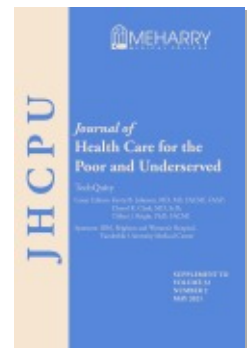




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Centering TechQuity through Biomedical Informatics Centers at Minority-Serving Academic Institutions Providing Informatics Solutions for Urban Safety-Net Settings

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Abstract: The Charles R. Drew University of Medicine and Science (CDU) Center for Biomedical Informatics (CBI) is the only center of its kind at a U.S. minority-serving academic institution. The CBI's goal is to help fulfill CDU's mission of reducing health disparities through biomedical informatics, a multi-disciplinary field focusing on how biomedical data can be transformed to improve human health. We review CBI activities promoting health information technology solutions to enhance health equity for medically underserved and under-resourced South Los Angeles populations experiencing a digital divide, and we contextualize such a center's importance for TechQuity. Working with Los Angeles safety-net clinics and hospitals, which provide care to patients regardless of insurance status, ability to pay, or citizenship status, CBI faculty members have conducted research and provided solutions in a variety of areas, including telehealth, machine learning, computerized decision support, sociotechnical expertise, mHealth apps, and international efforts to create health information systems standards.

Key words: Telehealth, machine learning, artificial intelligence, safety-net providers, computerized decision support, sociotechnical studies, mHealth.

Charles R. Drew University of Medicine and Science (CDU) is one of four historically Black medical schools in the United States, the other three being Meharry Medical College, Morehouse School of Medicine, and Howard University College of Medicine. A recent study found that although these schools represent 2.4% of medical schools in the U.S., they enroll more than 14% of Black medical students.¹ The CDU mission statement reads, "Charles R. Drew University of Medicine and Science is a

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private non-profit student centered University that is committed to cultivating diverse health professional leaders who are dedicated to social justice and health equity for underserved populations through outstanding education, research, clinical service, and community engagement.” The university’s vision is “Excellent health and wellness for all in a world without health disparities.”

Recognizing the vital and growing role that health information technology and biomedical data play in improving the delivery of health care, enhancing clinical education, and reducing health disparities, CDU established a Center for Biomedical Informatics in 2007. Biomedical Informatics is a multi-disciplinary field that studies how biomedical data, information, and knowledge can be acquired, stored, communicated, and transformed to produce insights that improve human health. A goal of the CDU Center for Biomedical Informatics is to center on TechQuity. By this we mean reducing health disparities by providing biomedical informatics solutions to problems that affect medically underserved and under-resourced communities, in partnership with patients and providers in these communities. Faculty members at the Center have backgrounds in computer science, clinical medicine, sociology, and public health.

To achieve its goals, the Center has worked with multiple Los Angeles safety-net clinics and hospitals, which provide care to patients regardless of insurance status, ability to pay, or citizenship status. Faculty members at the Center work with clinicians from these health care partners to provide targeted biomedical informatics solutions to challenges that they confront as they care for the most vulnerable patients.

The University also has worked with other institutions serving predominantly minority populations through the National Institutes of Health (NIH)-funded Research Centers in Minority Institutions Translational Research Network initiative (RTRN). This initiative reaches the previously mentioned historically Black medical schools plus the following other minority-serving institutions (MSIs): the University of Texas at El Paso; the University of Texas at San Antonio; Texas Southern University; Xavier University of Louisiana; Northern Arizona University; the University of Puerto Rico Medical Sciences Campus, Ponce School of Medicine, Puerto Rico; Universidad Central del Caribe; Clark Atlanta University; Jackson State University; City College, New York; Hunter College, New York; Tuskegee University; Florida A&M University; Florida International University; North Carolina Central University; and the University of Hawaii at Manoa.

