

**Health Systems- The Next Generation**  
**Forum 2017**



**Poster Listings**

#	Poster Title	Poster Presenter
1	<b>Multidimensional Measures of Health Disparity</b>	Shatakshee Dhongde (Georgia Tech)
2	<b>Defining the Next Era of Mental Health Research and Practice with Social Media</b>	Munmun De Choudhury (Georgia Tech)
3	<b>Prioritizing Hepatitis C Treatment Decisions in U.S. Prisons</b>	Turgay Ayer (Georgia Tech)
4	<b>Using Machine Learning and Simulation to Help Patients Decide Whether to Accept a High Risk Kidney or Remain on the Waiting List</b>	Ethan Mark, Pinar Keskinocak, Joel Sokol, Dave Goldsman, Brian Gurbaxani (Georgia Tech)
5	<b>Autism Disparities: Assessing Quality of Care and Structural Barriers to Diagnosis and Services</b>	Jenifer Singh; Leslie Rubin (Georgia Tech; Morehouse School of Medicine)
6	<b>Mobile app review for epilepsy self-management</b>	Jonathan Bidwell, Sookyong Koh, Elizabeth Mynatt; Cam Escoffery (Georgia Institute of Technology, School of Interactive Computing; Emory, Rollins School of Public Health)

7	<b>Supporting everyday self-management practices for pediatric patients with epilepsy</b>	Jonathan Bidwell, Sookyong Koh,; Cam Escoffery (Georgia Institute of Technology, School of Interactive Computing; Emory, Rollins School of Public Health)
8	<b>Integrated Bioionics for Public Health</b>	Thomas Igou, Steven Van Ginkel, Yongsheng Chen (Georgia Tech)
9	<b>Army Family Web Portal and the Next Generation Homefront Readiness</b>	Margarita Gonzalez, Sheila Isbell, Jessica Pater, Moon Kim, Samantha Lie-Tjauw; David Severson (Georgia Tech Research Institute; U.S. Army IMCOM HQ G9)
10	<b>C4G BLIS - STATUS &amp; FUTURE CHALLENGES</b>	Sakshi Gandhi (Georgia Tech)
11	<b>Optimized Oral Cholera Vaccine Distribution Strategies to Minimize Disease Incidence</b>	Hannah K. Smalley PhD , Pinar Keskinocak PhD , Julie Swann PhD , Alan Hinman MD (H. Milton Stewart School of Industrial and Systems Engineering, Georgia Institute of Technology; Task Force for Global Health)
12	<b>Personalized Catch-up Schedulers for Childhood, Adolescent, and Adult Immunization</b>	Sheila Isbell <sup>1</sup> , Dr. Pinar Keskinocak <sup>2</sup> , Dr. Larry Pickering <sup>3</sup> , Scott Appling <sup>1</sup> , Therese Boston <sup>1</sup> , Josh Cothran <sup>1</sup> , Arya Irani <sup>1</sup> , Moon Kim <sup>1</sup> , Faramroze Engineer <sup>2</sup> , Cathy Hogan <sup>3</sup> , Shilpa Kottakapu <sup>3</sup> , Hannah K. Smalley <sup>2</sup> , Gregory Abowd <sup>4</sup>  (1:Georgia Tech Research Institute, 2:Industrial Systems Engineering, 3:Center for Disease Control and Prevention, 4:College of Computing )
13	<b>Improving Continuous Electroencephalography (cEEG) Monitoring in Pediatric Intensive Care Units (PICU): Whom Should We Monitor?</b>	Mingyoung Jo <sup>1</sup> , Qing Li <sup>1</sup> , Jan Vlachy <sup>1</sup> , Pinar Keskinocak <sup>1</sup> , Turgay Ayer <sup>1</sup> , Julie Swann <sup>1</sup> , Atul Vats <sup>2</sup> , Larry Olson <sup>2</sup>  (1School of Industrial and Systems Engineering, Georgia Institute of Technology; 2Children's Healthcare of Atlanta)

