

Health Systems- The Next Generation
Forum 2019

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Poster Abstracts

1. Building a Transplant Decision Support tool to Accept/Decline Organ Offers

Kirthana Hampapur, Ethan Mark, Pinar Keskinocak, Joel Sokol, David Goldsman, Brian Gurbaxani (Georgia Tech)

There are thousands of patients on the transplant waitlist, and the gap between the number of patients waiting and the number of available deceased donor organs has been growing. At the same time, many deceased donor organs which are viable for transplant are discarded. When a patient on the waitlist is presented with an organ offer, they need to evaluate the following two scenarios: (1) Accept and undergo transplant. (2) Decline and remain on the waitlist, hoping to receive a better quality organ offer in the future. Assessing the tradeoffs between these scenarios is challenging since the waiting times are usually very high and the organs are of varied characteristics that could affect post-transplant survival. Utilizing data from thousands of organ transplants in the US, we developed several machine

learning models and embedded them into a decision-support tool to help patients and their physicians in evaluating the available options. The tool predicts the multi-year survival probability of a patient under both scenarios and aids patients and physicians in making more informed decisions. In addition, we develop a simulation model to test different allocation policies and quantify the impact to the individual patients as well as the overall system under different offer acceptance models.

2. Can Big Data Cure Risk Selection in Healthcare Capitation Programs?

Zhaowei She, Turgay Ayer (Georgia Tech), Daniel Montanera (Georgia State University)

We analyze the risk selection problem in Medicare Advantage (MA), the largest capitation payment program in the U.S. healthcare market. In practice and current literature, the observed risk selection in MA is primarily attributed to data limitations and low explanatory power (e.g. low R^2) of the current risk adjustment design. However, our study shows that MA cannot eliminate risk selection even if its risk adjustment design becomes informationally perfect (e.g. $R^2 = 1$) in the age of big data. To address risk selection in capitation programs, payers should not solely rely on big data and advanced ML algorithms but need to consider mechanisms other than pure statistical risk adjustment designs.

3. Decision Support in the Prenatal Screening Space

Akane Fujimoto Wakabayashi, Pinar Keskinocak, Turgay Ayer, Jia Yan (Georgia Tech), Kalyan Pasupathy, Santiago Romero-Brufau, Mustafa Sir, Myra Wick, Lars Nielsen (Mayo Clinic)

During pregnancy, expectant parents have the option to test for common chromosomal aneuploidies in the baby such as Down Syndrome. In the past, maternal age during pregnancy and medical history were the only indicators to assess the risk of having an affected pregnancy. Currently, there are multiple screening and diagnostic tests that use blood, ultrasound, and other biomarkers, with high sensitivity and specificity. Decisions made in this space are heavily based on the personal belief and values of the parents and are known to be emotionally charged and difficult.

In this research, we present an overview of a decision support tool designed to improve the users' understanding of prenatal testing to facilitate decision making. Additionally, we present three screening strategies that use different types of tests and interpretation methods and compare their performance using an age-based approach. The purpose of the comparison is to find what strategies are optimal in terms of reducing the number of adverse outcomes for the different age groups as opposed to a one-size-fits-all strategy approach.

4. Empowering Adults with Mild Cognitive Impairment and their Families with Conversational Assistants

Tamara Zubatiy, Elizabeth Mynatt (Georgia Tech)

We explore how commercial conversational assistants (CAs), such as Google Home and Amazon's Alexa, can empower older adults with degenerative mild cognitive impairment (MCI), by extending the environment of active care from the clinic and into the everyday

lives of patients. This work is part of the Cognitive Empowerment Program, a collaboration between technologists at Georgia Tech and clinicians at Emory Brain Health Center, to evaluate the impact of behavioral interventions on delaying progression of MCI. This poster offers a framework to understand CA activities in three levels of interaction. Each level offers broader functionality but has usability tradeoffs. The first level, out of the box, is unlocked as soon as a user pairs their phone using the Alexa or Google Home mobile app, and includes functions such as weather, timers, music, and internet Q&A. The second level, personalized, is activated when users connect authorize other third-party accounts, and includes functions such as scheduling, personalized reminders, and voice identification for multiple home-members. The third level, skill, is activated if a user asks for the specific skill by name. The skill level also enables push notifications from sensors, which can, for example, cause the CA to alert to alert the home-members that the stove has been left on, without any work on the users' end. We worked with the project's Therapeutic Core at Emory to prioritize five activities in the first and second levels to implement first. The program includes training for caregivers and patients on setting up the device and accessing personalized interactions. Beginning in mid-January, we will collect CA usage logs weekly, along with program-wide surveys to capture empowerment and other metrics. We will learn how the MCI population uses CAs, identify key challenges, and evaluate the potential for CAs to support empowerment in adults with MCI.