While the RTRN partnership involves some clinical research informatics with respect to providing tools for research data storage (e.g., REDCap²) and research networking (e.g., the Profiles Research Networking System/RNS³) to faculty at the participating universities, CDU is the only RTRN partner with a Center for Biomedical Informatics dedicated to addressing health disparities by (1) conducting original research in the biomedical informatics domain in partnership with local health care organizations, and (2) teaching formal semester-long courses in biomedical informatics to master’s students in Biological Sciences and Public Health. A two-year master’s degree program in Health Informatics is currently under development at CDU. A potent method for addressing health disparities in medically underserved communities is for MSIs to establish centers for biomedical informatics that collaborate with area hospitals and clinics to leverage biomedical data and develop tailored informatics solutions to meet the needs of those communities, including workforce development.

Charles Drew University is located in South Los Angeles' Service Planning Area 6 (SPA 6), which is home to approximately 1.1 million people, predominantly of Latino (68%) and African American (28%) heritage.⁴ This SPA serves the communities of Athens, Compton, Crenshaw, Florence, Hyde Park, Lynwood, Paramount, and Watts. Of the eight Los Angeles County service planning areas, SPA 6 has the highest death rate from diabetes mellitus, the second highest rate of people diagnosed with diabetes mellitus, the highest percentage of adults with obesity, the second highest death rate from coronary heart disease, the highest death rate from stroke, the second highest percentage of low-weight births, the highest percentage of low-weight African American births, and the highest infant death rate.⁴

Informatics Projects Addressing Health Disparities in SPA 6 and Beyond

With a view to improving the lives and outcomes of patients and assisting clinicians who serve in medically underserved areas such as SPA 6, CDU's Center for Biomedical Informatics has undertaken a number of projects over the years, in partnership with safety-net providers.

Telehealth to increase patient access to specialists: Teleretinal screening for diabetic retinopathy. Diabetes mellitus disproportionately affects individuals in SPA 6, the service planning area in which CDU is located. The Centers for Disease Control and Prevention estimate that diabetes mellitus affects 34.2 million people in the United States, with an additional 88 million people aged 18 years or older being pre-diabetic.⁵ Racial and ethnic minorities are disproportionately affected by diabetes: 7.5% of non-Hispanic Whites, 9.2% of Asian Americans, 12.5% of Hispanics, 11.7% of non-Hispanic Blacks, and 14.7% of American Indians/Alaska Natives had been diagnosed with the condition between 2017 and 2018.⁵

Diabetic retinopathy is a major ocular complication of diabetes mellitus and the leading cause of blindness among working-age adults in the U.S. (adults between the ages of 20 and 74 years).^{6,7} If diabetic retinopathy is detected early, laser photocoagulation surgery is an effective way of treating it^{8,9} thereby reducing the likelihood of eyesight loss. Annual retinal screening has been recommended as a means of detecting diabetic retinopathy¹⁰ and potentially reducing the incidence of resulting blindness. Some studies have shown that on average, only 60% of diabetic patients in the U.S. receive timely eye examinations,¹¹⁻¹⁵ while other studies focused on the urban safety-net setting have shown annual eye examination rates for inner-city diabetic patients to be much lower than the national average.¹⁶⁻¹⁸ There are many reasons for the disparities between national and urban safety-net screening rates, including patients being un- or under-insured, a limited number of ophthalmologists practicing in urban safety-net settings, and limited patient access to specialty care facilities for screening.

