Efficient Resource Allocation in Hospital Networks

Submitted by: Fernanda Bravo
Other authors: Marcus Braun, Vivek Farias, Retsef Levi
School/Department: Sloan
Program/Laboratory: Operations Management
Email: fbravo@mit.edu
Position/Degree/Year: Ph.D. candidate

Abstract:

Over the past several years the healthcare industry witnessed the consolidation of multiple community hospitals into larger care organizations. For large care providers to best utilize their growing networks, it is critical to understand not only system-wide demand and capacity, but also how the deployment of limited resources can be improved. Our optimization model allows decision making on how to allocate network resources efficiently in order to offer additional services and to recapture leaked demand within the network-owned hospitals. The model was calibrated using real data from a network of two community hospitals and one academic medical center.
Critical Data: Crowd Sourcing Knowledge Generation in Medicine

Submitted by: Thomas Brennan
School/Department: School of Engineering / IMES
Program/Laboratory: Laboratory of Computational Physiology
Principal investigator: Roger Mark
Email: tpb@mit.edu
Position/Degree/Year: Staff researcher

Abstract:

Failure to store and analyze the vast amount of data generated on a daily basis is a key hurdle in advancing the practice of critical care medicine. An equally necessary and important goal is creating a culture that reacts to and translates the findings of such “big data” into a better system of care. Together, these changes will close a feedback control loop and help provide more standardized and also more personalized care. The intensive care unit (ICU) provides an example of a data-rich clinical domain in which an insufficient portion of the data generated has been employed for guiding practice. Examples of guiding practice might include supporting the creation of clinical decision support tools, identifying significant patterns in population data, and employing feedback on system outputs for the formulation of systematic process improvements. We present the current state of data capture, analysis, and utilization failure and provide several examples of how a data-driven system could be leveraged to improve processes and outcomes in the ICU.
ComfyBall: The Smart Interactive Tool To Better Assess Pain and Anxiety

Submitted by: Andrew Brown, MD
Other authors: Mahek Shah MD, Israel Green-Hopkins MD
School/Department: Sloan
Program/Laboratory: General Management
Email: brownand@mit.edu
Position/Degree/Year: MBA candidate 2015

Abstract:

The ComfyBall is a “smart” interactive tool that helps children better express pain and anxiety to their hospital care team.

A clinician’s job is to find out who is and is not in pain. In pediatrics, pain is difficult to assess because kids cannot accurately tell us how much pain they’re in. This means some kids underreport their pain. It’s a $650-billion problem.

We created the ComfyBall to solve this problem. It’s a squishy ball with pressure sensors inside it. When we do “pain rounds,” we ask children to squeeze the ball to show how much pain they are in. As they squeeze harder, the light and sound intensify. More pressure is more pain.

The ball on its own is a useful product, but we have the opportunity to do more. We can keep track of a patient’s “squeeze-data” over time. This allows us to understand what is normal vs. abnormal discomfort for each child and helps clinicians to recognize what actually requires attention.

Four orthopedic trauma nurses with a combined 50 years of experience said this product improved their quality of care. They all said they would gladly pay for a ComfyBall. Boston Children’s Hospital is interested in partnering in the implementation.
Augmented Infant Resuscitator (AIR): Using Car Parts To Help Babies Breathe

Submitted by: Kevin Cedrone
Other authors: Dr. Kristian Olson, MD; Dr. Data Santorino, MD; Craig Mielcarz
School/Department: School of Science / Plasma Science and Fusion Center
Program/Laboratory: Sloan Automotive Lab
Email: kcedrone@mit.du
Position/Degree/Year: Postdoc

Abstract:

Each year, approximately six million babies die or suffer severe neurological disability because of breathing problems at birth (asphyxia). Most of these outcomes could be prevented with timely effective ventilation administered by healthcare professionals (HCPs). However, one in five trained HCPs fails to perform ventilation correctly; those who do experience a rapid decline in proficiency.