5. Estimating the Impact of Interventions for Medicaid-Enrolled Children with Asthma
Melike Yildirim, Pinar Keskinocak (Georgia Tech), Julie Swann (North Carolina University), Paul Griffin (Purdue University)

Since the effect of intervention programs are not visible, we aim to quantify the impact of pediatric asthma interventions on healthcare utilization and medication costs. We analyze four interventions: influenza vaccine, spacer, self-management education (AS-ME), and nebulizer. We further investigate the probability reductions of related emergency department, primary care physician, and inpatient visit with interventions. The estimated effects of interventions varied by the state, setting or target population.

6. Evaluation of a Community-Based Autism Clinic in Atlanta, Georgia
Jennifer Singh (Georgia Tech), I. Leslie Rubin (Morehouse School of Medicine)

Community-based autism clinics that serve primarily low-income, minority, and underserved populations are limited in the U.S. despite evident disparities to diagnosis and services based on race, ethnicity, and social class. To address the needs of underserved children with autism and their families in Atlanta, Georgia, the Autism Clinic at Hughes Spalding Children's Hospital, an affiliate of Children's Healthcare of Atlanta (CHOA), was established in 2002. The purpose of this study is to evaluate the quality of care provided by the Autism Clinic to identify strengths of this model of care and areas for improvement.

We conducted a Quality of Care Survey with caregivers (N=70) who utilize services at the Autism Clinic to evaluate three levels of care: Access to Care; Family Centered Care; and Care Coordination, as well as overall level of satisfaction. Caregivers were most satisfied with various elements of Family Centered Care. Caregivers were less satisfied with the

time to first appointment (Average = 127 days) and access to services outside the clinic (78% of participants were usually, always or sometimes frustrated with accessing autism services). Overall, caregivers were satisfied with the diagnosis process, referrals provided, follow-up services, and range of services offered at the clinic.

We identified strengths in the quality of care offered by the Autism Clinic, including various components of family centered care and the overall experience of the diagnosis process. These strengths support the multi-disciplinary model provided by the Autism Clinic; a model of care particularly effective for underserved families because they are able to see four or more different providers in one visit. However, there are needed areas of improvement since 43% of families did not feel prepared for the first visit. Parents also indicated that they did most of the care coordination for their child (71%).

7. Exploring the variance of breast cancer diagnostic service utilization across cost-sharing plans

William Espinoza, Danny Hughes (Georgia Tech)

Preventive care provides an opportunity to proactively address long-term health concerns. However, for these methods to be effective, it requires the at-risk population to actively participate. Although many factors affect participation, the degree of patient cost-sharing has been identified as a potential barrier for patients. This study sheds insight on this potential barrier by examining the association between differences in patient cost-sharing and subsequent diagnostic test utilization for patients that have received a positive initial breast cancer screening. Using administrative claims data from a large U.S. commercial insurer, we identify all women over 40 years old that received a screening mammogram in 2016 and tracked their subsequent utilization for the next 364 days. These patients are associated with 23,000 different cost-sharing plans that are defined by three parameters: copay, coinsurance, and deductible. For most plans, one parameter completely dominates the other two, or all three are relatively low. Using cluster analysis, we allocate these plans into 4 different groups to differentiate the degree of patient cost-sharing. The proportion of patients that had at least one instance of follow-up care was consistent across the clusters. However, when limited to more advanced follow-up care (i.e. ultrasound, MRI), the variance is more pronounced. The higher coinsurance plans and the all-around low plans respectively have the highest and lowest utilization by a wide margin. This may indicate that deductibles and copays serve as a greater barrier to entry to breast cancer diagnostic services.

8. Factors for Successful Vaccination Coverage in Developing Countries.

Francisco Castillo-Zunino, Pinar Keskinocak, Dima Nazzal, Matthew Freeman

This research aims to identify successful strategies and factors for improving vaccination coverage based on information and data from several developing countries. We analyze how DTP3 coverage performance interacts with performance regarding other vaccines, other health system outcomes, and other development outcomes outside of the healthcare system.

9. Impact of Light Therapy on People with Dementia: An Evidence-Based Review

Fatemeh Motamed Rastegar, Jennifer Dubose, Robert Davis (Georgia Tech)

Light therapy is increasingly proposed as a nonpharmacological treatment for a variety of health-related problems including treatment of Elderly People with Dementia (EPD). While the visual effects of light on older adults are well-documented and integrated into design guidelines, evidence related to the non-visual effects of lighting is scattered and less studied, especially for EPD. This review synthesizes the available evidence on non-visual effects of light on EPD to identify lighting conditions that are most favourable for yielding positive non-visual outcomes.

We carry out a systematic review of 34 empirical studies on the non-visual impacts of light on EPD, which largely are focused on the areas of sleep, alertness, mood and cognitive performance. The intervention methods used can be categorized into two: 1) light intensity, 2) color temperature or wavelength manipulation.