# Poster Abstracts

## 1. **Multidimensional Measures of Health Disparity**

*Shatakshee Dhongde (Georgia Tech)*

Health disparities refer to population-specific differences in the presence of disease, health outcomes, quality of health care and access to health care services that exist across racial, ethnic, regional groups. In order to successfully reduce health disparities we need to accurately measure the extent of health deprivations in different groups. In this project, I develop an innovative multidimensional framework to measure health disparities. The new approach takes into account the interdependence between health outcomes, provision and quality of health care and socio-economic factors influencing the quality of health. High levels of disparities continue to exist among racial and ethnic groups of the elderly in the U.S. I demonstrate the value and feasibility of the proposed approach, by undertaking a pilot study comparing health disparities among individuals aged 55 and above, by race. By using data from the American Community Survey on more than 1 million elderly adults, I find that American Indians and Blacks were the most deprived population subgroups.

## 2. **Defining the Next Era of Mental Health Research and Practice with Social Media**

*Munmun De Choudhury (Georgia Tech)*

Social media platforms have emerged as rich repositories of information relating to our activities, emotion and linguistic expression. In this talk I will discuss how this data may be harnessed to reason about our mental and psychological well-being. First, I will discuss a series of projects that examine how cues derived from social media around life-altering events (e.g., giving birth to a child, experience of abuse) and societal disruptions (e.g., urban violence, socio-political unrest) may help infer risks to mental health challenges. Second, I will discuss the emergent role of social media in providing a platform of self-disclosure and support to distressed and vulnerable communities. Broadly, I will reflect on how this new line of research bears potential in informing the design of timely and tailored interventions, provisions for improved personal and societal well-being assessment, privacy and ethical considerations, and in this context, the challenges and opportunities of the increasing ubiquity of social media.

## 3. **Prioritizing Hepatitis C Treatment Decisions in U.S. Prisons**

*Turgay Ayer (Georgia Tech)*

About one out of six inmates in the United States (U.S.) is infected with hepatitis C virus (HCV). HCV prevalence in prison systems is ten times higher than the general population, and hence prison systems offer a unique opportunity to control the HCV epidemic. New HCV treatment drugs are very effective, but providing treatment to all inmates is prohibitively expensive, which precludes universal HCV treatment in prison systems. As such, current practice recommends prioritizing treatment based on clinical and incarceration-related factors, including disease staging, remaining sentence length, and injection drug use (IDU) status. However, there is controversy about how these factors should be incorporated because of the complicated tradeoffs. In this study, we propose a restless bandit modeling

framework to support hepatitis C treatment prioritization decisions in U.S. prisons. We first prove indexability for our problem and derive several structural properties of the well-known Whittle's index, based on which, we derive a closed-form expression of the Whittle's index for patients with advanced liver disease. From the interpretation of this closed-form expression, we anticipate that the performance of the Whittle's index would degrade as the treatment capacity increases; and to address this limitation, we propose a capacity-adjusted closed-form index policy. We parameterize and validate our model using real-world data from Georgia state prison system and published studies. We test the performance of our proposed policy using a detailed, clinically-realistic simulation model and show that our proposed policy can significantly improve the overall effectiveness of the hepatitis C treatment programs in prisons compared with the current practice and other benchmark policies, including the commonly used Whittle's index policy. Our results also shed light on several controversial health policy issues in hepatitis C treatment prioritization in the prison setting and have important policy implications including: 1) prioritization based on only liver health status, a commonly practiced policy, is suboptimal compared with many other policies we consider. Further, considering remaining sentence length of inmates and IDU status in addition to liver health status in prioritization decisions can lead to a significant performance improvement; 2) the decision of whether to prioritize patients with shorter or longer remaining sentence lengths depends on the treatment capacities inside and outside the prison system, and prioritizing patients with shorter remaining sentence lengths may be preferable in some cases, especially if the treatment capacity inside the prison system is not very tight and linkage-to-care level outside prison system is low; and 3) among patients with advanced liver disease, IDUs should not be prioritized unless their reinfection is very-well controlled.

