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Healthcare Disparities, Origins, Outcomes and Opportunities in the United States of America

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Abstract

Health is the fundamental cornerstone for all activities, yet substantial inequities exist in the access to healthcare. Health equity is a fundamental goal in healthcare and public health, aiming to ensure that everyone can achieve their optimal health regardless of socially determined circumstances. A multitude of factors such as socioeconomic position, ethnicity, gender, sexual orientation, disability status, individually or in combination—can contribute to create circumstances that affect quality of life. The purpose of this paper is to 1) Delineate the challenges contributing to health inequity, 2) Identify the opportunities and 3) Outline a comprehensive strategy for managing and mitigating these disparities using the Innovation Think Tank Roadmap.

There is a myriad of opportunities to address the disparities in access to healthcare, and by leveraging a broad set of technological solutions and process improvements, patient outcomes can be improved. These solutions focus on reducing costs, improving healthcare quality, engaging and empowering patients, and simplifying access for patients. This strategy can be summarized by five “P”s: Personalization, Precision, Productivity, Prevention and Partnerships.

Together with Innovation Think Tank, Siemens Healthineers, RUSH aims to identify and develop opportunities and strategies to address healthcare disparities. This paper highlights these strategies, activities and approaches identified to address these healthcare disparities.

Keywords: Health equity, RUSH University System for Health, Innovation Think Tank, Artificial Intelligence

Introduction

Significant progress has been made in the field of global health over the last quarter century; nonetheless, inequities are driven by a range of variables both within and outside the healthcare system. Significant disparities in healthcare access between high- and low-income countries persist, resulting in rising mortality and illness rates associated with routine surgical needs, both in absolute terms and in comparison to other health improvements, particularly in the world's most economically challenged countries. Despite a rise in demand for surgical services due to an increase in the incidence of cancer, cardiovascular disorders, and metabolic disorders, approximately 5 billion people lack access to safe and cost-effective surgical services, with countries housing more than a third of the world's population accounting for only 6% of the total [1]. This shows that the pace and extent of progress in health equity have not been consistent across all regions or areas of focus.

If one delves deeper into the causes of these disparities and inequities, it becomes evident that some of them are indeed associated with systemic healthcare biases. Most of these disparities are linked to factors such as gender, culture, race, age, social status, economic conditions, and, most notably in recent times, mental health issues, all of which result in unequal care for many patients [2].

In the coming years, it is projected that the global population aged 65 and above will exceed the number of younger individuals worldwide. At present, the worldwide population of individuals aged 65 and older stands at 617 million, and by 2050, this figure is anticipated to rise to 1.6 billion [3]. This significant demographic shift can be attributed to several factors, including advancements in public health, improvements in medical care, and declining fertility rates. Nevertheless, with the aging of the population, healthcare costs see a substantial increase. Back in

2016, the spending for individuals aged 65 and older reached around 1 trillion dollars, and projections indicate a substantial surge to 6 trillion dollars by 2050 [4]. Additionally, it is noteworthy that once individuals surpass the age of 65, their annual healthcare spending on Hospital and Nursing Care Facilities exceeds the combined annual healthcare expenditure for all age groups [5].

We currently stand at a pivotal moment in history marked by big changes in the healthcare landscape, such as a shifting age demographic and the rise of machine learning (ML). Artificial Intelligence (AI) seeks to imitate human intelligence and has the potential to enhance decision-making across various domains, including healthcare. ML is a form of AI that involves algorithms that draw information from extensive datasets and acquire the knowledge necessary for making predictions. ML is becoming increasingly integrated into various aspects of healthcare, including the establishment of diagnostic, risk stratification, and patient recruitment tools. As the capabilities of ML expand, its potential in healthcare is extensive. For instance, ML models are utilized in predicting risk and outcomes of heart failure and atrial fibrillation [6, 7]. These tools have also been used in the diagnosis and treatment related decision making of diabetic retinopathy, different cancers and coronary artery disease. Benefits of AI have also surfaced in preventative care, medical robotics, and health services in rural or underserved areas. Additionally, patient centered care is expected to improve with the use of AI powered digital applications, specifically to communicate with patients who have limited English proficiency, a known risk factor for developing a greater number of medical complications.