Results indicate that while subjects report significant improvements in behavioral symptoms, and cognitive functions when they get exposed to high levels of light, not many objective measurements affirm these effects. In the second category, preliminary objective evidence shows that short wavelength light can slow down cognitive decline and reduce the speed of health decline; however, these evidences are not consistent across all studies. Interestingly, among the collected studies, some features such as the impact of blue light on alertness decreases substantially as we age; while others like the response to green and violet lights remain intact.

Altogether, we identify a growing body of evidence on the therapeutic benefits of lighting and its use in treating mental and behavioral disorders among the EPD. The experiments using light as therapy have improved our understanding of the underlying principles, but the integration of therapeutic aspects of lighting in design practice and guidelines is still lacking. Finally, we propose a framework to facilitate further study and analysis of effect of light on EPD.

10. Outcome-based vs Traditional Pharmaceutical Contracts

Andrew ElHabr, Turgay Ayer (Georgia Tech), Can Zhang (Duke University)

We study under what market conditions and drug characteristics payers and pharmaceutical manufacturers are better off engaging in an outcomes-based contract, an agreement that links payments for drugs to drug effectiveness, over a traditional pharmaceutical contract using a game-theoretic stylistic model with risk-averse decision-makers in which the scope is not limited to new or specialty drugs. We find that the manufacturer prices the drug higher in an outcomes-based contract than it does in a traditional contract. However, the manufacturer does not price the drug so high that the payer is best off placing the drug in a higher cost-sharing drug formulary tier than it would have in a traditional contract. High drug effectiveness, high drug variance of effectiveness, and strong payer risk aversion all make outcomes-based contracting more likely to be preferred by the stakeholders. We also find that an agreement on preferred drug formulary placement in exchange for lower per-unit drug price can be beneficial to all stakeholders.

11. Projection of Prevalence and Mortality Associated with Alcohol-Related Liver Disease in the United States from 2019 to 2040

Jovan Julien, Turgay Ayer (Georgia Tech), Emily Bethea (Massachusetts General Hospital), Elliot Tapper (University of Michigan), Jagpreet Chhatwal (Harvard Medical School)

Alcohol-related liver disease (ALD) is the leading indication for liver transplantation in the United States (US). After remaining stable for over three decades, the number of alcohol-related cirrhosis deaths has been rising as a result of increased high-risk drinking. To project temporal trends in alcohol-related liver disease and mortality in the United States from 2019 to 2040 under different rates of alcohol consumption.

There are Multi-cohort state-transition (Markov) model of the high-risk alcohol drinking patterns and ALD in high-risk drinking populations born between 1900 to 2016 in the US. We compared a modest intervention that reverted high-risk drinking to 2001 levels and a robust one that decreased high-risk drinking 3.5% per year (comparable to decreases in tobacco consumption since 1964), to a scenario where high-risk drinking rates continued increasing following reported trends.

Our model closely reproduced the observed trends in ALD-related deaths from 2005-2016, as reported by the US National death registry. Under current drinking patterns, the annual number of deaths from ALD is expected to increase from 27,500 in 2019 to 49,600 in 2040 (an 80% increase of 66% in males and 108% in females). From 2019 to 2040, 852,500 people are projected to die from ALD. Bringing the high-risk drinking rates to the 2001 levels will marginally reduce the number of deaths by 2% during this period; whereas, decreasing high-risk drinking rates by 3.5% per year (similar to reduction in tobacco consumption after 1964) would reduce ALD-related deaths to 603,500 (a 30% decrease). Conclusion: Without significant changes in drinking culture or interventions to address high-risk drinking, ALD-related deaths and disease burden will worsen. The drinking culture of young adults forebodes a significant increase in alcohol related cirrhosis deaths in the long-term.

12. Seeing like a Bike

Alexandra Nguyen, Christopher le Dantec, Kari Watkins (Georgia Tech)

Our goal was to create an exploratory data visualization tool for City Planners to help inform decisions about City Planning & Infrastructure. With interviews and surveys from the research team, City Planners, and cyclists of Atlanta, we were able to identify stress factors that people experience. With the data visualizations, users can determine and highlight what areas of Atlanta are problematic and draw their own hypothesis and conclusions as they explore the tool.

