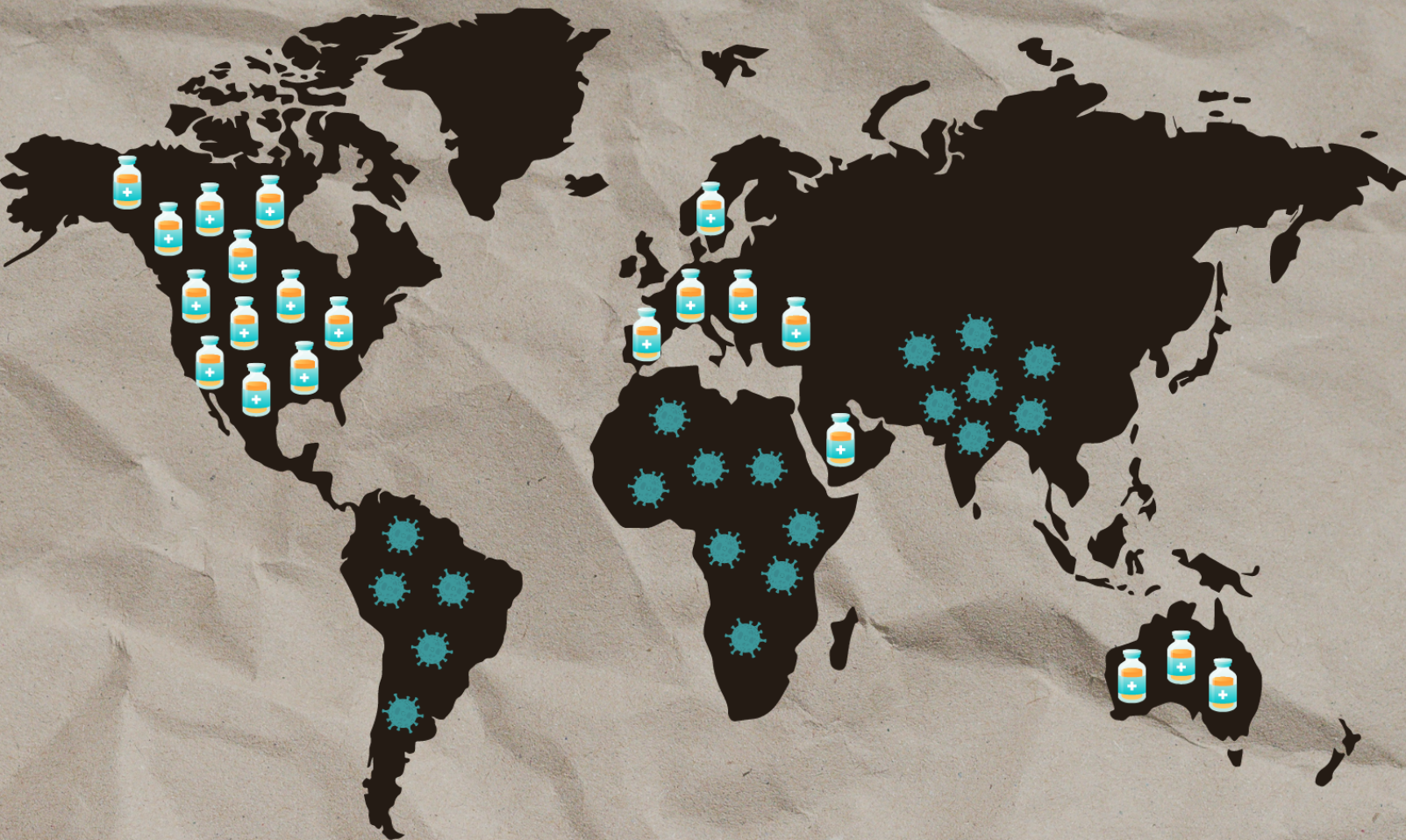


JUSTHealth

Issue 05 | Fall 2022



“The idea that some lives matter less is the root of all that is wrong with the world” – Dr. Paul Farmer

About the Web Publication

JUST Health is a community-sourced web publication hosted by the Center of Excellence at Stanford School of Medicine, dedicated to elevating the voices of the San Francisco Bay and beyond around health justice, activism, and advocacy. This publication is designed to spotlight thought, research, challenges, and inroads in health disparities, health inequity, and social justice in medicine, health and wellness.