With funding from the National Institute on Minority Health and Health Disparities, Charles R. Drew University Center for Biomedical Informatics investigators worked with six South Los Angeles federally qualified health centers (FQHCs) on a pilot study to examine the feasibility of introducing teleretinal screening in the primary care setting

as a means to increase access to eye specialists for diabetic patients requiring annual eye examinations. A total of 2,876 teleretinal screenings were performed for diabetic retinopathy, with 2,732 unique diabetic patients from six South Los Angeles safety-net clinics screened.¹⁹⁻²² Results from this pilot study provided key insights that aided participating ophthalmologists from the Los Angeles County Department of Health Services (LACDHS) in launching the LACDHS Teleretinal Diabetic Retinopathy Screening Program, which currently screens over 50,000 diabetic patients every year for diabetic retinopathy.²³ In establishing the partnership with the FQHCs, CDU addressed clinic concerns about the future of teleretinal screening once the funded grant was over by agreeing to have the expensive digital nonmydriatic cameras purchased for the study remain in use after the end of funding. While the funded study employed board-certified ophthalmologists, after the study's end, the clinics established contractual relationships with providers (mainly optometrists) on cost and convenience grounds, so that the teleretinal screening work that began with the study continues today.

Machine learning to detect diabetic retinopathy. One key insight that arose from the pilot study on teleretinal screening was that electronic health record data from diabetic patients for whom a diagnosis of retinopathy or no retinopathy had been made, could be used to develop machine learning models that identify patients at a higher risk of diabetic retinopathy.^{24,25} Such models could then be used to appropriately target patients who do not avail themselves of guideline-recommended annual eye examinations. This is a current area of investigation at the Center, funded by a grant from the National Library of Medicine.²⁶

Computerized decision support for chronic diseases. Recognizing a need to develop health information systems designed for and informed by clinicians practicing in non-academic medical settings, investigators at the CBI worked with clinicians in the Family Medicine Clinic of the Hubert H. Humphrey Comprehensive Health Center (HHHCHC) in Los Angeles to develop the CDU Electronic Disease Registry to Improve Chronic Care (CEDRIC) for managing chronic diseases, such as diabetes.²⁷ The HHHCHC is a Los Angeles County Department of Health Services ambulatory care clinic that has approximately 13,000 annual patient visits and caters to a patient population that is 55% Latino and 37% African American, with 70% or more of the patient population lacking public or private insurance.

Sociotechnical studies to support provider effectiveness and patient engagement in health care and research. The Center's expertise has supported a body of award-winning and award-nominated scholarship focusing on the intersection of technology and health care particularly in urban, under-resourced clinical health care settings and among low-literacy multicultural patient populations. Technological advances that allow innovations such as electronic health records, telemedicine, and mobile apps are exciting since they have the potential to be very effective responses to the problem of limited health care resources, especially in safety-net health care settings. However, there can be incongruities between the biomedical aims that drive such solutions and the on-the-ground experiences of those administering and receiving care, making essential the

role of sociocultural variables, health communication, health literacy, and community-based participatory research approaches to evaluate the sociotechnical factors at play.

The introduction of new health information technologies (HIT) in health care settings can have a tremendous impact on the workflow as well as relationships between clinical teams and patients. An early collaboration of the Center faculty with Kaiser Permanente's Division of Research led to a paper on the introduction of computers into the exam room and the impact of this technology on doctor-patient interactions that was an Editor's pick for the "Best of Journal of General Internal Medicine."²⁸ Under-resourced safety-net settings may have additional challenges to such introduction of HIT. The Center has lent its sociotechnical expertise to the development and evaluation of a community-partnered participatory approach to the development of a clinical information system in such a safety-net clinic,²⁹ to the workflow concerns and workarounds of clinicians who were readers in an urban safety-net teleretinal screening study^{*,22} as well as to the study of overall factors shaping effective use of HIT in such safety-net clinics.³⁰