The Augmented Infant Resuscitator (AIR) is a low-cost, add-on device for existing bag-valve masks (BVMs) that measures air pressure and flow to monitor common mistakes occurring with BVM resuscitation, namely failed face-mask seal, blocked airways, improper ventilation frequency, and insufficient lung inflation.

AIR will improve infant resuscitation training and HCP competency, thereby reducing infant mortality due to asphyxia, in three ways:

1. Providing real-time feedback to HCPs on resuscitation quality.
2. Logging resuscitation data to enable objective quality improvement evaluation and review.
3. Improving the efficiency and effectiveness of HCP training.

AIR represents a unique-in-market advance for high-income countries and is affordable enough for wide deployment in low- and middle-income countries. A feasibility and technology acceptance field trial with end-users in Uganda is scheduled for January 2014.
Needle-free Interstitial Fluid Acquisition Using a Lorentz-force Actuated Jet Injector

Submitted by: Jean Chang  
Other authors: Dr. N. Cathy Hogan  
School/Department: School of Engineering / Mechanical Engineering  
Program/Laboratory: BioInstrumentation Lab  
Principal investigator: Ian Hunter  
Email: jean_c@mit.edu  
Position/Degree/Year: Ph.D. candidate 2014

Abstract:

Interstitial fluid (ISF) provides information on a patient’s health; it contains regulatory molecules that are correlated with disease-related processes. However, current ISF acquisition techniques can be slow, resulting in patient discomfort and erroneous measurements. We present a fast (< 4 s), minimally-invasive, needle-free technique of extracting ISF samples using a Lorentz-force actuated jet injector. The jet injector is used to inject a small volume of physiological saline to breach the skin, and the actuator is subsequently back-driven to create a vacuum in the ampoule to collect a sample that contains a mixture of ISF and injectate. Injection and extraction parameters are tested and optimized for minimal acquired sample dilution and extracted volume repeatability. Using this method, we are able to collect a sample that contains up to 3.5% ISF in 3.1 s from post-mortem porcine skin. The feasibility of the acquisition process is then successfully demonstrated on live rats; the process is revealed to extract samples that have been diluted by a factor of 111-125.
2D imaging in a low-cost portable MRI scanner

Submitted by: Clarissa Cooley  
 School/Department: School of Engineering / EECS  
 Program/Laboratory: A. A. Martinos Center for Biomedical Imaging  
 Principal investigator: Prof. Lawrence Wald  
 Email: clzimmer@mit.edu  
 Position/Degree/Year: Ph.D. candidate 2014

Abstract:

As the premiere modality for brain imaging, MRI could find wider applicability if low-cost, portable systems were available for siting in unconventional locations such as Intensive Care Units, physician offices, surgical suites, ambulances, emergency rooms, sports facilities, or rural healthcare sites. We have constructed and validated a truly portable (<100kg), proof-of-concept MRI scanner that replaces conventional gradient image encoding with a rotating lightweight magnet. When rotated about the object, the inhomogeneous field pattern of the magnet is used to create generalized projections. Data from this non-linear image encoding strategy is iteratively reconstructed to form 2D images. Unlike conventional scanners that cost $1-3M, the small low-field magnet parts cost <$8k and the construction of a scanner suite (~$500k) is unnecessary. Although the low-field system lacks the sensitivity of conventional high-field scanners, this new architecture shows convincing proof of concept images that are expected to further improve with refinement of the calibration and methodology.
Using Mobile Phones in Resource-Poor Settings in the Developing World for a Thermal Vision of the Lungs To Save Lives of Children with Pneumonia

Submitted by: Sara Dolcetti
School/Department: School of Engineering / LGO (ESD and Sloan)
Program/Laboratory: LGO
Email: dolcetti@mit.edu
Position/Degree/Year: M.B.A. candidate 2015

Abstract:

The purpose of this project is to accelerate the development and scale-up of a low-cost, mobile phone-based thermal imaging camera for healthcare workers in the developing world to use as a simple tool to screen for severe pneumonia in resource-limited settings.