#### **4. Using Machine Learning and Simulation to Help Patients Decide Whether to Accept a High Risk Kidney or Remain on the Waiting List**

Ethan Mark, Pinar Keskinocak, Joel Sokol, Dave Goldsman, Brian Gurbaxani (Georgia Tech)

In 2012, over 10% of organ donors in the U.S were labelled "Increased Risk" (IR). With an organ shortage that has been increasing every year, many patients are faced with a decision: should patients offered an IR organ accept it, or remain on the waiting list for non IR organ? Using machine learning and simulation, we built an interactive tool to help patients make this decision. We will discuss our model building process and show some interesting results from our simulation. We find that in a large number of cases, patients would have a higher benefit for accepting the "increased risk" organ. In this talk, we will focus on the Kidney, and organs coming from donors with either HBV, HCV or HIV.

#### **5. Autism Disparities: Assessing Quality of Care and Structural Barriers to Diagnosis and Services**

Jenifer Singh; Leslie Rubin (Georgia Tech; Morehouse School of Medicine)

The purpose of this study was to measure the quality of care at Children's Healthcare of Atlanta Autism Clinic at Hughes Spalding, where 90% of patients rely on Medicaid. The study also identified structural barriers to autism diagnosis and services for low-income, minority and/or other underserved children and their families.

Methods: This study consisted of a survey to assess quality of care offered by the Autism Clinic, followed by open-ended questions to identify barriers to autism services. Sixty surveys/in-depth interviews were conducted with caregivers whose child receives services

at the Autism Clinic. Participant observation of the clinic processes and interviews with clinic staff were also conducted.

Results: The strongest measure of quality of care was the family-centered care, including careful listening by the clinic staff, and ability of caregivers to ask questions or raise concerns. Overall, caregivers were very satisfied with the diagnostic processes, the diagnostic communication, the follow-up visits, and the range of services offered by the clinic. Respondents were less satisfied with the ability to access service referrals made by the clinic and the time it took to get an initial appointment, which, on average, took 156 days. Social factors that shaped structural barriers included limited access to transportation, a single parent household, lack of flexible employment, and limited services available outside of metro Atlanta and/or through Medicaid.

Conclusions: This study identified structural inequalities that shape access to autism diagnosis and services. This knowledge will inform the development of new approaches to offer autism services to underserved populations, such as mobile therapeutic units that are available during the evenings and/or weekends. Caregiver feedback will be used to improve services. While the Autism Clinic provides outstanding family centered care, there is a need for more appointment availability, and updated referral resources, especially for families who rely on Medicaid insurance.

## **6. Mobile app review for epilepsy self-management**

Jonathan Bidwell, Sookyong Koh, Elizabeth Mynatt; Cam Escoffery (Georgia Institute of Technology, School of Interactive Computing; Emory, Rollins School of Public Health)

Mobile health applications (apps) are playing an increasingly important role in supporting the daily self-care for people with epilepsy. Self-care is often challenging for people with epilepsy. Notable barriers include medication management, recording seizures and daily behaviors such as getting sufficient sleep and managing stress for reducing the risk of seizures. In practice, while mobile apps support aspects of these needs, patients, caregivers, and clinicians often continue to struggle with one or more aspects of daily medication adherence, self-reporting and self-regulation behaviors.

The purpose of this poster is to present our review of existing epilepsy self-management apps. We assessed apps on the Apple App Store in terms of 1) availability, 2) applicability for patient education and self-management (SM) and 3) utility for chronic disease management. Inclusion criteria included apps that were: 1) developed for pediatric or adult patients; 2) made available in English, and 3) less than \$5.00. The search resulted in 149 apps, of which 20 fully addressed these criteria. We reviewed each app in terms of 1) epilepsy-specific SM categories, 2) Mobile Health Rating Scale (MARS) sub-domain scores; and 3) the taxonomy of behavioral change strategies by Michie et al.

