RUSH

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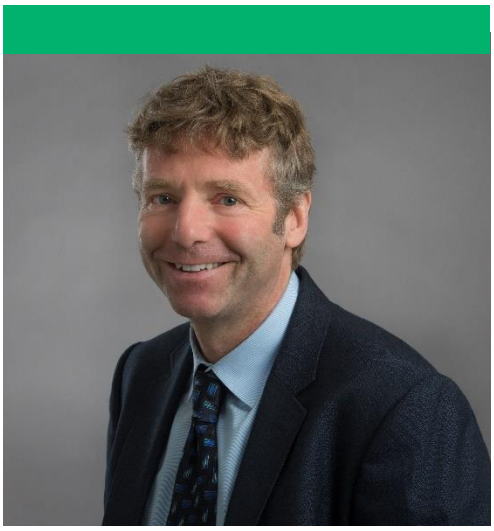

Advancement of Medicine

My research focuses on the complex interactions between surfaces in both natural and artificial joints. By integrating engineering principles with biological sciences, I aim to improve joint health and orthopedic implant longevity.

For years, my team and I have contributed to the selection of safe and biocompatible materials for joint replacement. In September 2025, I was honored to become president of the International Society for Technology in Arthroplasty, or ISTA. With a rich history of over 30 years, ISTA is the world's leading forum for innovations in joint replacement technologies. Due to its international reach, ISTA showcases the technologies that emerge from around the world. As its president, I am preparing a meeting that bridges innovation and orthopedic excellence. Among many themes, the meeting will highlight technologies that counter periprosthetic joint infection, or PJI, a devastating and still unresolved complication of arthroplasty surgery.

My own group has been active in the field of PJI since 2019. We etch nanotubes, pockets smaller than the human hair, into the metallic stems of implants and fill those with antimicrobial drugs using "electrophoretic deposition," a process that our group patented. In 2025, we published two studies providing preclinical evidence of the efficacy of these drug-filled nanotubes against one of the most common and troubling bugs in PJI. We also demonstrated that the process of filling nanotubes with antibiotics in gel doesn't impede bone fixation of the implant; it enhances it.

In the past year we made also strides to improve our understanding of cartilage wear. While there is a wealth of literature describing its lubrication mechanisms, little is known about the specific wear mechanism, such as how cartilage mechanically disintegrates and thins over time. This understanding is important because cartilage wear is a hallmark of osteoarthritis, and despite decades of research, there is no disease modifying drug available. Knowledge of the wear mechanism

will provide a basis for counteractions. Hence, we started the analysis of mechanical and biological response variables in an ex vivo model of cartilage wear. This work is ongoing and partially supported by a current R01 grant from the National Institutes of Health, the most competitive grant available from the agency.

Research

The endowment has provided salary support for several individuals, including myself, who have been involved in the research described above. Without such resources it would be impossible to enter unknown territory and make new discoveries. The fund also allowed us to purchase supplies for our research that otherwise could not have been obtained. Further, the fund provided means to disseminate our findings at scientific meetings and conferences.

Grants

Our activities in PJI resulted in a NIH R21 grant. One of the strengths of this grant is the underlying animal model, which has been developed using resources from the endowment.

Publication Highlights — Abbreviated

As related to above work performed in 2025:

- Hamilton, J.L., Gianotti, S., Fischer, J., Della Fara, G., Impergre, A., De Vecchi, F., AbuAlia, M., Fischer, A., Markovics, A., **Wimmer, M.A**. (2025) Electrophoretic deposition of gentamicin into titania nanotubes prevents evidence of infection in a mouse model of periprosthetic joint infection. J Orthop Res 43(3):671-681.
- Fischer, J., Hall, D.J., Moran, M.M., Markovics, A., Pennekamp, P.H., Hamilton, J.L., **Wimmer, M.A.** (2025) Antibacterial electrophoretically loaded titania nanotubes on titanium alloy implants enhance osseointegration. Pathogens 14 (11):1072
- Ramirez, E.M., Ebinger, K., Ferrigno, C., Nam, D., **Wimmer, M.A.** (2025) A machine learning approach to discover functional differences between stable and unstable knees after total joint arthroplasty. The Knee 54:167-177
- Wittrock, A., Beckmann, C., **Wimmer, M.A.**, Fischer, A, Das, S.M., Liebscher, C.H., Debus, J. (2025) Fretting-induced formation of nanocrystalline CoSx tribomaterial at the hip implant taper junction. ACS Appl. Bio Mater. 8(10):9019-9030

- Antognini C, Ortigas-Vásquez A, Knowlton C, Utz M, Sauer A, **Wimmer M.A**. (2025) Comparison of markerless and marker-based motion analysis accounting for differences in local reference frame orientation. J Biomech 185:112683.
- Cedin, L., Knowlton, C., **Wimmer, M.A.** (2025) Exploring musical feedback for gait retraining: A novel approach to orthopedic rehabilitation. Healthcare 13(2):144.

The Year Ahead: 2026 and Beyond

In 2026, we will continue activities in the field of periprosthetic infection as well as cartilage wear. We will use the funds to advance our research and become competitive for federal grant applications. We will also use the resources to train and mentor students in the field of musculoskeletal research.

Another focus of my lab has been markerless motion analysis. Since this technique is now validated, we plan to use it for our upcoming research activities. Another project that has been supported by internal grants is the exploration of musical feedback for musculoskeletal rehabilitation. We may partially support ongoing activities from this fund.

With Gratitude

I wish to express my sincere appreciation to the donors in recognition of their generous support. Without this support it would be impossible to make new and significant discoveries that shape the future of orthopedic research. Dr. Galante served as a model of excellence in translational research. His work helped many patients receive long-lasting joint replacements, allowing them to maintain an active lifestyle. We strive to carry on his spirit.