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Developing a Simulator to Teach Femoral Arterial Access: Channeling Simulation to Enhance Patient Safety

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Albert Shih, Professor, Mechanical Engineering, Biomedical Engineering, Associate Director of the Medical Innovation Center, Acting Director of Manufacturing Engineering, University of Michigan at Ann Arbor. After received his PhD degree at Purdue, Dr. Shih worked at Cummins Inc. at Columbus, Indiana as a manufacturing engineer to develop advanced machining process for a wide variety of diesel engines and fuel systems applications. From 1998 to 2002, he was Associate Professor in the Department of Mechanical and Aerospace Engineering, North Carolina State University. He joined University of Michigan (UM) in 2003. Dr. Shih's research and teaching interests are in design and manufacturing. He has conducted research in precision machining of advanced materials, precision machine design, non-contact optical metrology, electrical discharge machining, semiconductor ceramic machining, and friction stir joining. Currently, Professor Shih's research and teaching focus are in biomedical design and manufacturing - the application of advanced design and manufacturing technology to advance medical devices, healthcare operations, and patient safety. He works closely with collaborators in the Medical School and is a co-founder of the Medical Innovation Center. Professor Shih is the Fellow of ASME and SME. He is the recipient of the 1999 ASME BOSS Award, 2000 NSF CAREER Award, 2004 SAE Ralph Teetor Education Award, 2009 Fulbright Scholar, 2010 UM Rackham Faculty Recognition Award, and 2011 UM College of Engineering Research Award.

Dr. Hitinder S. Gurm is an Associate Professor of Internal Medicine at the University of Michigan Health System as well as Director, Inpatient Services for the Division of Cardiovascular Medicine and Director, Carotid Interventions in Cardiovascular Medicine. He is also the Project Director of the Blue Cross Blue Shield Cardiovascular Consortium Percutaneous Coronary Intervention Registry (BMC2-PCI). BMC2-PCI is a multi-center, quality improvement registry funded by Blue Cross Blue Shield of Michigan, designed to improve quality of care and outcomes for patients who undergo percutaneous coronary interventions in the state of Michigan. Hitinder is a graduate of Christian Medical College in India. He subsequently trained in the United Kingdom and was elected to the Membership of the Royal College of Physicians. He joined the Cleveland Clinic Foundation in 1996 and did a residency in Internal medicine followed by a year as Chief Resident. He completed his fellowship in Cardiology and Interventional Cardiology at the same institution. He joined the cardiology division of the University of Michigan in the summer of 2005. His clinical interests include cardio-vascular interventions with special interest in carotid and acute myocardial infarction. His research interests include carotid interventions, pharmacotherapy of PCI, quality improvement and outcomes assessment focused on acute coronary syndromes and PCI, and development of novel devices for endovascular interventions. He has published more than 100 original articles and book chapters and has been named as an inventor on 4 patent applications.

Every year over 2 million patients undergo cardiac catheterization via the femoral arterial. The first step in these procedures entails gaining access to the femoral artery. Femoral arterial access carries with it a 3-5% risk of complications including bleeding, arterial dissection and thrombosis. The procedure involves correctly identifying the common femoral artery through palpation and use of radiographic landmarks, inserting of a needle through the front wall of the artery, and subsequent placing of an arterial sheath over the wire. Currently, trainees presently learn this technique by observing senior physicians and personally practicing it on a patient. The nature of the procedure precludes intervention by the instructing physician once the needle has been introduced, and an error can lead to significant morbidity and possible mortality.

The Blue Cross Blue Shield of Michigan Cardiovascular Consortium (BMC2) data suggests two spikes in vascular complications: one at academic centers from August to October during the start of the academic cycle and introduction of new trainees to the procedure and another in January when physians come back from a long break. To help improve patient safety, we are developing a simulation model that provides realistic training for obtaining femoral arterial access, a program to incorporate the simulation model in the education curricula of cardiology fellowships at four major training institutions, and follow up collection of data to assess change in complication rates across these institutions. Our goal is to make this simulation model available to all the cardiac catheterization laboratories in the State of Michigan for training of any member of the catheterization laboratory who might be involved in obtaining arterial access.

This project will have direct, population-level impact by reducing vascular complications in patients in Michigan, and ultimately elsewhere. BMC2 enables us to rapidly diffuse our findings to a large group of hospitals and patients. Results from this study will also inform large payers (including CMS) and regulators (particularly JCAHO) as they set incentives and standards for enhancing the safety of invasive procedures in the United States.

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