The literature on the adoption and diffusion of new technology, such as telemedicine and electronic medical records, suggests that patient perceptions about innovations and the extent to which they see them as a relative advantage are keys to the rate of diffusion and adoption. In a post COVID-19 world, an innovation such as telemedicine has quickly become a necessity in most health care settings. Thus, it has become even more essential to understand how such technology is used and understood by safety-net patients, who tend to experience a digital divide. In this vein, the Center's expertise in sociotechnical research has contributed to the scholarship on the acceptability of telemedicine among urban, multicultural populations,^{31,32} and on the knowledge gap experienced by U.S. safety-net patients when provided teleretinal screening.^{**,33} Furthermore, mobile technologies are increasingly bridging the gap to boost patient engagement since patients are more likely to use HIT tools on their smartphones rather than less accessible patient portals. Faculty of CBI have collaborated with colleagues at the University of California, Irvine on a Robert Wood Johnson Foundation grant called *Project Health Design* to help develop a smartphone-based HIT to improve quality of care and support for parents of low-birthweight infants.³⁴ In another project with colleagues at AIDS Project, Los Angeles, we have assessed the acceptability of cellphone-based text messaging as an intervention for sexual health communication among young African American and Latino men who have sex with men.³⁵

Research shows that populations with limited health literacy are often more open to visual media-based health informational materials, such as animated educational

* The work was nominated for the American Medical Informatics Association (AMIA) Diana Forsythe Award (DFA) for the top sociotechnical/medical informatics research published in a peer reviewed journal in 2011. Fish A, George S, Terrien E, Eccles A, Baker R, Ogunyemi O. Workflow concerns and workarounds of readers in an urban safety net teleretinal screening study. AMIA Annual Symposium proceedings / AMIA Symposium AMIA Symposium. [Research Support, N.I.H., Extramural]. 2011;2011:417-26.

** This paper was also nominated for AMIA's DFA. George SM, Hayes EM, Fish A, Daskivich LP, Ogunyemi OI. Understanding the knowledge gap experienced by US safety net patients in teleretinal screening. AMIA Annual Symposium Proceedings. 2016;2016:590.

videos.^{36,37} With funding from the NIH, Center faculty developed a script for an animated video, based on a systematic literature review on key barriers and facilitators to minority participation in clinical research.³⁸ In collaboration with *Health Nuts Media*, a health-related animation company, we developed an animated video entitled *What is Health Research?*, which is available in English and Spanish, found to be acceptable to low-income African American, Latino, Asian American, and Pacific Islander communities of color in enhancing health research literacy.^{39,40}

mHealth Apps. With the increasing ubiquity of mobile communication and computing platforms, a key component of CBI's efforts to use HIT to reduce health disparities involves implementation and study of mHealth apps. In particular, given the health disparities associated with mental health disorders and substance use, CBI has collaborated on several projects addressing these specific challenges. In mental health and substance abuse treatment, individualized assessments provide information on the specific thoughts and cognitive processes that influence a person's behaviors, emotional responses, and psychological functioning.⁴¹ Having information about the individual's thoughts and cognitive processes facilitates the development of clinical interventions tailored specifically to an individual patient. Research suggests that interventions based on information from such individualized assessments are likely to have greater effectiveness than those that are not.⁴²

The objective of one such exploratory pilot study was to develop and implement an intervention that combined individualized web-based attention training with evidence-based counseling to promote HIV treatment adherence and reduce psychological distress. This study targeted African American and Latino young men who have sex with men (YMSM), two population groups in the United States that continue to experience disadvantages in HIV treatment outcomes compared with other groups. This study involved web-based attention training on a daily basis using study subjects' own mobile devices or computers to reorient their attention away from negative or emotionally-charged stimuli associated with poor adherence and diverting it toward positive or neutral stimuli linked to favorable adherence behaviors through an individualized patient assessment. Using a pre-test/post-test design, this approach demonstrated significant improvements in depressive symptoms, antiretroviral therapy adherence, and attentional processing speed.⁴³

Relevant for additional mHealth efforts by CBI, in the United States men who have sex with men (MSM) and transgender women (TW), especially those with criminal justice involvement, are disproportionately affected by HIV.⁴⁴ HIV prevalence estimates in jail populations are four times those of the general U.S. population, and for MSM and TW populations, the rates of incarceration are higher.⁴⁵ Furthermore, a majority of people in jail have substance use disorders.⁴⁶ The period following community reentry from incarceration is critical for addressing potential risks of HIV/sexually transmitted infection acquisition and negative sequelae of substance use. To address these issues, a mobile health intervention study was designed to reach a high-risk population at a critical point for increased risk of HIV infection, namely, MSM and TW who have substance use disorders and are leaving (or have recently left) jail.