The Team

Co-Editor-in-chiefs:

Derek Chen

Makaelah Murray

Staff Members:

Muhammad Khan, Social Media

Staff Editor:

Marcella Anthony, MPA

Editor Emeritus:

Melodyanne Cheng

Contact Us

JUSTHealth.stanford.edu

JUSTHealthStanfordSOM@gmail.com

All Rights Reserved. 2022 JUST Health.

Table of Contents

Letter from the Editors	4
Health is Wealth: The COVID-19 Pandemic as a Way to Understand the Connection between Global Stratification and Global Health through a Sociological Lens	5
The Impact of COVID-19 Pandemic on the Perinatal Mental Health of Asian Women	11
Trials of Triage: A Look into the Implicit Biases Prevalent in the American Medical System	13
Sickle Cell Disease Pain Management in California	18
The American Healthcare System is Failing Rural America	21
Biodegradable Cacti-based plastic; The new solution to limited availability and high operating costs of medical tools and devices	26
Acknowledgements	29
Corrections	29

Letter from the Editors

Welcome to the Fall 2022 issue of JUST Health!

This Letter from the Editors is different than the ones we (Derek & Makaelah) have published in the past. For two years, and across four issues (soon five), we have served as co-Editor-in-Chiefs. We'd like to reflect on the journey we've taken with JUST Health and where JUST Health is headed moving forward.

As 2022 comes to a close, we can't help but look back at how far we've come as a journal since our inaugural issue was released in 2020. A mere couple of years ago, the JUST Health Web Publication was an idea initially proposed by Melodyanne Cheng following her time with the then-Center of Excellence in Diversity in Medical Education (COEDME, now ODME) at the Stanford School of Medicine before attending medical school. As alumni of COEDME programs ourselves, we worked closely with Marcella to make the idea a reality.

Both of us are passionate about highlighting disparities in health through the voices of the community. As a society, we can learn from those most impacted by health disparity issues. Unfortunately, community voices aren't always highlighted in everyday media. Recognizing the media's lack of attention, we were motivated to rally behind JUST Health and turn it into the publication it is today: aiming to eliminate health injustices by providing a platform for community voices.

Over the course of two years and four issues, we have published over 40 authors! Very recently, we started a podcast & subscription-based newsletter with the help of many fantastic LEAP students.

Operating this journal has been an immense privilege for both of us and one that has taught us so much. As we approach new chapters in our lives, we believe in passing on the torch to the next iteration of JUST Health leadership and having innovative minds oversee JUST Health operations and its future. Although our team may be changing, our organization's mission remains unchanged: to elevate the voices of those who need it and ultimately commit to ending injustice in health.

We want to extend our deepest gratitude to every author, artist, poet, and countless others who graced JUST Health with their voice. To our audience & readers, we appreciate you for continually returning to our publication issue after issue. Furthermore, Marcella & Muhammad: You have been hugely instrumental in your invaluable contributions to the journal. Thank you, everyone, for raising JUST Health to new heights.

If you would like to get involved with JUST Health as a staff member, we will soon release more information on how to join our team. We can't wait to introduce the future Editor-in-Chief(s), and we look forward to seeing the new direction of the JUST Health Web Publication.

Finally, we stand with Ukraine. We stand with the protestors of Iran. We stand with the global community fighting against oppression, mistreatment, discrimination, racism, misogyny, homophobia, and antisemitism.

In justice and in health,
The JUST Health Editorial Board

"Injustice anywhere is a threat to justice everywhere." — Martin Luther King Jr.

Health is Wealth: The COVID-19 Pandemic as a Way to Understand the Connection between Global Stratification and Global Health through a Sociological Lens

By Nicole Boardman

No one was hit harder by the COVID-19 pandemic than those in low and middle-income countries (LMICs). Perhaps the most prominent case of this was in India, where we saw how the physical and financial burden of a global health crisis destabilized an entire country, which in turn had rippling effects on other LMICs. However, we must acknowledge that the pandemic did not create these issues; it simply spotlighted and exacerbated deeply rooted systems of inequality that suppress the development of countries and the health of their people. By bringing into scope the historical context of colonialism, we can trace back the origins of modern-day social and economic hierarchies on a global scale. Recognizing these power differentials are key to understanding why health infrastructure and health outcomes are so poor in LMICs compared to wealthy countries.