The mobile apps achieved high MARs ratings for functionality and aesthetics while they scored low on user engagement and information provision. Most apps addressed only a subset of SM categories relating to treatment, seizure tracking, response, and safety aspects of self-management, while none of the apps provided a comprehensive coverage of all categories in this review. The app coverage of SM categories ranged from 0-10 ( $M=3.95$ ,  $SD=2.66$ ) while the coverage of behavioral changes strategies ranged from 1 to 9 ( $M=3.74$ ,  $SD=2.10$ ). Our findings suggest a need for a broader set of SM domains, behavioral change techniques, and evaluated outcomes.

## **7. Supporting everyday self-management practices for pediatric patients with epilepsy**

Jonathan Bidwell, Sookyong Koh,; Cam Escoffery (Georgia Institute of Technology, School of Interactive Computing)

The Everyday Computing Lab (ECL) is working with adolescent patients (11-18 years old), caregivers and clinicians at the Children's Healthcare of Atlanta (CHOA) to investigate how mobile and wearable computing and motivational incentives can support self-management (i.e. adhering to medication, reporting seizures and health behaviors and self-regulating behaviors).

The study is ongoing and will include 45 families at CHOA. The research will investigate mobile surveys, context-sensitive notifications, health tracking and incentives through a multi-stage study design

## **8. Integrated Bioponics for Public Health**

Thomas Igou, Steven Van Ginkel, Yongsheng Chen (Georgia Tech)

The U.S. has the largest economy on Earth and faces significant challenges maintaining a constant supply of food to its urban populations. By 2050, approximately 87% of the American population will reside in urban areas while consuming mass and energy created and transported from far outside their boundaries. In order to ensure the sustainability of our food system, we propose to expand and redirect food waste nutrient streams to support urban, controlled environmental agriculture (CEA) systems. Currently 40% of food is wasted, primarily at the points of retail and consumption. Therefore, up to 40% of our food demand can theoretically be supplied by the efficient recycling of food waste back into edible products. CEA systems use ponics-type technologies to grow vegetables at 10-30 times the areal productivity and less than 10% of the freshwater requirement of traditional (soil-based) agricultural practices. Since nutrient-dense water replaces soil as the growth medium, nutrients from food waste or other sources can be readily recycled into plant biomass. The key inputs to CEA systems are light, nutrients, water and heating and cooling. Large cities such as Atlanta are able to support highly concentrated populations due to massive, coordinated, and interconnected water, energy and transportation infrastructures. By utilizing these currently established infrastructures, and the localized spatial distribution of food demand and waste production, a realistic, tangible reduction in material and energy waste can be obtained by stimulating the growth of urban CEAs. If the high efficiency of CEAs can offset the cost burden of land in already constrained urban areas, urban CEAs will lay the groundwork for a more efficient and sustainable food system.

## **9. Army Family Web Portal and the Next Generation Homefront Readiness**

Margarita Gonzalez, Sheila Isbell, Jessica Pater, Moon Kim, Samantha Lie-Tjauw; David Severson (Georgia Tech Research Institute; U.S. Army IMCOM HQ G9)

The United States Department of the Army provides a range of social services to soldiers and their families at installations across the U.S. and overseas in support of family and soldier readiness. Soldier readiness is operational at its core and family readiness is about stability and self-sufficiency. Although they are different, studies have shown that there is a direct link between family readiness and soldier readiness. Factors known to weaken families' self-sufficiency while their soldier is mobilized or deployed can potentially threaten the soldiers'