Severe pneumonia is one of the most common reasons that children under age five die (UNICEFm 2012), but is often difficult to diagnose in young infants and children based on physical examination alone. The limited progress toward the United Nations Millennium Development Goal #4 – to reduce childhood mortality in developing countries by two-thirds by 2015 – has been partly related to the lack of progress in early recognition and diagnosis of childhood pneumonia and neonatal pneumonia.

In developing countries there is a vast unmet need to provide diagnostic capabilities in the first-level health clinics where most patients are first evaluated and where there are usually no diagnostic capabilities, x-ray machines, or radiologists to provide x-ray interpretations. Given the superior availability of smart phones, and helpful clinical information that will influence patient management decisions to save lives, the device proposed in this study can make it possible to bring an easy-to-use screening tool for severe pneumonia to most first-level clinics.
Innovative Integrated Systems Design of the Diabetes Care and Management Model

Submitted by: Sahar Hashmi
School/Department: School of Engineering / Engineering Systems Division (ESD)
Program/Laboratory: SSRC
Principal investigator: Prof. Nightingale
Email: drhashmi@mit.edu
Position/Degree/Year: PhD candidate

Abstract:

With healthcare in a time of transition and Accountable Care Act in play, being able to understand and relate the many different variables in a complex sociotechnical system could mean the difference between a successful or unsuccessful healthcare system management strategy. There are complexities in the existing system of diabetes care and management, e.g., there is unclear involvement of stakeholders in the care model, technologies are not well integrated, communication issues with patients and physicians throughout the chronic disease care process, etc. By looking at the existing care model from a systems perspective, we can better understand the importance of each stakeholder at a larger scale. We can benefit from the existing advancing technologies and the big data analysis opportunities available in other industries besides healthcare. This proposed model can help resolve important issues in the care model, for example, patient-physician communication problems throughout the treatment process of a chronic disease like diabetes.
A Machine Learning Approach for Localizing Cancerous Nodules

Submitted by: Zack Hendlin
School/Department: Sloan / Electrical Engineering and Computer Science
Program/Laboratory: CSAIL
Email: zgh@mit.edu
Position/Degree/Year: 1 MBA candidate 2014, and 3 CSAIL Ph.D.s

Abstract:

We propose the application of statistical machine learning approaches to:

1. the primary identification of atypical nodules in medical imaging data, and
2. supplemental verification of atypical clinical results.

Image recognition and classification approaches which rely on pre-specified feature sets (e.g., shape, color intensity, symmetry). We explore the applicability of a more generalizable approach that aims to better develop nuanced hierarchical feature sets from medical images to facilitate the development of higher performance models for the recognition of atypical nodules.

Specific aims:

1. Explore the viability of applying deep machine learning algorithms to unstructured and unnormalized medical imaging data.

2. Determine the statistical properties of various computational models (both supervised and unsupervised statistical learning) for determining atypical nodules.

3. Fine-tune model parameters for more accurate prediction and detection of atypical nodules.

4. Understand key limitations of unsupervised learning and how the introduction of application-specific features can enhance classification ability.
Chairbot: “Stand with the Comfort of Sitting – All Day Long.”

Submitted by: Simon Hong  
School/Department: School of Science / Brain and Cognitive Sciences  
Program/Laboratory: Graybiel Lab  
Email: simon_h@mit.edu  
Position/Degree/Year: Research scientist  

Abstract:  

It is generally accepted that prolonged, static sitting postures are likely to aggravate a preexisting low back condition or instigate the development of a new condition. It has also been reported that sitting long hours contributes to health problems and shortens life expectancy. There is thus a recent trend to adopt standing desks. Unfortunately, standing has its own problems, such as the tiring and discomfort of the legs, therefore leaving millions of people without any good solutions. To solve these problems, I have developed the Chairbot (US patented, 2012). It features a unique split seat. The moving halves of the seat make the user sit on alternating buttocks while standing on the opposite leg. The basic design of frequent alternation prevents trauma to the spine caused by maintaining a single posture for an extended period of time. In addition, the chair encourages the proper degree of extension of the spine, as in a standing posture. The chair can also be used as a conventional chair when desired. Currently the chair has endorsement from five back pain-related doctors. A movie link of the chair is available here: https://www.dropbox.com/s/aj9nrdzu9xb5geg/Sit_Stand_short.mp4
Architecting the Future Telebehavioral System of Care in the Army

