Forecasting and Control Methodology for Monitoring of Glaucoma Patients We present the work of our multidisciplinary collaboration between the Department of Industrial and Operations Engineering and the Kellogg Eye Institute to develop a forecasting tool that assists eye doctors by (a) helping to identify which patients will experience worsening of existing glaucoma, and at what pace, (b) recommending when the patient should next be assessed for possible disease worsening as well as which test to take, and (c) calculating the patient's optimal intraocular pressure (IOP). The IOP is a vital measurement of eye pressure that can be controlled through carefully targeted treatment. These forecasts and recommendations which would be extremely difficult for an eye doctor to estimate using brain power alone. Using novel extensions of linear quadratic Gaussian (LQG) control and Kalman filtering, the forecasts and controls are calculated by incorporating detailed longitudinal testing information from two landmark clinical trials and data on the specific patient for whom the forecasts and recommendations are being made. This tool has the potential to greatly inform doctors' decisions on who, when, and how to treat glaucoma patients in a personalized manner. The objective is to avoid overtreatment and unnecessary treatment, while giving the patients at highest risk for blindness their best possible chance at preserving their sight in the long term.

Dr. Mariel Lavieri is an Associate Professor in the Department of Industrial and Operations Engineering at the University of Michigan.
She has bachelor's degrees in Industrial and Systems Engineering and Statistics and a minor in String Bass Performance from the University of Florida. She holds a Masters and PhD in Management Science from the University of British Columbia. In her work, she applies operations research to healthcare topics. Among others, Dr. Lavieri has developed dynamic programming, stochastic control, and continuous, partially observable state space models to guide screening, monitoring and treatment decisions of chronic disease patients. She has also created models for health workforce and capacity planning. Dr. Lavieri is the recipient of the 2016 National Science Foundation CAREER Award, the 2013 International Conference on Operations Research Young Participant with Most Practical Impact Award, and the 2006 Bonder Scholarship. She received the 2009 Pierskalla Best Paper Award, and an honorary mention in the 2010 George B. Dantzig Dissertation Award. She participated in the 2016 Frontiers of Engineering Symposium organized by the National Academy of Engineering. Dr. Lavieri has mentored students who won the 2012 Doing Good with Good OR, the 2013 Society for Medical Decision Making Lee Lusted Award, the 2015 IBM Research Service Science Best Student Paper Award, and the 2016 Production and Operations Management Society College of Healthcare Operations Management Best Paper Award.

As a board-certified ophthalmologist and a fellowship-trained glaucoma specialist, **Joshua Stein** has over 10 years of clinical experience caring for patients with different types and severities of glaucoma. In addition to his clinical experience, as a health services researcher, he has extensive experience in designing and implementing studies involving cohorts of patients followed longitudinally over time. Additionally, as a recipient of a K23 Career Development Award from the National Eye Institute, he has honed his skills in clinical research, modelling, and study design. Over the past 4 years, he has been collaborating with Drs. Lavieri and Van Oyen from the University of Michigan Department of Industrial and Operations Engineering to develop, calibrate, and validate an innovative novel algorithm which is capable of detecting glaucomatous progression more efficiently and requiring fewer resources than existing techniques. They have received funding from the National Science Foundation and Glaucoma Research Foundation to support this work. This research has led to manuscripts in a major ophthalmology and engineering journal highlighting the details of their forecasting and decision support tool and he has presented findings of this work at the 2013 American Glaucoma Society Meeting and the 2013 World Glaucoma Congress.

Mark Van Oyen is a Professor of Industrial and Operations Engr. (IOE) at the University of Michigan, which he joined in 2005. His interests include the analysis, design, control, and management of stochastic systems (models and applications). His current research focuses on healthcare operations and medical decision making. He co-authored papers that won the 2016 Manufacturing and Service Operations Management (MSOM) Best Paper award, 2016 MSOM Service Science SIG best paper award, 2010 Pierskalla Award, first prize winning papers in the 2016 and 2011 POMS CHOM competitions (with second prizes in 2013 and 2011). His awards with student advisees include 2nd prize in the Dantzig Dissertation Award, first prize in the 2012 MSOM Student Paper Competition (and two other finalist paper in other years) and the 2012 INFORMS "Doing Good with Good OR" first prize. He was the IOE Dept. Faculty of the Year for 2008-9, and the 2003 Researcher of the Year at Loyola University Chicago's School of Business. He has served as Associate Editor for Operations Research, Naval Research Logistics, and IIE Transactions (and IIE Trans Healthcare Syst. Engr.) and Senior Editor for Flexible Services & Manufacturing. He was a faculty member of the Northwestern Univ. Sch. of Engr. (1993-2005) and Loyola Univ. of Chicago's Sch. of Bus. Admin. (1999-2005). He has received grant funding from the NSF, NIH, NEI, ONR, EPRI, Glaucoma Research Found., ALCOA, GM, and the VA.

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