operational readiness due to preoccupation with their family's status. The Army Community Service (ACS) and its many programs aim to address these factors and provide services to support the collective readiness of the family and the soldier – or Homefront Readiness. To advance their mission to “provide comprehensive, standardized, coordinated, and responsive services that support Soldiers and Families regardless of geographical location”, the HQ Installation Management Command (IMCOM), Army Community Service Division has partnered with Georgia Tech Research Institute (GTRI) to modernize and streamline a suite of information systems used by ACS programs for client management and provision of services. At the heart of this modernization effort is the goal of creating an ecosystem in the cloud, called the Army Family Web Portal (AFWP). While the motivation for this cloud ecosystem is cost-effectiveness, AFWP will potentially provide the Army with technological affordances, such as secure data exchange, better coordination of services, and improved ways to empower the soldiers and families. Through this poster presentation, IMCOM and GTRI aim to summarize the modernization effort and the potential technological opportunities of AFWP to support a comprehensive Homefront Readiness. To this end, the poster will highlight select AFWP use cases and the technological opportunities for service providers, soldiers, and families with information and tools needed to make informed decisions.

## **10. C4G BLIS - STATUS & FUTURE CHALLENGES**

Sakshi Gandhi (Georgia Tech)

Health care delivery in resource-constrained settings presents many challenges, including highly diverse workflows, lack of standardization in data collection and reporting, and scarcity along many dimensions such as infrastructure, income and education. Many attempts to introduce state-of-the-art standardized systems for electronic record keeping have met with limited success in these settings. We present the design, implementation and evaluation of C4G BLIS, a system that tracks patients, laboratory samples, test results, and generates customized reports and trends for patients, physicians and health officials. The system was designed and deployed based on two major principles: (1) an Iterative Cooperative Design (ICD) methodology (2) immediate and continuous benefits for day-to-day users of the system. C4G BLIS is currently in use in many large hospital laboratories in Africa, and we report on the experience and results from these deployments, including improved turn-around times, reduced error rates and user satisfaction.

## **11. Optimized Oral Cholera Vaccine Distribution Strategies to Minimize Disease Incidence**

Hannah K. Smalley PhD , Pinar Keskinocak PhD , Julie Swann PhD , Alan Hinman MD (H. Milton Stewart School of Industrial and Systems Engineering, Georgia Institute of Technology; Task Force for Global Health)

In addition to improved sanitation, hygiene, and better access to safe water, oral cholera vaccines can help control the spread of cholera in the short term. However, there is currently no systematic method for determining the best allocation of oral cholera vaccines to minimize disease incidence in a population where the disease is endemic and resources are limited. We present a mathematical model for optimally allocating vaccines in a region under varying levels of demographic and incidence data availability. The model addresses the questions of where, when, and how many doses of vaccines to send. Considering

vaccine efficacies (which may vary based on age and the number of years since vaccination), we analyze distribution strategies which allocate vaccines over multiple years. Results indicate that, given appropriate surveillance data, targeting age groups and regions with the highest disease incidence should be the first priority, followed by other groups primarily in order of disease incidence, as this approach is the most life-saving and cost-effective. A lack of detailed incidence data results in distribution strategies which are not cost-effective and can lead to thousands more deaths from the disease. The mathematical model allows for what-if analysis for various vaccine distribution strategies by providing the ability to easily vary parameters such as numbers and sizes of regions and age groups, risk levels, vaccine price, vaccine efficacy, production capacity and budget.

## 12. Personalized Catch-up Schedulers for Childhood, Adolescent, and Adult Immunization

Sheila Isbell<sup>1</sup>, Dr. Pinar Keskinocak<sup>2</sup>, Dr. Larry Pickering<sup>3</sup>, Scott Appling<sup>1</sup>, Therese Boston<sup>1</sup>, Josh Cothran<sup>1</sup>, Arya Irani<sup>1</sup>, Moon Kim<sup>1</sup>, Faramroze Engineer<sup>2</sup>, Cathy Hogan<sup>3</sup>, Shilpa Kottakapu<sup>3</sup>, Hannah K. Smalley<sup>2</sup>, Gregory Abowd<sup>4</sup>