Submitted by: Andrea Ippolito
School/Department: School of Engineering/ Engineering Systems Division (ESD)
Program/Laboratory: Sociotechnical Research Center (SSRC)
Principal investigator: Deborah Nightingale
Email: akippolito@gmail.com
Position/Degree/Year: Ph.D. candidate 2015

Abstract:

Since October 2001, approximately two million U.S. troops have been deployed as part of Operation Enduring Freedom (OEF; Afghanistan) and Operation Iraqi Freedom (OIF; Iraq) with more than 800,000 service members facing multiple deployments (Military Health System, 2012). “We continue to face a growing demand for services and a recognition that service members will be contending with the psychological consequences of wars for years to come” (Department of Defense MHS Stakeholder Reports, 2012). Although one of the short-term, knee-jerk responses would be to hire and train more providers, there is more that can be done in the form of system management to better meet the demand of services with limited resources. One potential option is to further utilize technology to take advantage of the existing provider resources and “multiply” them for more effective and efficient care delivery. Therefore, the authors investigated the role of technology to serve as a force extender to improve access to and timeliness of care within psychological health care services. Specifically, they utilized a systems approach to evaluate the initiation and adoption of telehealth within the Military Health System. By utilizing the enterprise lenses of strategy, policy, organization, services, processes, infrastructure, and knowledge to analyze the current state of telebehavioral health, they discovered that each region developed telehealth based on local need and have since grown the telehealth capability to further meet their needs over time. As part of this study, the team worked collaboratively with the US Army Telehealth Office to envision a future state architecture for telehealth delivery and developed seven “enterprise requirements” to carry out this vision.
A Dynamic Model for Breast Cancer Screening: Misperceptions and Feedback in Screening Mammography Debate

Submitted by: Ozge Karanfil
School/Department: Sloan
Program/Laboratory: Management Science Program in System Dynamics
Email: karanfil@mit.edu
Position/Degree/Year: Ph.D. candidate 2015

Abstract:

The implications of widespread mammography screening remain controversial, and several major health organizations in the US have adopted different guidelines that reflect significant variations in actual practice. Recent evidence also suggests that implementation of routine screening over the past 30 years has incurred less significant mortality benefit and more frequent over-diagnoses than formerly believed.

In this study, we analyze the anatomy of a medical decision-making process, i.e., the breast cancer screening decision, which has been embedded in a highly charged socio-political system dominated by single-issue advocacy groups. We develop a feedback rich theory to explain the dynamic nature of the problem within the US context. Our model is tightly grounded in evidence base and replicates basic dynamics concerning breast cancer, including the diffusion dynamics for mammogram screening and the noncompliance with medical recommendations. We demonstrate how the medical decision making-process is distorted by misperception of risks, over-awareness, and other social factors. The entire system is shown to dynamically interact to cause a self-reinforcing over-awareness and over-screening trend for breast cancer in the US, which leads to over-diagnosis and over-treatment. The dominant feedbacks are shown to drive the system toward a balance that is not consistent with the optimum.
Technology Development in Long-Term Care Settings

Submitted by: William Li  
School/Department: School of Engineering / CSAIL  
Program/Laboratory: EECS  
Email: wpli@mit.edu  
Position/Degree/Year: Ph.D. Candidate

Abstract:

We present a customized speech-activated computer system for a single individual in a long-term residential care setting.

Our work is the product of efforts focused on a single target user with high speech recognition error rates. The system, which includes off-the-shelf and custom hardware and software, allows the user to use speech to send emails with recorded audio attachments.

Over the past 16 months, our target user has sent and received hundreds of emails and has integrated the system into his daily life. Key factors contributing to the long-term adoption of the device include our extended efforts to understand the target user over multiple years, iterative design, and the collaboration of our multidisciplinary team of assistive technology (AT) designers, clinicians, software developers, and researchers.

