Center for Health Organization & Transformation (CHOT)

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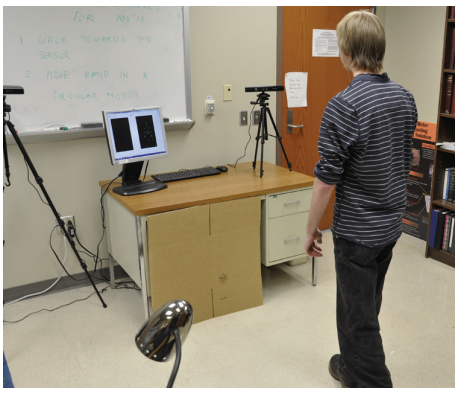
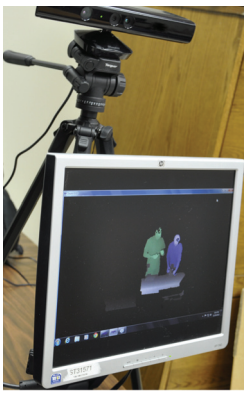
Detection/Intervention System for Individuals with Neurological Movement Disorders



A researcher conducting Parkinson's Disease diagnosis test.



Sensor hardware and visual output of individuals performing related activities.

The goal of this breakthrough research is to advance the early detection and management of neurologically induced movement disorders (e.g., Parkinson's Disease) through the use of low cost, non-invasive sensors. The long-term goal of this research is to develop a patient-centered approach to health management using remote, real time feedback between patients and healthcare providers. The developing system is non-invasive, automated, and usable from the comfort of one's home, allowing for remote diagnosis and management of neurologically induced movement disorders. This will eventually empower individuals to play more active roles in their health management.

The main limitation of existing neurological disease diagnosis and management systems is that diagnosis of neurological diseases often occurs at the latter stages of the disease, after severe neurological damage has already occurred. The challenge facing healthcare officials is the ability to develop a proactive system of healthcare management, where individuals actively participate in their own health status and progress. Furthermore, existing diagnosis tools for neurologically induced movement disorders rely on MRI scans which can be expensive.

This detection and intervention system being developed by CHOT researchers at Penn State provides a platform for exploring how digitized health information from video can be safely and securely collected and mined in order to facilitate early detection of motor/gait dysfunction as well as long-term disease management. The system is based on advancements in sensing and information technologies that make it pos-

sible to capture body movement (in a non-invasive, privacy preserving manner) and model and predict the emergence (or lack thereof) of neurologically induced movement disorders such as Parkinson's Disease.

System components include: 1) acquisition and transformation of non-invasive skeletal tracking data relating to each patient; 2) use of data mining algorithms to identify latent patterns in behavior-related patient gait movement; 3) use of those models to quantify, evaluate, and investigate effective methods for early detection of Parkinson's Disease, and then to gauge progression and therapeutic effects; and 4) support for the development of customized healthcare solutions that promote patient safety at different stages of Parkinson's Disease (i.e., predicting falls). An initial research study involving Parkinson's patients and controls revealed a predictive accuracy of over 92.3% using 10-fold cross-validation.

> **Economic Impact**: This may be an increasing important area of research and development for IT companies to explore because early diagnosis of neurological movement disorders is essential and low cost sensors for use in homes and offices are becoming more prevalent.

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Multi-Project Interdependency Mapping

Multi-project interdependency mapping is used to increase the absorptive capacity of health care organizations to effectively implement and sustain innovations.

Health care organizations are frequently faced with the problem of simultaneous projects, initiatives, implementations, or transformations, without always a clear understanding of how these efforts interrelate or support each other. Multi-project interdependency mapping is a tool applied to multiple transformations in order to increase the absorptive capacity of health care organizations to effectively implement and sustain innovations.

The project relies upon both narrative and numeric responses to standard interview items in detailed interviews with dozens of leaders in each health system. Subsequent mapping is based upon leader's discussion of such interdependencies or linkages among projects, prioritization assigned by leaders to each transformational effort, and these leaders' perceptions of the relative reliance of each effort upon each of four organizational technologies – administrative, information, clinical/work, and social technologies. The organizational technologies framework is derived from theories of control and coordination and socio-technical conceptualization of organizations. The organizational technologies framework was developed by CHOT researchers and has been used to compare and contrast a number of major transformation efforts and is currently being applied in two studies of organizational change.

Economic Impact: Top leadership in two large health systems identified this study as being of critical importance to their organizations' learning and bottom lines. The health systems studied were engaged in numerous transformational programs such as the electronic medical record implementation, Six Sigma, culture change, physician engagement, Baldrige review, and ongoing initiatives around quality, patient safety, and cost-effectiveness.

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Advancing Emergency Department Workflow and Operations

This work optimizes resource allocation in emergency rooms by improving scheduling and workflow efficiency.

In this Center for Health Organization and Transformation (CHOT) project, a novel emergency department decision-support system was designed that couples machine learning, simulation, and optimization. The system allows healthcare providers to optimize workflow globally, taking into account the uncertainties of incoming patient diseases and associated care, thereby significantly reducing the length of stay (thus the wait time) of patients. This was achieved without changing physical layout, focusing instead on process consolidation, operations tracking, and staffing.

The Advancing Clinic Workflow and Operations (ACWO) project has resulted in a patient flow optimization model that improves the operations of emergency departments, both in terms of efficiency and quality of care. The large-scale computerized system model developed by CHOT researchers at Georgia Institute of Technology models emergency department operations with greater realism and accuracy than was previously possible. The ACWO model is generalizable and has been tested and implemented successfully at seven other emergency departments. ACWO was named the second-place winner for the 2013 the Institute for Operations Research and the Management Sciences Daniel H. Wagner Prize for Excellence in Operations Research Practice.

The clinic workflow operations model takes into account major elements in emergency departments, including patient flow, clinic workflow, staffing, equipment, and beds. It seeks to optimize emergency department systems to optimize results for patient outcomes. It allows for systems optimization and global intervention that affect both the quality of care and efficiency of delivery. The model is helping organizations deal with critical issues within emergency rooms. It helps address over-crowdedness, where the presence of over 40% of patients with non-urgent medical conditions results in long wait times. Such misalignments of services also result in unnecessarily long lengths of stay, and, at times, decreased quality of care and patient satisfaction.

This work is impacting operations within the emergency department at Grady Memorial Hospital in Atlanta and should be applicable in any emergency department setting. Technically, the model uses an extensive and time-motion study of patient arrival patterns and service process distributions that are more comprehensive than previous studies. Results are important both for understanding the bottleneck, as well as serving as input for the optimization system model.

Economic Impact: This work aims to optimize resource allocation in emergency departments and to improve scheduling and workflow efficiency. Implemented at Grady Memorial Hospital in Atlanta, Georgia, the system has helped reduce length of stay by roughly 30% (from over 10 hours to roughly 7 hours). By identifying patients who may return and place them in observation before discharge, the hospital has realized a 32% of the non-urgent-care cases from the ED. At Grady, emergency department non-urgent case reduction translates to millions of dollars savings. The readmission work should help hospitals avoid penalties as noted in the Affordable Care Act. Reduction in length of stay allows the hospital to see more urgent patients. All of these savings and revenues are essential, not just for Grady, but for the entire United States healthcare system.

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