The GeoPass Mobile App was designed from scratch using Java for Android devices,

Swift for iOS devices and using ASP.NET for Mobile Web applications. The app includes reminders, access details for service providers, positive automated feedback when services are used and goals attained, and messages from peer mentors. The app requires participants to provide feedback involving close-ended responses to four short questions about services accessed, in order to obtain the associated incentives. Incentives will be provided in the form of mobile gifts. A Geofencing feature was designed in the smartphone app to validate service utilization by participants. The intervention is intended to increase rates of service utilization and use of pre-exposure prophylaxis (PrEP) for HIV prevention over standard-of-care case management (provided to study participants in the control group). Thematically aligned with the rest of CBI's research portfolio, the ultimate goal of this app is reduction in health disparities in the HIV domain.

International efforts to create health information technology standards. While the specific projects of the Center mediated through HIT have a direct and beneficial effect on minority and under-resourced populations at a particular place, an important part of generalizing this impact beyond the specific site of implementation is the development and use of HIT standards.⁴⁷ Use of standard data models increases the likelihood that software applications built to deliver innovative informatics solutions to patients and health care organizations that require patient data can be implemented and used in other environments. Clinical decision support interventions that promote behavior change with consequent health benefits are more likely to see uptake if they use standards for knowledge representation that allow these interventions to execute in different HIT and organizational environments. Toward this end, Center faculty members have been active in international standards development efforts in HIT, with a focus on leadership in Health Level Seven International, which is the premier standards development organization in this space.⁴⁸ This has included standard programming languages for CDS such as the Arden Syntax.⁴⁹ This knowledge representation formalism has been implemented by several vendors in their electronic health record systems and at multiple sites worldwide. Compliance with this standard allows health care organizations to code and share artifacts such as clinical practice guidelines, electronic clinical quality measures, and order sets that can be shared, thereby facilitating knowledge dissemination, reducing the cost of knowledge engineering, and promoting evidence-based medicine. Generalizing from this specific technology in order to promote its use, CBI faculty members have helped lead efforts to provide practical advice regarding use of CDS by health care organizations, including publication of *Improving Outcomes with Clinical Decision Support: An Implementer's Guide, Second Edition*.⁵⁰ The book was named 2012 Book of the Year by the Healthcare Information and Management Systems Society (HIMSS), the largest professional organization for HIT in North America. Overall, by helping to develop HIT standards and leveraging them, the Center magnifies the impact of the technology it develops, thereby promoting more widely the reduction in health disparities that is a key goal of CDU and CBI.

Conclusion

In this paper, we have examined the role that an active Center for Biomedical Informatics at a minority-serving institution, in partnership with clinicians and health systems that cater to medically underserved and under-resourced communities, can play in utilizing biomedical informatics methods to help reduce health disparities experienced by these communities relative to other communities in the U.S. We highlight the importance of a multidisciplinary group of researchers at such centers to address not only the challenges of the development and deployment of HIT in under-resourced environments, but also the sociotechnical challenges and the appropriate standards to allow interoperability across multiple types of HIT and organizational environments. We plan to expand our footprint in these areas in several directions. First, we have invited a board of distinguished informaticians and industry leaders with sustained track records in this field to provide us with guidance on our growth. Second, we are in the process of developing an educational track with a focus on health informatics in under-resourced settings that will begin with a master's program and culminate in a doctorate, in a field where there is a dearth of programs with that particular focus. We believe that an increase in this type of center across the U.S. can enhance the targeted use of biomedical data to improve health outcomes for patients as well as help to educate clinicians and train students on the positive impact that biomedical informatics can have by providing multiple tools in the box to reduce health disparities.

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