at Brockton Hospital. Since the collaboration between BIDMC and Signature Healthcare was established, Signature's orthopaedic outpatient visit and surgical volume has doubled.

Sharing strengths

Collaboration between BIDMC and Signature Healthcare continues to be key to the success of the Spine Center at Signature Healthcare. The new center uses dozens of protocols developed at BIDMC. Such protocols are important to patient safety, which was key to Signature Healthcare from the beginning. "Signature takes special pride in their patient safety, improved outcomes and reduced risks," said White. "These are areas that benefit from experience, familiarity and knowledge about systems practices."



Drs. Sapan Gandhi (top) and Andrew White provide surgical spine care in Brockton, and when appropriate, at BIDMC in Boston.

Care pathways are also shared, according to White. "For example, many years ago I helped develop a spinal fusion pathway. Putting this pathway in front of Brockton clinicians makes their familiarity as good as ours and allows them to accelerate the maturity of the program."

In addition to its clinical knowledge contributions, BIDMC's academic affiliation helped in the recruitment of highly qualified physicians for the new spine service. "Dr. Gandhi is interested in doing research with us, in helping us with training fellows and residents, and participating in our weekly conferences," said White. "That part of professional fulfillment is meaningful to him and people like him. That's why the affiliation between Signature Healthcare and our orthopaedic group is so important. It has allowed us to recruit terrific people who are doing great work."

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Optimizing exosuits to prevent back injury continued from page 1

Walsh's team has shown the back-support exosuit reduces muscle activation, or the amount of effort required to lift materials while wearing it. "In our lab," said Anderson, "we want to enhance that analysis to understand the effect of this suit on the actual loads applied to the spine or the muscles of the spine."

To kick off the study, Walsh's group will recruit 32 healthy men and women to perform lifting tasks that replicate lifting and material handling tasks

computer simulation tool so we can try different scenarios more easily and see if we can predict what would happen. That might point us toward a better approach."

Ultimately, the Harvard Biodesign Lab exosuit could benefit not just soldiers but also others who perform repetitive lifting tasks at work or have health conditions for which back support would provide more mobility. And Anderson's biomechanical computations in this arena may help

injury due to reduced strength and osteoporosis.

"We're going to conduct a comprehensive biomechanical evaluation to find out if this exoskeleton can reduce spinal loading during lifting tasks, a key factor in vertebral fracture in older adults," said Alemi. "Our findings will inform our long-term goal of developing a new generation of passive exosuits for older adults that are comfortable and effective for injury prevention during



Lowe's



Assistive Robotics Laboratory (ARL)@Virginia Tech.

A passive back-support exosuit designed by Virginia Tech and Lowe's uses flexible carbon fiber beams to ease bending and lifting. The exoskeleton applies forces to the front of the chest, top of the thighs and seat area.

of military personnel, both with and without exosuit. As they do so, the team will measure their movements and muscle activity.

Then, using the data collected, Anderson will create computer models for each subject. From there, he will use the models to analyze the effect the suit has on the loads on the muscles and joints.

The co-investigators are looking to improve the suit's design and functionality, starting with how the suit is controlled. "Right now, the design team has various control parameters to describe when and how much force the suit generates when it's trying to help somebody, but doesn't yet know which one is best," said Anderson. "We're working on developing a

other researchers working on similar devices. "There are quite a few groups around the world developing this kind of technology, but there are many unanswered questions about how effective they are in doing what we think they should be doing."

Lift assistance for older adults

In a parallel study, postdoctoral research fellow at CAOS, Mehdi Alemi, PhD, will evaluate a passive back-support exosuit he helped develop while a doctoral student. The device has been tested on young adults; now, Alemi will look at its potential for helping older adults avoid back injury. It is expected that 13.4 million people age 65 and over will be in the workforce by 2024, and this population is at greater risk of back

routine workplace tasks and activities of daily living."

The lightweight, wearable exosuit was designed and developed at Virginia Tech in collaboration with home improvement retailer Lowe's. It reinforces proper lifting form and is intended to lower the risk of back injury by storing energy during lowering and returning it back to the user during lifting. As the user bends and stands, flexible carbon fiber beams in the suit's legs and back act like a taut bow ready to launch an arrow, helping them spring back up more easily.