Equity in health: Potential AI concerns

When examining the socioeconomic determinants of health, viz., hunger, access to care, housing, mental health, transportation, education, income and jobs, isolation, environment, and safety [8], it becomes evident that there exists a substantial disparity in life expectancy based on socioeconomic status and income. In the United States, men within the top 1% income bracket live 15 years longer than those in the lower percent. For women, this gap is slightly less but still significant, at nearly 10 years. This disparity is particularly stark in the city of Chicago, where a mere three or four bus stops can result in a 15-to-20-year difference in life expectancy. Additionally, individuals with lower levels of education face a 1.5 times higher risk of developing cardiovascular disease, and there is a clear association between poor mental health and an increased likelihood of experiencing cardiovascular-related issues. These socioeconomic disparities begin early in life and continue to widen as individuals age [9]. Racial disparities also represent a significant challenge, particularly in the United States. Over the next two decades, it is anticipated that African Americans will experience the highest incidence of cardiovascular disease [10].

Considering peripheral vascular disease within the context of cardiovascular disorders, for individuals dealing with peripheral vascular disease, frequently, a major amputation becomes the primary, and sometimes the only solution when confronted with limb-threatening ischemia. Surprisingly, majority of patients with limb-threatening ischemia do not undergo angiography, even though this procedure could substantially reduce the likelihood of amputation by over 90% [11]. Furthermore, over two-thirds of these patients do not receive revascularization before resorting to a major amputation. It is unfortunate that the likelihood of undergoing a major amputation is influenced by a range of factors, including one's identity, location, race, ethnicity, age, gender, socioeconomic status, and the specific hospital where they seek treatment for this condition [12].

When considering the African American population in the context of peripheral artery disease, it becomes apparent that there is a 2.3 times greater risk of critical limb ischemia among African American patients. They tend to present with more severe ischemia and are more likely to exhibit gangrene as opposed to ulcers or rest pain. Additionally, they have a higher prevalence of and more severe comorbidities, particularly diabetes and chronic kidney disease. Regarding gender disparities, African American females experience significantly higher rates of critical limb ischemia when compared to white females (53% vs. 43%). Furthermore, African American ethnicity is an independent predictor of amputation rates when comparing African Americans to whites [13].

There is also evidence to prove that low socioeconomic status and Black Race corelate to amputation rates in metropolitan areas in United States [14].

In the realm of structural and coronary heart disease, a parallel scenario of inequality emerges. Studies paradoxically show a higher prevalence of risk factors for atrial fibrillation (AF) in racial/ethnic groups (such as Black, Hispanic or American Alaska Native individuals), yet a lower prevalence of diagnosed cases suggesting under diagnosis in these groups. Additionally, Black and Hispanic patients are less likely to be prescribed guideline-based therapies, and suffer from higher rates of stroke, bleeding and mortality [15]. Furthermore, these ethnic groups are underrepresented in clinical literature and much remains to be known about the contribution biologic influence and racial bias has on the observed associations between ethnicity/race and cardiovascular disease [16].

Evident inequalities in health and life expectancy, notably within the city of Chicago, become apparent. An analysis of the community health needs assessments (CHNA), unveiled that common chronic ailment such as cardiometabolic disease and cancer, significantly contribute to premature mortality rates in the proximity of RUSH. These neighborhoods with reduced life expectancies are predominantly located in racially segregated communities marked by concentrated poverty, substandard housing, limited availability of nutritious food, unsafe streets, and suboptimal educational prospects.

While ML improves and gets more powerful in its ability to have a positive impact on public health, its use in healthcare raises concerns, particularly about bias, and its potential to exacerbate health disparities. For example, a study showed that a ML risk algorithm advised decreased healthcare evaluations for Black patients in contrast to White patients, most likely a result of the algorithm being trained on a dataset which represented unequal access and lower levels of care for Black patients [17]. This is one of many studied examples where the software is inherently and implicitly social biased against underrepresented communities. The ML assessments can only be as objective as the data presented to it, and therefore are prone to algorithm bias.