13. Sleep Stage Classification Using Single Lead Electrocardiogram

Cyrus Rich, Samruddhi Kulkarni, Shafa-at Sheikh, Zifan Jiang, Yue Lu (Georgia Tech)

As we uncover more about how the human body operates, it has become abundantly clear that the value of ample regenerative sleep has a long history of being under recognized. Despite this, nearly 20% of the US population suffers from chronic sleep deficiency. To properly diagnose sleep disorders, sleep studies are conducted using a wide array of sensors that measure brain activity, heart rhythm, eye movement, blood oxygen saturation

levels, and limb movement. Gathering polysomnographic data traditionally requires highly sophisticated equipment and is disruptive to a patient sleep. To address this, we developed a sleep stage classification model heart rhythm data alone. We will develop our analysis using the MIT-BIH Polysomnographic database, which is freely available on-line at Physionet.org. This data set consists of labelled polysomnographic data obtained from 16 individuals, representing over 2,800-time epochs. We used these data to implement a convolutional neural net (CNN) to classify each epoch as one of four stages: awake, REM sleep, non-REM light sleep, and non-REM deep sleep. The CNN achieved an accuracy of .942 on the test data, far outperforming a variety of simpler classifiers. With wearable devices becoming more prevalent and more accurate, the ability to analyze and understand one's own sleep patterns are attainable now. Furthermore, as wearable devices develop the capacity to capture more than EKG alone, it is expected that sleep classification will only increase in accuracy.

14. Survival Following Split-liver Transplantation: A Review

Zhuoting Yu, Pinar Keskinocak, Joel Sokol (Georgia Tech)

Split liver transplantation, where a liver is split into two parts and transplanted to one or two recipients, has the potential to expand the supply of livers and increase the availability of size-matched livers for pediatric patients. However, it is still unknown if the split liver transplantation (SLT) has inferior outcomes compared to whole liver transplantation (WLT). In this retrospective study of national registry data, we summarized the differences in donor/recipient features of the pediatric and adult group. We compared the patient survival probability and graft failure probability by Kaplan-Meier curves and computed the unadjusted survival probability of different allograft types in both pediatric and adult groups. We used the Cox proportional hazards models to analyze the association between survival probability and allograft type. In the pediatric group, we identified the correlation between donor weight and allograft type. Therefore, we selected subgroups of the records. We found that the SLT has comparable outcomes with WLT, and it suggests that SLT might be a good consideration to increase the liver supply for both pediatric and adult patients without risks of worse outcomes.

15. The Effects of Dental Hygienist Autonomy on Dental Care Utilization

Jie Chen (Georgia Tech), Chad Meyerhoefer (Lehigh University), Edward Timmons (Saint Francis University)

Because of the limited supply of health care providers relative to the demand for health care services, increases in provider autonomy are believed to improve access to health care. However, research on the impact of scope of practice laws for health and dental care providers is limited. We investigate the effects of dental hygienist scope of practice and autonomy regulations on dental care access, utilization, and expenditure. We measure the strength of these laws by extending the Dental Hygiene Professional Practice Index to the years 2001 to 2014. Data on dental care utilization for our analysis come from the 2001-2014 Medical Expenditure Panel Survey. We use a difference-in-difference approach that

exploits variation within states over time in scope of practice laws for identification. We find evidence that increasing the autonomy level of dental hygienists modestly improves dental care utilization, on average, but that increases in utilization are more pronounced in areas with a shortage of dental care providers.

16. Using Simulation and Co-Design to Inform the Design of Safer Environments: Biocontainment Unit Design Review for a Pediatric Hospital

Zorana Matić, Benton Humphreys, Alexandra M. Nguyen, Jennifer R DuBose (Georgia Tech), Amanda Grindle (Children's Healthcare of Atlanta)

The 2014 Ebola outbreak highlighted the challenges of caring for Ebola patients and ensuring the safety of healthcare workers (HCW) during doffing of personal protective equipment (PPE) in the biocontainment unit (BCU). Doffing of PPE is a high-risk activity because of the potential for self- and cross-contamination and occupational injury. The SimTigrate Design Lab, as part of Georgia Tech, together with Emory University and Georgia State University was involved in the Prevention Epicenter of Emory and Atlanta Consortium Hospitals (PEACH) research program for several years. We looked at the design of the BCUs both from the perspective of HCW safety and patient experience. Building on the knowledge gained through these projects and our body of evidence-based design research, we are currently helping a large tertiary pediatric referral hospital in the southeast US to arrive at a world-class design for the new 6-bed Special Care Unit (SCU). This project looks at refining the design of the doffing space to improve safety and reduce contamination risk.

Our team observed interactions between HCWs and the built environment during simulations exercises at a full-scale hospital mock-up, evaluated the proposed designs, analyzed alternatives, and proposed specific design solutions for the space and doffing process that work together in synergy to ensure the safety of the healthcare team. We also participated in a co-design session with the HCWs, to understand their anticipated use of the doffing area, and how space can support their needs. Together with the HCWs, we reviewed the proposed layouts and designed solutions to optimize the design of the doffing space to best fit their protocol.

The final design, based on ergonomic principles, empirical guidelines and developed in the participatory design process with the end users, can reduce the physical and cognitive burden of healthcare workers and reduce the risk of potential errors.