Overall, we ask: If we set our sights on developing and supporting a technology that someone will actually use daily, what can we learn? We share our approach, system design, user observation, and findings with implications for healthcare and assistive technology research and development.
Improving Electronic Medication Administration Using a Near Field Communication Enabled Mobile Device

Submitted by: Stephen Miles
Other authors: Michael J. Dinsmore, Manager Software Engineering, Broad Institute
School/Department: School of Engineering / Engineering Systems Division (ESD)
Program/Laboratory: Center for Biomedical Innovation
Principal investigator: Co-Investigator, Adam Landman, MD, MS, MIS, MHS, is an emergency physician and Chief Medical Information Officer for Health Information Innovation and Integration at the Brigham and Women's Hospital (BWH)
Email: s_miles@mit.edu
Position/Degree/Year: Research affiliate; Sloan MOT '03

Abstract:

Barcode-based electronic Medication Administration and Reconciliation (eMAR) has been shown to reduce medication errors and potential adverse drug events. However, current eMAR systems use computers on wheels that can be cumbersome and barcode scanners that often require multiple scans and may result in workflow and data entry backlogs. We developed and evaluated a prototype next-generation eMAR system using an Android tablet equipped with a Near Field Communication (NFC) reader. NFC is a wireless communication protocol that allows secure exchange of small amounts of data, allowing nurses to perform eMAR by tapping NFC tags to the tablet. In our initial study at the STRATUS Center (20), BWH nurses performed a clinical scenario with both the BWH and NFC Mobile eMAR systems. We collected time, scan attempts, and participant feedback through a survey and brief interview. More than 90% of participants agreed the system was easy to use and learn and enabled them to complete scenarios effectively and quickly. NFC enabled mobile eMAR was well received by nurses in a simulated scenario and has the potential to improve nurse efficiency. The mobile platform also enables the efficient data collection of serialized NDCs as mandated for product authentication.
Building mHealth Capacity Through Co-Creation in Resource Poor Communities: The Sana Approach

Submitted by: Vipan Nikore  
Other authors: Melek Somai, Kenneth Paik, Leo Celi  
School/Department: School of Engineering/ Institute for Medical Engineering & Science (IMES)  
Program/Laboratory: Computer Science and Artificial Intelligence Lab (CSAIL)  
Principal investigator: Vipan Nikore  
Email: vipan.nikore@gmail.com  
Position/Degree/Year: MD, MBA, Research scientist

Abstract:

Sana aims to revolutionize healthcare quality and delivery in resource-limited settings following a unique approach of “collaboration, co-creation, and capacity building.” Sana’s core organizational initiatives include:

1. a customizable open source mHealth technology platform and
2. an experiential learning curriculum centered on innovations in global health informatics.

The Sana technology platform is an open source solution that greatly expands potential access to quality care. The mobile end-to-end tele-health system allows for the ubiquitous capture of patient demographic information, medical data, and complex physiological signals while integrating with a backend digital record allowing for responsive clinician access and improved continuity of care.

The aspiration of Sana’s capacity-building initiatives is to train the next generation of global health informaticians. Sana promotes sustainability through innovation and co-creation from within developing countries rather than relying on external support and resources. Sana has established a distributed global network of innovation courses with educational partners in 10 countries across five continents to promote the free exchange of knowledge and learning. A standard online curriculum is designed for open access for anyone to attend remotely and allows for local customization. The innovative curriculum then brings together multinational teams of students from engineering, medical, business, public health, and policy to learn and work collaboratively on real-world projects focused not only on technology innovation but also the components of successful project deployment, such as quality, disease burden, and project management.
How Would You ReThink Health?