Mitigating algorithm bias and using ML to advance health equity

Biases can arise in various stages, including data collection (measurement biases), data selection (representation and minority bias), model training (algorithm bias), and model deployment (translation bias). There are opportunities to address potential biases at every stage of the ML model development. To diminish bias in training datasets, data from underrepresented groups should be included, perhaps through outreach programs and digital tools.

Patient specific information collected from electronic medical records (EMR), AI- powered mobile applications and wearable devices with sensors can be used to record and create large datasets which can be used for early cardiovascular disease prevention and management. Wearable devices should be validated to work on different skin tones and body types. Validated devices should be marketed to targeted populations and young adults to integrate its use into their daily routine. Health records should be encrypted and standardized protocols should be established for sharing and accessing anonymized patient health data. Digital health systems should be compatible and accessible through centralized platforms for the generation of large diverse datasets from which ML software can make objective recommendations.

Furthermore, social determinants of health can be embedded into ML algorithms for analysis, to provide personalized assessments for diverse groups of patients.

In 2016, RUSH University Medical Center implemented a health equity plan to combat these significant disparities within its main service region. The key steps included- the initiation of a healthcare equity strategy, the development of the RUSH health equity framework, which extended into the community through the establishment of West Side United (WSU), a collaborative effort focused on racial health equity, aligning with the City of Chicago's Healthy Chicago 2025 public health plan. Additionally, they adapted their health equity strategy in light of the COVID-19 pandemic and considered its implications for the future.

RUSH University Medical Center has invited Innovation Think Tank (ITT) to establish an operational hub within its premises, with the

mutual objective of working together to optimize care pathways and improve operational efficiency. Drawing upon ITT's extensive experience in over 2,500 research and strategy projects, access to its global co-creation resources, and expertise in developing more than 20 clinical disease pathways, the aim is to share their successful strategies and partner with RUSH in addressing the issue of healthcare inequality [18].

The collaboration between the ITT and RUSH is an integral aspect of identifying the solutions with the highest value for the customer and successfully commercializing a longitudinal network of care. The ITT cultivates innovation, entrepreneurship, and commercialization skills through its Capacity Building programs. These programs are tailored to address the specific issues or challenges of the region. By leveraging the ITT methodologies, RUSH identifies a holistic set of solutions that are assessed on their technology readiness level, cost, impact to patient outcomes, and impact on healthcare providers [18].

At RUSH, we propose a Capacity Building program designed to tackle health inequity challenges, with a strong emphasis on shifting from short-term, transactional approaches to long-term longitudinal strategies focusing on preventive measures through screening, early detection, and intervention rather than relying solely on treatment after the onset of disease. For patients without access to quality care, treatment is often administered after a diagnosis has been identified. This transactional approach does not yield outcomes as favourable to the patient compared to a longitudinal clinical pathway that focuses on monitoring the patient proactively to detect and intervene with care prior to the onset of disease.

Through this program, our objective is to explore the development of new, safer therapeutic devices and cost-effective interventions. Simultaneously, we aim to harness the capabilities of robotics, AI, and decision support analytics to develop a longitudinal clinical pathway that promotes equitable and accessible clinical, financial, and social outcomes.

This paper provides insights into institutions like RUSH University which has already been a forefront in building healthier communities. For over 2 decades now, RUSH has been working towards achieving health equity both within and outside of RUSH through various initiatives, programs, missions, and activities that are connected to education, workforce development, healthy food, and access to care.

This study identified 5 topics (the so called 5 Ps) that have opportunities to make the largest impact on improving access for patients:

Personalization: By engaging and impowering patients they become their own agents for seeking and receiving the care necessary to provide the best outcome.
Precision: By leveraging technologies with the highest readiness levels, the best quality healthcare can be offered to a larger population of patients.
Productivity: Through a combination of implementing new technologies and improving healthcare workflows, access to healthcare is expanded with minimal impact on available resources.
Prevention: Taking a proactive approach to a patient's health is the most effective form of keeping the patient healthy [19]. By implementing digital solutions to monitor and treat patients with minimal visits to healthcare facilities, the ease of access is drastically improved.
Partnerships: No single organization can tackle all the solutions on their own. Working collaboratively between ITT and all healthcare providers creates an effective system to improve patient outcomes.