On December 14th, 2019, the first doses of the COVID-19 vaccine administered in the United States were given to healthcare workers, sparking a sense of hope across the country for an end to the coronavirus pandemic. For the United States, Canada, the United Kingdom, and other developed countries, the long-awaited end was very much in sight. This, however, was not the case for citizens of the developing world. According to a study by the British Medical Journal, over half of the reserved doses of available vaccines had been purchased by the world's wealthiest countries during the initial rollout, despite these countries only making up 14% of the world's population [1]. As wealthy countries began buying up all of the expensive, delicate, yet most efficacious doses produced by Pfizer-BioNTech and Moderna, low and middle-income countries (LMICs) looked to India to provide them with vaccines [1]. The Serum Institute of India, which is the largest vaccine producer in the world by volume, was contracted by COVAX, a global vaccine-sharing program co-run by the World

Health Organization, to manufacture AstraZeneca's cheaper, more durable vaccine [2]. In this deal, India was meant to produce and distribute 1.8 billion doses of the AstraZeneca vaccine to 92 LMICs [2]. However, in 2020, India experienced the worst COVID-19 outbreak in the world, with perhaps the highest death toll [2]. With the entire country overwhelmed by the virus, India made the decision to restrict vaccine exports and keep more doses for their own citizens [2]. Thus, citizens of LMICs were left without their promised vaccines as they were solely dependent on India.

Andrea Taylor, the assistant director of programs at Duke Global Health Innovation Center commented on the predicament, saying, "What's happened was not only highly predictable — it was predicted. We have put so many eggs in one basket with vaccine manufacturing in India. Unfortunately, it was a huge strategic error to expect one country to produce vaccines for so much of the world" [2]. The tragedy in India was devastating not only for its citizens but for people in

developing countries all over the world, and it is something that should not have happened. There are many factors that contributed to the lack of pandemic preparedness and recovery in the Global South, but the one overarching theme is vast global inequality. The COVID-19 pandemic did not create issues of global health; it simply spotlighted and exacerbated deeply rooted systems of inequality that suppress the development of countries and the health of their people. What are the root causes of global health inequalities? What has allowed these inequalities to persist for generations? What impacts did the COVID-19 pandemic have on local and global health systems?

To fully understand contemporary issues of global health, we must first understand the relationship between health and economic development. Historically, society has viewed and addressed issues of health using what is known as the Biomedical Model of Health, which suggests that health outcomes are a result of purely biological factors [3]. However, in recent years, especially in the wake of the COVID-19 pandemic, there has been a shift towards the Social-Ecological Model of Health, which suggests that one's health outcomes are influenced by factors beyond one's control, like race and nationality, or access to nutritious food and clean water [3]. In this model of health, there are many different levels, all interacting and influencing each other, from large-scale public policy, to interpersonal relationships [1]. Unlike the Biomedical Model, the Social-Ecological Model takes into account the important role that social, environmental, and psychological factors can have on one's health. By changing the way we conceptualize disease to be more

encompassing and holistic, we can explain the abundance of poor health outcomes we see in certain parts of the world despite us living in the most medically advanced era of human history. Doing so provides a more honest and accurate depiction of the root causes of disease and the factors that make some people more susceptible than others. Sociologists Bruce Link and Jo Phelan utilized the Social-Ecological Model when they came up with their Fundamental Causes Theory, which posits that certain social conditions like socioeconomic status, race, and gender are directly related to outcomes of health, illness, and longevity [4]. This theory is epitomized in global health trends today: people with the least amount of money and power have the worst health. We saw this in full force with the severe COVID-19 outbreak in India, where the surge predominantly affected the poor. When you live in a crowded urban slum, it is almost impossible to self-isolate. When your family will go hungry if you do not show up for work, there are no sick days off work. Through the Social-Ecological Model of Health and Link and Phelan's Fundamental Causes Theory, it's easy to see the interplay between poverty and health and why LMICs suffered more than wealthy countries from the direct and indirect effects of the pandemic.

