2018 IMAG Futures Meeting – Moving Forward with the MSM Consortium (March 21-22, 2018)

Poster *Abstract Submission Form*

Please submit to https://msmmeeting.nibib.nih.gov/instructions-for-submitting-materials by* ***March 1, 2018 (you may update your submission through this registration site after re-entering your login)*

**Save your abstract as "MSM PI Last Name _ 2018 IMAG Futures Poster Abstract"*

PI(s): A. Erdemir (PI); T. F. Besier, J. P. Halloran, C. W. Imhauser, P. Laz, T. Morrison, K. Shelburne (Co-Is)
Institution(s): Cleveland Clinic (AE), University of Auckland (TFB), Cleveland State University (JPH), Hospital for Special Surgery (CWI), University of Denver (PL and KS), US Food and Drug Administration (TM)
Grant Number: R01EB024573
Title of Grant: Reproducibility in simulation-based prediction of natural knee mechanics

Abstract Title

A collaborative pathway to establish credible practice of modeling and simulation in knee biomechanics in conformance with community recommendations

Abstract Authors

A. Erdemir, T. F. Besier, C. W. Imhauser, P. Laz, T. Morrison, K. Shelburne, J. P. Halloran

Abstract Text

In computational biomechanics, modeling and simulation of the knee joint has become a routine activity for scientific explorations and clinical guidance [1]. As in many areas of computational medicine, reproducibility and credibility of simulation-based investigations in knee biomechanics can be challenged due to subjective decision making processes of the modelers. Recently, we have designed and launched a multi-team collaboration to understand the influence of variations in modeling and simulation workflows on the reproducibility of joint and tissue level predictions in computational knee biomechanics. Our goal with this document is to outline how the design of this study was inspired by guidance on credible practice from the broad biomedical modeling and simulation community [2]. The intended use of the proposed knee models are determined by the model reuse cases, essentially aiming for prediction of joint kinematics-kinetics and tissue mechanical response for passive flexion, pivot shift, cartilage load bearing, and sit-to-stand motions (relevance to *Rule 1 – Define context clearly*). Comprehensive anatomical and mechanical testing data, which were acquired in a specimen-specific manner [3,4], will provide the foundations for development and evaluation of the models (relevance to *Rule 2 – Use appropriate data*). Five research teams will independently build models based on the same data sets (relevance to *Rule 9 – Test competing implementations*). The teams' workflows will include model calibration and benchmarking phases to fine tune model parameters and understand model performance, respectively (relevance to *Rule 3 – Evaluate within context*). Data used for model development, calibration, and benchmarking phases will be distinct. All the teams will document their individualized strategies for modeling phases by developing specifications before the execution of a phase and by noting protocol deviations (relevance to *Rule 4 – List limitations explicitly* and *Rule 6 –*

Document adequately). The documentation from each team and the modeling outcomes of each phase (e.g., virtual representations of anatomy, mechanical properties, loading and boundary conditions) will be uploaded on the project site regularly, throughout the lifecycle of the models. This will not only serve the purpose of tracking the models' evolution (relevance to *Rule 5 – Use version control*) but will also provide an access point for the broad community to download and use them (relevance to *Rule 7 – Disseminate broadly*). Collaboration with the US Food and Drug Administration will provide the opportunity for third-party review of documentation and modeling and simulation outcomes by a team who will not be involved in the modeling phases (relevance to *Rule 8 – Get independent reviews*). The teams will adapt these ten rules of credible practice in modeling and simulation [2] and they recognize guidance on documentation of simulation studies that are biomechanics focused [5] or more broad [6-8] (relevance to *Rule 10 – Conform to standards*). The outcomes will be knee models with established credibility. The process will also provide a demonstration of how broadly applicable guidance on credible modeling and simulation practices can be employed. The biomechanics community and the larger biomedical simulation community are encouraged to engage with the collaborating teams at the project site, https://simtk.org/projects/kneehub.

[1] Kazemi, M., Dabiri, Y. and Li L. P. (2013) Recent advances in computational mechanics of the human knee joint, Computational and Mathematical Methods in Medicine, 718423.

[2] Erdemir, A., Mulugeta, L. and Lytton, W. W. Ten "not so" simple rules for credible practice of modeling and simulation in healthcare: a multidisciplinary committee perspective, 2015 Biomedical Engineering Society / Food and Drug Administration Frontiers in Medical Devices Conference: Innovations in Modeling and Simulation, May 18-20, 2015, Washington, DC.

[3] SimTK: Open Knee(s): Virtual Biomechanical Representations of the Knee Joint. Available at: https://simtk.org/projects/openknee.

[4] Natural Knee Data | Center for Orthopaedic Biomechanics | University of Denver. Available at: https://digitalcommons.du.edu/natural_knee_data/.

[5] Erdemir, A., Guess, T. M., Halloran, J. P., Tadepalli, S. C. and Morrison, T. M. (2012) Considerations for reporting finite element analysis studies in biomechanics, Journal of Biomechanics, 45, 625-633.

[6] U.S. Food and Drug Administration. Reporting of Computational Modeling Studies in Medical Device Submissions. Available at: https://www.fda.gov/MedicalDevices/DeviceRegulationandGuidance/GuidanceDocuments/UCM381813.

[7] NASA-STD-7009: Standard for Models and Simulations. Available at: https://standards.nasa.gov/standard/nasa/nasa-std-7009.

[8] ASME V&V American Society of Mechanical Engineers - Committee Pages - V&V 40 Verification and Validation in Computational Modeling of Medical Devices. Available at: https://cstools.asme.org/csconnect/CommitteePages.cfm?Committee=100108782.

**Save your abstract as "MSM PI Last Name _ 2018 IMAG Futures Poster Abstract"*

Click here to email your form to the NIBIB IMAG mailbox