Through collaborations, engaging and empowering patients, improving healthcare quality, optimizing efficiency and costs, and simplifying the patient experience, effective healthcare is accessible to a broader range of patients in a larger number of communities. This leads to an equitably quality of life and longevity across all demographics and regions.

RUSH, with its community-based practices, has engaged with school-based health centers which focuses on providing access to primary care and mental health services, immunizations, and preventive care to keep young people healthy and on track for successful adulthood. With its previous years of experience collaborating with community partners, RUSH has developed a health equity strategy to overcome disparities in health outcomes elsewhere as well. This was especially true during the COVID-19 pandemic where

immediately action protected people at higher risk.

Continuing these efforts and strategies at RUSH, a collaboration with ITT will bring in the key areas of expertise from ITT. This includes extensive stakeholder and community outreach and collaboration with other like-minded universities, institutions, and hospitals. Developing an innovation and co-creation mindset among the communities will produce proactive, innovative, cost-effective, and sustainable solutions protecting the health of all individuals.

Implementation

Undoubtedly, addressing health equity is a complex and ongoing process. Numerous organizations, policymakers, and healthcare providers need to and have been working to reduce these disparities through initiatives aimed at improving access to care, promoting preventive measures, and addressing social determinants of health. Digital technologies play a crucial role in enhancing healthcare accessibility and advancing outcomes on a global scale. This significance of digital tools became particularly evident amidst the challenges posed by the COVID-19 pandemic, where the need for inventive approaches to deliver healthcare services and information became paramount.

RUSH's invitation to establish an ITT lab underscores its unwavering dedication to continually enhancing healthcare access for all individuals, irrespective of their economic status, gender, age, education, social standing, or societal stigmatization. With its worldwide presence, ITT has garnered substantial experience and expertise in fostering local innovation, entrepreneurship, and commercialization. Utilizing the ITT methodology framework, this paper suggests an implementation roadmap plan that aligns with the vision of putting RUSH on the map for cutting edge cardiology and healthcare innovations [Figure 1].

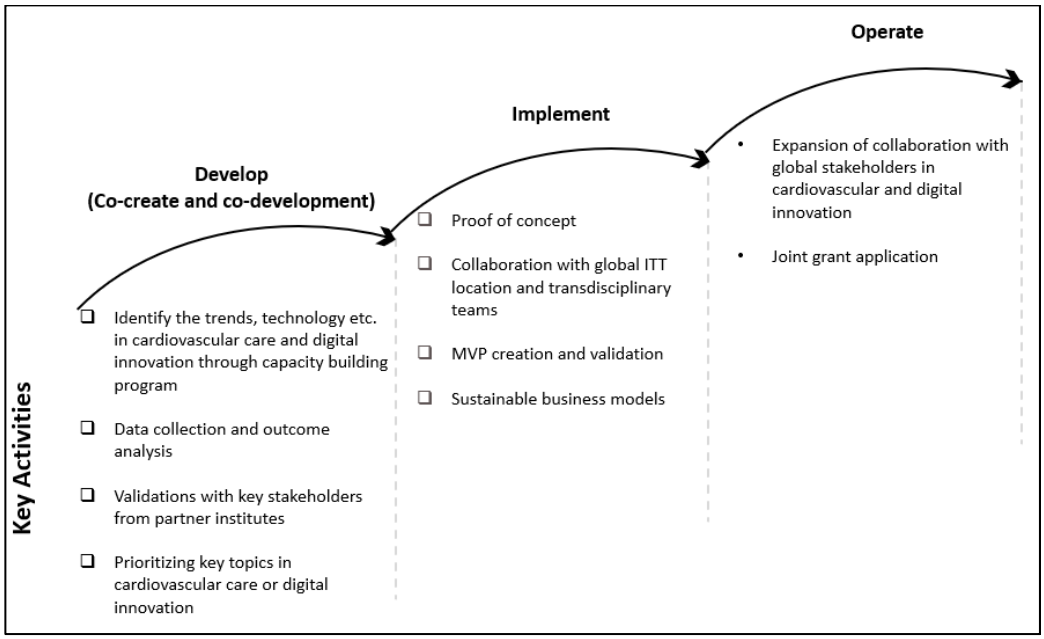

Figure 1: Implementation roadmap

The first step of this program would involve the organization of a robust Capacity Building program with a dual focus on cardiovascular care and digital innovations. This program can be designed to bring together participants with varying backgrounds and levels of experience, fostering a multidisciplinary environment where they will actively participate in co-creation and co-development exercises. Over the course of the program, participants will be introduced to the ITT innovation methodology, which will equip them with the skills to identify emerging trends, technologies, and challenges within the realms of cardiovascular care and digital innovation.