To better understand the history behind global stratification and why it has been perpetuated for so long, it is important to acknowledge the role of colonialism and its modern remnants as driving forces of inequality. Because of the exploitation of their lands and peoples by colonial powers, countries in the Global South were set far behind colonial powers when it came to industrialization. Nations that were previously colonized were stripped of their

natural resources and politically displaced, while natives were traumatized by the abuse they often suffered from their colonizers. There is no denying that wealthy countries with a colonialist past gained the wealth and power they have today off the backs of the countries they exploited.

The relationship between colonialism and underdevelopment in the Global South is central to Dependency Theory. Developed by Raul Prebisch in the 1950s, Dependency Theory is defined as a “historical condition which shapes a certain structure of the world economy such that it favors some countries to the detriment of others and limits the development possibilities of the subordinate economics [5].” Essentially, the structure of the capitalist global economy inherently positions poorer countries at the bottom and keeps them there. As a result, poorer countries become economically and functionally dependent on richer countries. They are unable to develop and modernize independently, and they experience “persistent poverty as a consequence of capitalist exploitation [5].” This concept of dependency and how colonialism established the economic hierarchy that persists today is echoed in Wallerstein’s World Systems Theory. Wallerstein explains stratification in the world economy by grouping nations into one of three categories: core, semi-periphery, and periphery [6]. The semi-periphery and periphery countries function to grow the wealth of core countries by providing raw materials and cheap labor [6]. This idea of dependence and the rigid structure of the global economy proposed by Wallerstein is especially important when looking at what happened with India and the COVID-19 vaccine. India, in this case, is a

semi-peripheral country utilized by core countries to fulfill a need: vaccine production. Yet, the decision to have India— a country with poor health infrastructure that was evidently struggling to cope with the pandemic given widespread poverty throughout the country— be the sole producer of vaccines for the world’s lower and middle-income countries was undeniably a deliberate one. Why would wealthy countries rely on a less reliable vaccine producer? They wouldn’t, so wealthy countries produced vaccines for themselves and left the poorer countries to rely on India. Because of dependence, peripheral countries did not have the infrastructure or resources to recover from the pandemic the way core countries did without outside assistance. By analyzing global health disparities, we can see how colonialism has shaped power dynamics that created this economic hierarchy and set in motion the exploitation of semi-peripheral and peripheral countries.

Not only did colonialism literally create power differentials through political and economic instability, but it also created a culture and attitude that values Western people, practices, products, and ideas above all else. In the words of global health activist Dr. Paul Farmer, “The idea that some lives matter less is the root of all that is wrong with the world [7].” This sentiment allows inhumane health inequalities to persist readily. Dr. Farmer argues that this sort of unjust suffering is structural violence because it is a systemic way in which people are harmed and continue to be harmed [8]. In a world where space travel is possible, there is no reason children should be starving to death. How can we allow this to happen when we have every tool available to us to stop such easily preventable suffering? It is because racism,

classism, sexism, and other forms of discrimination are embedded in our history and pervade into the modern day, enforcing the idea that some lives matter more than others.

With colonialism setting global inequality in motion, one might wonder why certain countries have still not been able to develop and industrialize since the end of colonialism. Whereas Wallerstein explains the global economy via the interconnections between nations, Paul Collier focuses on what is happening within each individual country to explain the persistence of poverty in the modern era [9]. Collier suggests that periphery and semi-periphery countries are stuck within one or more “development traps” that prevent them from reaching economic independence and full participation in the global economy [9]. These development traps include the conflict trap, natural resources trap, landlocked with bad neighbors trap, and bad governance trap [9]. In their book *Poor Economics: A Radical Rethinking of the Way to Fight Poverty*, Abhijit Banerjee and Esther Duflo argue that health is another development trap [10]. The book explains that sickness keeps people poor, and poverty keeps people sick [10]. For example, low-wage laborers in developing countries are often exposed to unsafe conditions in the workplace, like hazardous fumes in a factory. Imagine that a factory worker could be the primary breadwinner of their family, and if they become sick, they can no longer work and provide for their family. Not only is the family’s poverty perpetuated, but the laborer’s health also cannot improve because they cannot afford treatment without an income. The development of entire countries can be halted by health alone. Take countries

like Zambia, for example, where more than half of the population is exposed to malaria [10]. The per capita income of countries where malaria is highly prevalent is extremely lower than those without malaria [10]. This can at least partly be attributed to the fact that the workforce is too sick to work, and therefore the country is too poor to invest in public health efforts to eradicate malaria [10].