Submitted by: Rebecca Niles
Other authors: Jack Homer, Gary Hirsch, John Sterman
School/Department: Sloan alum
Program/Laboratory: ReThink Health
Principal investigator: Bobby Milstein
Email: rebeccadniles@gmail.com
Position/Degree/Year: SB1993, SM 1993

Abstract:

How would you ReThink Health? Submit your proposal for improving the health care system of Anytown, an average community of 300,000, across measures of health care costs, quality of care, population health, equity, and productivity. Allocate your budget of $22 million per year for five years across 25 potential initiatives and simulate the results in seconds to see what you can achieve. Your results will be compared with those of other participants to glean what we can about effective techniques for ensuring a healthier health system.
Wellframe - A Clinically Proven Care Machine

Submitted by: Trishan Panch
Other authors: Vinayak Ramesh
School/Department: HST
Program/Laboratory: LCP
Email: tpanch@mit.edu
Position/Degree/Year: Lecturer

Abstract:

We develop a mechanistic model of the operations of a health system, in particular the processes of delivering and receiving care, as a finite state machine. In this model, nodes represent a patient’s health state and edges represent a medical intervention by a stakeholder in the health system. We show how this abstraction naturally lends itself to a digital care amplification platform for remote care delivery and patient monitoring, engagement, and population health management. We present a platform with four key facets: a logic structure for representing complex clinical care protocols; a mobile application for delivering care protocols as personalized, adaptive to-do lists; an inference engine for dynamically deriving the health state of a patient from their interaction with their care plan; and a system that determines the optimal future path and the recommendations to the relevant health system actors based on patient’s interaction with the platform. Our platform (Wellframe) has been used with patients and studied at Brigham and Women’s Hospital and South Shore Hospital in Massachusetts in cardiac care and is currently being studied at McLean Hospital and New York Presbyterian in mental health care and post discharge care for patients with complex chronic diseases.
Label-free Nanosensors To Control Antibody Drug Production and Quality

Submitted by: Nigel Reuel  
School/Department: School of Engineering / Chemical Engineering  
Program/Laboratory: Strano Group  
Email: reuel@mit.edu  
Position/Degree/Year: PhD candidate 2014

Abstract:

A carbon nanotube-based fluorescent sensor platform was engineered to monitor critical quality attributes of antibody production: mainly glycosylation (surface sugars) with additional information on cell productivity and antibody affinity. The platform provides online analytical capabilities that are currently unfeasible with existing analytics (ELISA, LC/MS). This invention has immediate implications for improving biomanufacturing process development by creating safer and more efficacious therapies. It also holds promise for future uses in clinical diagnostics. The platform has been reduced to practice with two portable prototypes, one of which is on display with the poster.
Night Back Brace

Submitted by: Samantha Simmons
Other authors: Mahek Shah MD, Israel Green-Hopkins MD
School/Department: Sloan
Program/Laboratory: MBA
Email: ssimm@mit.edu
Position/Degree/Year: MBA candidate 2015

Abstract:

The Night Back Brace is designed specifically for sleep and works by sedating areas of stress and/or pain in the body, therefore allowing users to fall asleep faster and stay asleep longer. The brace serves three customer groups: those suffering from fibromyalgia pain, those suffering from low back pain, and those suffering from stress/anxiety; all conditions that impede individuals from falling asleep at night.

The design consists of four major components: weight, compression, acupuncture, and cooling or heat. The weighted (but breathable) material of the brace places pressure on the muscles, which in effect relaxes muscle tension. The compression component provides a sense of comfort and security, which relieves nighttime anxiety and calms the nerves. The acupuncture component is an optional component, which the user can choose to activate or not activate before going to bed. There are no needles involved; rather the acupuncture component provides stiff pointed pressure along the shoulders, spine, and lower back, simulating the effects of acupuncture. Lastly, there is a pouch (perpendicular to the lumbar spine) designed to hold a cold or hot pack, allowing the user to fall asleep with the hot or cold pack safely in place.
Point of Care Electrical and Optical Cytometer for Monitoring Disease Progression

Submitted by: Hao-Wei Su  
School/Department: School of Engineering / EECS  
Program/Laboratory: Biological Microtechnology and BioMEMS Biological Microtechnology and BioMEMS Group  
Principal investigator: Joel Voldman  
Email: haowei@mit.edu  
Position/Degree/Year: Ph.D. candidate 2015