Furthermore, the program will incorporate key stakeholders from partnering institutes and subject matter experts, who will contribute their valuable insights and feedback, helping to refine and shape the proposed solutions.

In the second phase, the ideas proposed, or projects identified during the program are deep dived with focus on the realization of a successful Proof of Concept. Collaborations with global ITT partners and transdisciplinary teams will be prioritized to leverage their expertise. A minimum viable product (MVP) will be created and validated to ensure its viability. Simultaneously, sustainable business models will be explored to guarantee the project's long-term success. This phase represents a pivotal step in bringing innovative ideas to life and ensuring their viability in the real world. In the final phase, we aim to expand collaborations with global stakeholders in cardiovascular and digital innovations.

The implementation roadmap is designed with a particular emphasis on three specific pathways for advancing fair health outcomes by harnessing the combined strengths of ITT and RUSH [Figure 2].

- Develop **workforce** through continuous capacity development trainings and nurture a culture of innovation by fostering interaction and integrating best practices from global ITT partnerships. Utilize the global customer engagement potential offered by ITT to gain valuable insights into healthcare access challenges and the effective practices in use.
- Optimize the utilization of **technological advancements**, AI, decision support, big data, Internet of things (IoT), and new data platforms, and capitalize on ITT infrastructure frameworks such as labs and incubation centers to delve deep into exemplary transformative projects. ITT Labs provide the foundation for fostering innovation and crafting fresh solutions, making use of a range of digital resources, and tapping into the knowledge of experts from various fields.
- Simplify **operations** to achieve quick yet lasting outcomes. Evaluate and improve current workflows to enhance both the patient experience and staff contentment. ITT advisory provides support in identifying potential opportunities, formulating strategies, and implementing the roadmap to reach the organization's intended strategic objectives.

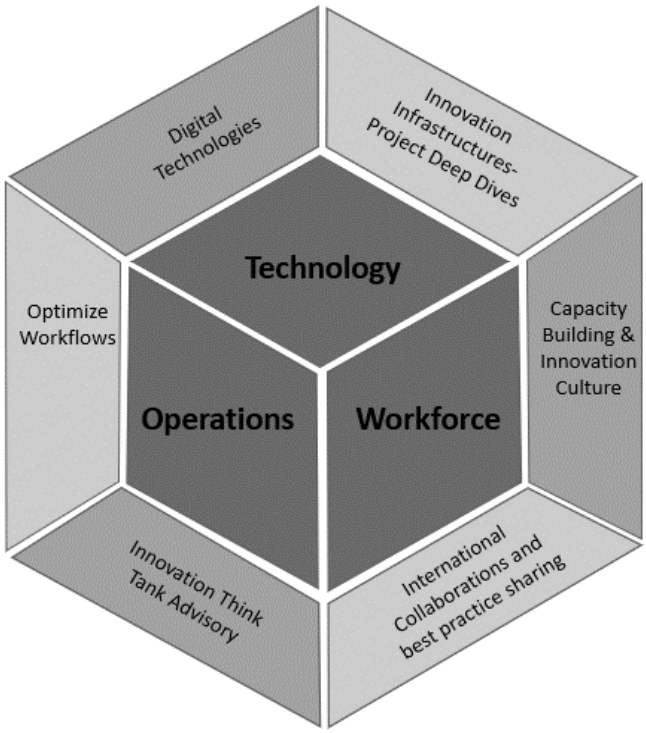

Figure 2: Three specific pathways for achieving equitable health outcomes: Technology, workforce, and operations.