The idea that health directly affects financial prosperity, and vice versa, was at the forefront during the COVID-19 pandemic. The New York Times called it the “Pandemic Inequality Feedback Loop,” where a health crisis like the COVID-19 pandemic has the power to exacerbate poverty, which in turn exacerbates illness, and a positive feedback system is created that makes poor people sicker and sick people poorer [11]. In the case of vaccine production, it would have made more sense from an ethical standpoint to prioritize vaccination for people who were most vulnerable to severe infection, such as people in developing countries who already have poorer health due to poverty. However, just as the priorities of the core countries guide political and financial decisions, they guide matters of life and death as well. Nonetheless, that doesn’t mean wealthy countries didn’t feel the impacts of leaving the developing world without a vaccine for so long. Without highly functioning periphery and semi-periphery countries, core countries cannot turn the same profit. With respect to health, we witnessed how a group effort needed to be made for any hope of putting an end to the pandemic. It didn’t matter if only some individuals took precautions or got vaccinated; it required us all to participate. Our world is too globalized for any of us to believe that, in the presence of a highly

infectious virus, the health of others does not affect our own.

From the global economic system to health disparities, there's no question that the COVID-19 pandemic fundamentally changed the way we see the world and how it works. We have been forced to rethink health on an institutional level and question the way healthcare and pharmaceutical systems have traditionally functioned. For example, the world now acknowledges the importance of public health or population-level health. Without a vaccine available for months – or for some, years – people were forced to shift from a reliance on medicines to reliance on their actions (like social distancing) for health solutions. Even the way we produce medicines has fundamentally changed. One would argue that the speed with which a vaccine was designed and produced was a feat of science and had never before been done. But this begs the question: what good is all of this innovation if such a large portion of the world cannot reap the benefits?

The pandemic didn't force the world just to question our healthcare systems; it forced us to question capitalism itself, specifically its role in health and pharmaceutical industries. What happened in India largely had to do with the fact that poorer countries could not afford the more expensive vaccines produced in core countries, hence the WHO contracting a country with low-wage workers to produce a cheaper vaccine. There is no reason why in a global health crisis, entire communities and even countries should not have access to life-saving medicines. As a result, Pfizer recently announced their Accord for a Healthier World, in which the company pledges to “provide all its current and future

patent-protected medicines and vaccines available in the U.S. or EU on a not-for-profit basis to 45 lower-income countries” and “calls upon global health leaders and organizations to join the Accord” in order to work toward bridging the gap in health inequities [12]. Pfizer's pledge is setting a precedent within ‘big pharma’ that large corporations do not have to stay the course that fuels inequality; they can choose to break free from the unjust social equilibria that perpetuate poverty and disease.

The COVID-19 pandemic was a rude awakening for the world in numerous ways, but primarily in the context of global health inequalities. We saw the calamitous fallout of generations of systematic inequality when India became so overwhelmed with COVID-19 cases that they were unable to fulfill its contract to provide other low and middle-income countries with much-needed vaccine doses. Historical, institutional, and cultural factors played a huge role in the way the pandemic disproportionately affected communities in the Global South. Colonialism shaped the way we view and treat people today, as well as helped create the economic hierarchy described in Wallerstein's World System. According to Collier, development traps are what's keeping people poor, and the pandemic has proved to us that perhaps the most pertinent trap is health. Poor health and poverty go hand in hand, and we cannot expect people to get healthier without improving their standard of living, nor can we expect to improve their standard of living without addressing health issues. The health crisis in India was a tragedy, and it shouldn't have happened, but we couldn't have expected any better with the way our world is set up to function. Although we cannot right

the wrongs of the past, we can choose to break away from systems of oppression and create new avenues for social change.