"We know the majority of workers are at risk of back pain or fatigue since

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Dr. Edward Rodriguez

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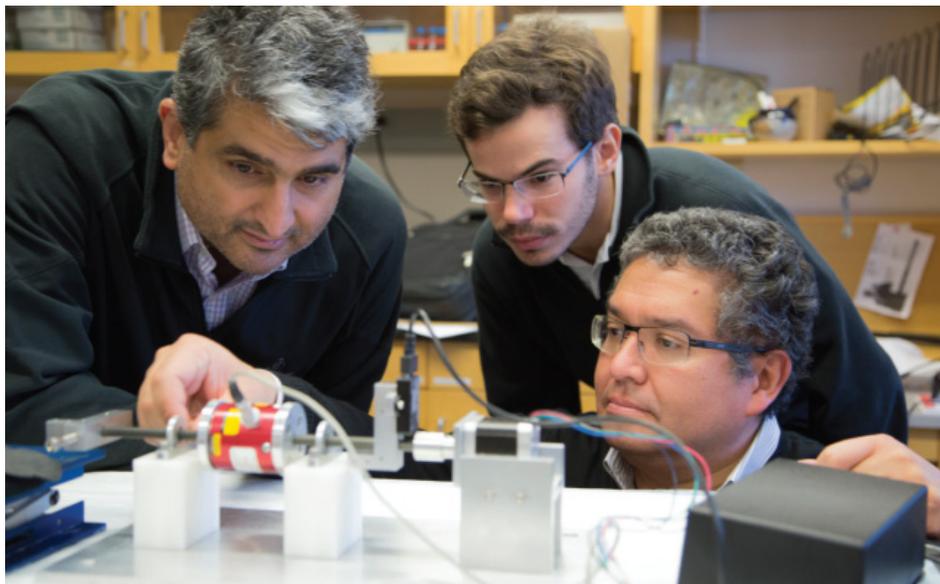
so when residents come to our rotations they are the primary trainees a freedom of operation they don't always enjoy at the other institutions. Doubling down on our strength, I want to increase the number of residents that come from the Harvard program to BIDMC.

Also, I appointed Dr. Paul Appleton to be our Vice Chair of Education. In this new role, when combined with his duties as BIDMC Associate Program Director for our combined residency, he will be empowered to seek and implement opportunities to further improve resident and medical student education and wellness. He will be designing new rotations for the additional residents coming to BIDMC and creating programs to improve resident well-being. For example, we just finished remodeling our new West Campus work area, which has been a critical need for many years. Dr. Appleton is also working on enhancing our resident curriculum across all divisions at BIDMC and integrating our didactics with the other institutions within the Harvard system.

Could you recount your journey here at BIDMC?

I've been part of the Harvard system since 1993—I went to medical school here at HMS, then did my residency in the Harvard Combined Orthopaedic Program. I was an intern the year BI and the Deaconess merged so I have had a connection with BIDMC for about 23 years. My first 16 years in the Orthopaedic Surgery Department were spent managing the orthopaedic trauma service, which has now grown to three fellowship-trained faculty members, an RN, a PA and several residents—not just orthopaedic residents but also emergency medicine and podiatry residents. I am still practicing trauma. I have fewer clinical hours, but I still take call and work weekends.

BIDMC is not just where I work, it is really my second home and family, so I care deeply about who we are and where we are going. I am very honored by the confidence our institutional



Rodriguez, right, has been actively engaged in translational research. Here he is pictured with Ara Nazarian, DSc, left, and Miguel Perez, MD, in BIDMC's biomechanical lab.

leaders have placed in me to lead the Department of Orthopaedics toward the future that I envision.

I understand you have also been involved with translational work for many years.

Yes, I have worked collaboratively with Dr. Nazarian on a number of translational projects. Probably the most important one is the development of the natural hormone relaxin, a potential therapeutic for preventing joint stiffness after injury or trauma, with Boston University. There have been many other projects over the years ranging from fracture prevention devices to infection preventing implant coatings.

What is your leadership style?

I put the most effort into being accessible to anyone who has questions or concerns—be it in the department, the institution or an affiliated hospital. I've always done that, not just because it's the right thing to do, but because it's offered me so many learning opportunities along the way. Also, I don't believe in exercising leadership by micromanaging folks into doing what I think is best but rather by trying to learn what motivates my colleagues and then finding a way to communicate how what I am proposing can support their career goals as well. The biggest challenge

so far has been the realization that unanimous consent is not always possible, even in a relatively small department.

You began your new role in the midst of a pandemic. How has that affected your first few months as chair?

It has required adjustment of many priorities. I came with ideas and goals that I wanted to implement immediately, but because of the COVID-19 pandemic, we have had to focus on critical patient-care issues and deal with limitations in OR access. We have had to prioritize and triage properly the cases that we can do, and explain to patients why they can't have their surgeries as they had initially been planned. While we are trying to manage patient-care operations, I'm still trying to implement many of the changes that I had planned. I've been fortunate that my colleagues have been incredibly supportive. And thankfully, the leadership teams at BIDMC and Harvard Medical Faculty Physicians are remarkable and have been wonderfully welcoming during this transition.

Overall, these first six months have been challenging at times, but it has been an honor and a rewarding learning experience, despite the difficulties of the pandemic.

NEWS AND NOTES

AWARDS

Edward Rodriguez, MD, PhD, chief of the Department of Orthopaedics, was selected as a recipient of the 2021 A. Clifford Barger Excellence in Mentoring Award at Harvard Medical School (HMS) in April. Award recipients are selected by an HMS and affiliated hospital advisory committee from nominations by faculty members, house officers, fellows and students of individuals who provided sponsorship, encouragement and support for their own and others' careers.