(1: Georgia Tech Research Institute, 2: Industrial Systems Engineering, 3: Center for Disease Control and Prevention, 4: College of Computing)

To ensure coverage against vaccine-preventable diseases for children, adolescents, and adults, and to aid individuals, caretakers, and providers in making vaccination decisions appropriately and in a timely manner, Georgia Institute of Technology in collaboration with the Centers for Disease Control and Prevention (CDC) developed the Catch-Up Immunization Schedulers, decision support tools for creating catch-up immunization schedules. <https://www.vacscheduler.org/>

In most countries, there are published immunization recommendations for children and adults. These published schedules contain recommended ages and specific rules regarding the minimum and maximum allowable age that each vaccine dose may be administered, and include minimum gaps between doses of the same vaccine. The immunization recommendations for adults may depend on factors such as medical condition, lifestyle, and work environment, in addition to age and vaccination history.

If an individual misses one or more doses of a recommended vaccine, it is typically a health-care professional's job to create a catch-up vaccination schedule which is feasible and maximizes the person's coverage against vaccine-preventable diseases. This task is often very challenging and time-consuming.

The catch-up scheduling problem for each targeted group is one of determining the best schedule (in terms of coverage) for each individual given their past vaccination history and current age. Doses of a vaccine may not be scheduled unless they may be feasibly administered and are not contraindicated, e.g., if the previous dose is administered at an age that no longer warrants further vaccination. The minimum and maximum age requirements for each dose of each vaccine and the gap between doses of the same vaccine must not be violated.

Through an easy-to-use interface, the scheduler accepts input from the user including date of birth, the dates of administration for each dose and the number of doses of each vaccine that have been administered. The tool then determines the recommended immunization schedule using a dynamic programming (DP) algorithm. The schedulers simplify and expedite the tedious process of constructing immunization schedules, eliminates errors, and help improve protection against vaccine-preventable diseases.

## 1. Improving Continuous Electroencephalography (cEEG) Monitoring in Pediatric Intensive Care Units (PICU): Whom Should We Monitor?

Mingyoung Jo<sup>1</sup>, Qing Li<sup>1</sup>, Jan Vlachy<sup>1</sup>, Pinar Keskinocak<sup>1</sup>, Turgay Ayer<sup>1</sup>, Julie Swann<sup>1</sup>, Atul Vats<sup>2</sup>, Larry Olson<sup>2</sup> (1School of Industrial and Systems Engineering, Georgia Institute of Technology; 2Children's Healthcare of Atlanta)

**OBJECTIVE:** cEEG is an emerging technology for which there are not clear guidelines for patient selection or length of monitoring. The purpose of this study was to identify subgroups of pediatric patients with high seizure risk.

**STUDY DESIGN:** We conducted a retrospective study on 517 children monitored by cEEG in the intensive care unit of a children's hospital. The children were stratified using an age threshold selection method. Using regression modeling, we analyzed significant risk factors for increased seizure risk in younger and older children. Using two alternative correction procedures, we also considered a relevant comparison group to mitigate selection bias and to provide a perspective for our findings.

**RESULTS:** We discovered an approximate risk threshold of 14 months: below this threshold, the seizure risk increases dramatically. The older children had an overall seizure rate of 18%, and previous seizures were the only significant risk factor. In contrast, the younger children had an overall seizure rate of 45%, and the seizures were significantly associated with hypoxic-ischemic encephalopathy (HIE;  $p=0.007$ ), intracranial hemorrhage (ICH;  $p=0.005$ ), and central nervous system (CNS) infection ( $p=0.02$ ). Children with HIE, ICH, or CNS infection accounted for 61% of all seizure patients diagnosed through cEEG under 14 months.

**CONCLUSIONS:** An extremely high incidence of seizures prevails among critically ill children under 14 months, particularly those with HIE, ICH, or CNS infection.