Abstract:

We developed an automated system that can measure electrical and optical properties of thousands of cells. We demonstrated using this system to distinguish live/dead cell and activation/non-activated neutrophils. This system involves optical/electrical/fluidic system, which can be further integrated into a point of care cytometer for monitoring disease progression.
HealtheTrek: Mobile Sensor Data Analysis for Behavior Modification

Submitted by: Jesus Trevino  
School/Department: Sloan  
Program/Laboratory: MBA  
Principal investigator: Dr. Kirsten Meisinger, Jesus Trevino  
Email: jesus.trevino@sloan.mit.edu  
Position/Degree/Year: MBA candidate 2014

Abstract:

Recent U.S. estimates indicate 35.7% of adults are obese and obesity-related healthcare spending is approximately $147 billion/year. As obesity is a significant driver of common chronic diseases in the U.S., effective, sustainable, and scalable weight loss methods are needed.

A promising frontier in weight loss counseling rests in mobile technologies and personalized services made possible through advanced analytics. The proliferation of activity sensor devices and weight loss mobile applications underscore the expanding opportunities to deploy weight loss interventions through mobile devices. Moreover, advances in predictive analytics that personalize recommendations for online shopping and media content offer a path to deliver personalized weight loss counseling.

Altogether, the HealtheTrek project will explore applications of mobile devices and predictive analytics for behavior modification and weight loss management in collaboration with healthcare providers at Union Square Family Health of the Cambridge Health Alliance.

Research objectives:

1. Explore end-user opinions regarding challenges with weight loss and the use of mobile applications and sensor data for weight loss counseling.
2. Develop a predictive model using mobile phone sensor data (i.e., GPS, accelerometer) for behavioral interventions.
3. Incorporate findings into an Android mobile application to evaluate the impact of the HealtheTrek project in terms of patient engagement and clinical outcomes.

Preliminary results:

Patient interviews revealed an even split between Android and iPhone users. Healthcare providers have expressed interest in using this mobile application as a tool to conduct motivational interviewing for lifestyle changes. Mobile application
development will be completed by January 2014; a technology pilot at Union Square Family Health will occur from January to March 2014.

References:
Low-Cost Point-of-Care Diagnostics for Cancer Using Synthetic Urinary Biomarkers and Paper Microfluidics

Submitted by: Andrew Warren
Other authors: Gabriel A. Kwong, David K. Wood, Kevin Y. Lin, and Sangeeta N. Bhatia
School/Department: Health Sciences and Technology
Program/Laboratory: Laboratory for Multiscale Regenerative Technologies (Koch Institute)
Principal investigator: Bhatia
Email: adwarren@mit.edu
Position/Degree/Year: Ph.D. candidate 2011

Abstract:

The last decade has seen cancer and other non-communicable diseases (NCDs) grow to constitute a majority of global mortality, resulting in a need for low-cost and non-invasive diagnostic methods, particularly in resource-limited environments. Molecular biomarkers detected by low-cost point-of-care (POC) assays have proven useful, but this approach is not feasible with many diseases that lack naturally occurring and clinically predictive markers.

Here, we demonstrate “synthetic biomarkers” for NCDs that produce urinary signals for inexpensive quantification by a companion paper microfluidics diagnostic test that functions like a home pregnancy test. These nanoparticle-based synthetic biomarkers are passively home to disease sites, such as solid tumors, and release ligand-encoded reporters into urine upon liberation by disease-associated proteases. Using these reporters, we demonstrate detection by standard clinical ELISA and low-cost paper lateral flow assay (LFA).

Using synthetic biomarker formulations tailored to release reporters in response to proteases associated with colorectal cancer, we demonstrate urinary disease detection by paper diagnostic. Together, the low-cost LFA and injectable synthetic biomarkers, which could be tailored for multiple diseases, demonstrate a diagnostic platform for cancer and other diseases with protease dysregulation that can be used in low-resource settings without expensive equipment or highly trained medical personnel.