PUBLICATIONS

The BIDMC Center for Advanced Orthopaedic Studies (CAOS) researchers and Department of Orthopaedics physicians publish their work regularly in academic journals. Here are a few recent samples.

Fjóla Jóhannesdóttir, PhD, Dennis Anderson, PhD, and Mary Bouxsein, PhD, CAOS, were authors on "Bone density and strength from thoracic and lumbar CT scans both predict incident vertebral fractures independently of fracture location," published in *Osteoporosis International* in February 2020.

Brian D. Snyder, MD, PhD, and PhD candidate **Taylor Lawson, CAOS**, were authors of a two-part article in the *Journal of Orthopaedic Research* titled "Nanotechnology and osteoarthritis," published in March 2021.

Ron Alkalay, PhD, CAOS, co-authored "Conventional finite element models estimate the strength of metastatic human vertebrae despite alterations of the bone's tissue and structure," which appeared in the December 2020 issue of *Bone*.

Ara Nazarian, DrSc, CAOS, and **Edward Rodriguez, MD, PhD**, Orthopaedic Trauma, were co-authors of "Clinical management of arthrofibrosis: state of the art and therapeutic outlook," which appeared in the *Journal of Bone & Joint Surgery Reviews* last July.

A multidisciplinary team that included **Nazarian**, members of his CAOS team **Robert Spang, MEng; Johnathan Egan, MD; Philip Hanna, MD; Aron Lechtig, MD;** and **Daniel Haber, MD**, along with surgeons **Joseph P DeAngelis, MD**, and **Arun Ramappa, MD**, Sports Medicine, published their study "Comparison of patellofemoral kinematics and stability after medial patellofemoral ligament and medial quadriceps tendon-femoral ligament reconstruction" in the July 2020 issue of *American Journal of Sports Medicine*.

Signature Healthcare

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Signature Healthcare, which remains an independent organization, provides facilities that include state-of-the-art operating rooms as well as MRI, CT, and other diagnostic tools.

Since the collaboration between BIDMC and Signature Healthcare was established, the orthopaedic outpatient visit and surgical volume has doubled.

"Prior to this partnership, the people of Brockton could get excellent spine care but they had to travel to Boston," said Mulroy. "Together, Signature and BIDMC are now providing top-notch spine care in their neighborhood or in their home. Looking into the future, we will continue to grow and add the latest advances in treatments to meet their needs."

[The spine team sees patients at the Signature Healthcare facility at 110 Liberty Street in Brockton. For referrals or appointments, call 508-565-3055 or visit \[MySignatureCare.org/Spine\]\(http://MySignatureCare.org/Spine\).](#)

Optimizing exosuits to prevent back injury

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they are exposed to the repetitive lifting and lowering and other static tasks," said Alemi. "The exoskeleton is helping them to offload the weight of the torso, significantly reducing the amount of force on the spine. So when you are picking up a 30-pound box, it feels like 20 pounds."

The study, funded by the National Institutes of Health, involves 12 subjects between 65 and 80 years old who will perform lifting and static holding tasks with and without the exosuit. The recruited participants will be gender-balanced and have no recent history of musculoskeletal disorders or low back pain.

The aim of Alemi's research is to understand how the exoskeleton impacts activity of the muscles, especially the back muscles, as well as how it affects the behavior of lifting, known as kinematics. He will pose

questions such as, "Does the wearer lift differently with and without the exoskeleton? Does the exoskeleton help the wearer have more balance? Help them have less muscle exertion and spinal loading?"

To find out the answers, Alemi will employ a combination of biometric measuring techniques and qualitative measures gathered from questionnaires. "We'll use electromyography, 3D motion analysis, and subject-reported outcomes—that is, how the subject perceives exertion, balance, comfort and usability."

With the collected data and the unique musculoskeletal model of the spine developed by Anderson, Alemi will then create new advanced musculoskeletal models that calculate the trunk muscle forces. These will enable him to verify if the exosuit helps reduce the spinal loading.

Like Anderson's project, this study focuses on healthy people avoiding back injury. But the next frontier for a passive exosuit may be a design for those who already have back issues. "If it works for these healthy people, we can modify this exoskeleton or develop a new generation of the exoskeleton that also helps people who have walking or back injury problems," said Alemi.

Perhaps further in the future, the exosuit's functionality will expand to aid older people in their homes and with daily activities like shopping or gardening. As one YouTube commenter noted, the exosuit may become the supermarket scooter of the millennial generation.

[See the passive exosuit demonstrated on YouTube at \[www.youtube.com/watch?v=zpLU04A9ySQ\]\(http://www.youtube.com/watch?v=zpLU04A9ySQ\).](#)