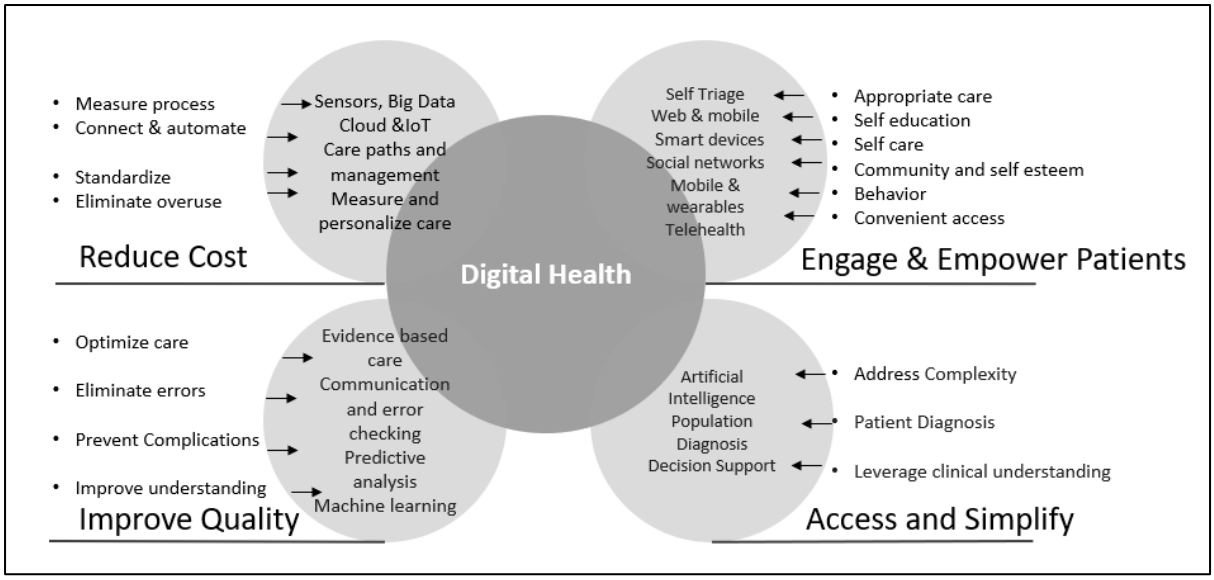

Figure 3: Digital Health Technologies for Optimal Solutions

Through the use of digital health, RUSH is dedicated to lowering expenses, enhancing quality, increasing access, simplifying patient care, and empowering its patients [Figure 3]. RUSH and ITT have collaborated to harness their synergies, bridging the gap between academia and industry, and accelerating the development of new products and services.

Conclusion

Let us be reminded of the words of Dr. Martin Luther King, Jr., that “of all forms of inequity, injustice in health is the most shocking and inhuman” [20]. While it may seem that addressing the broader socio-political factors contributing to health disparities is beyond our immediate control, it is imperative that we maintain our commitment to ensuring the accessibility of proven interventions and the ongoing persistence of initiatives aimed at reducing health inequities. The path to establishing a robust innovation framework that sustains the future of equitable healthcare lies in a commitment to research and development, the utilization of educational technologies for training, and the active involvement of key stakeholders, opinion leaders, and decision-makers in shaping and delineating the implementation process.

ML holds the potential to refine preventive care for cardiovascular disease, as is evident by the ML models in their various applications. In the years ahead, we can expect ML to be incorporated into existing healthcare systems and the development of new systems founded on these technologies. This presents us with a unique opportunity to prioritize our values and rebuild healthcare structures in a manner that improves patient outcomes, increases the value of care, and promotes equity. Given the early stage of ML implementation in preventive care, it is crucial for us to establish frameworks now that will shape our approach in the coming decades.

Author contributions

SH has established and confirmed the paper's framework as well as guided and initiated the paper's context. FH has provided crucial insights and inspirations for the health equity context. FN, SE, NN, BF and JV collected the data, analyzed the results, and added content to the whitepaper. All authors contributed to the paper’s drafting and approved the final version. The authors do not state any competing interests.

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Disclaimer

The information shared in this whitepaper is not an all-inclusive or comprehensive picture of the healthcare disparities in The United States and is a result of data collection through research and key opinion leader interactions. The key purpose of this paper is to provide pertinent information to decision makers, and budding innovators to systematically analyze the healthcare system and its respective impactful trends and challenges. Large language models were utilized for paraphrasing purposes only.

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