References

1. So AD, Woo J. Reserving coronavirus disease 2019 vaccines for Global Access: Cross Sectional Analysis. *BMJ*. 2020;m4750. doi:10.1136/bmj.m4750
2. Smith A. Covid-19: How India's crisis is inflaming global vaccine inequality. *NBCNews.com*. <https://www.nbcnews.com/news/world/covid-19-how-india-s-crisis-inflaming-global-vaccine-inequality-n1265968>. Published April 30, 2021. Accessed October 11, 2022.
3. Golden TL, Wendel ML. Public Health's Next Step in Advancing Equity: Re-evaluating Epistemological Assumptions to Move Social Determinants From Theory to Practice. *Front Public Health*. 2020;8:131. Published 2020 May 7. doi:10.3389/fpubh.2020.00131
4. Phelan JC, Link BG, Tehranifar P. Social Conditions as fundamental causes of health inequalities: Theory, evidence, and policy implications. *Journal of Health and Social Behavior*. 2010;51(1_suppl). doi:10.1177/0022146510383498
5. Secondi G. Dependency Theory: An Introduction. In: *The Development Economics Reader*. London: Routledge; 2010:58-64. <https://www.mtholyoke.edu/acad/intrel/depend.htm>
6. Wallerstein I. The Modern World-System as a Capitalist World-Economy. In: *The Modern World-System*. San Diego: Academic Press; 1989.
7. Powell A. Paul Farmer on Partners In Health, 'Harvard-Haiti,' and making the lives of the poor the fight of his life. *Harvard Gazette*. <https://news.harvard.edu/gazette/story/2018/05/harvards-paul-farmer-on-traveling-the-world-to-fight-inequality-in-health/>. Published February 21, 2022. Accessed October 11, 2022.
8. Farmer PE, Nizeye B, Stulac S, Keshavjee S. Structural violence and clinical medicine. *PLoS Medicine*. 2006;3(10). doi:10.1371/journal.pmed.0030449
9. Collier, P. *The Bottom Billion: Why the Poorest Countries Are Failing and What Can Be Done about It*. Oxford University Press, Oxford. 2008; 202–207.
10. Banerjee, A. V., and Duflo, E. *Poor Economics: A Radical Rethinking of the Way to Fight Global Poverty*. PublicAffairs. 2020.
11. Fisher M, Bubola E. As coronavirus deepens inequality, inequality worsens its spread. *The New York Times*. <https://www.nytimes.com/2020/03/15/world/europe/coronavirus-inequality.html>. Published March 15, 2020. Accessed October 11, 2022. <https://www.nytimes.com/2020/03/15/world/europe/coronavirus-inequality.html>.
12. Pfizer Launches 'an Accord for a Healthier World' to Improve Health Equity for 1.2 Billion People Living in 45 Lower-Income Countries. *Pfizer*. <https://www.pfizer.com/news/press-release/press-release-detail/pfizer-launches-accord-healthier-world-improve-health>. Accessed October 11, 2022.

The Impact of COVID-19 Pandemic on the Perinatal Mental Health of Asian Women

By Mikayla Malonzo Gomez

This research study looks at how the COVID-19 pandemic has affected the perinatal mental health of Asian women in the United States. It specifically examines how rising COVID-19 cases, social distancing protocols, and Asian hate crimes contributed to heightened levels of depression, anxiety, and stress among 6 case study participants. The case study participants were selected based on the following criteria: Asian ethnic heritage, female-identifying gender, and having to be pregnant or given birth during the COVID-19 pandemic. Those who agreed to be part of the research study came from middle-class backgrounds. The study method utilized quantitative research and qualitative research. Quantitative research was conducted via Qualtrics, and qualitative research was conducted via Zoom. It was discovered that the rise of COVID-19 cases increased stress levels among almost half of the study participants as they strongly feared for their health and their families. Social distancing protocols caused many of the study participants to feel heightened levels of anxiety and/or depression due to protocols that limited the number of guests during doctor visits. Moreover, the rise of Asian hate crimes increased the levels of fear and anger among the study participants. Bringing awareness to the rise of perinatal mental health issues among Asian women in the United States is crucial to saving the lives heavily affected by the COVID-19 pandemic.

Methods

Qualtrics, an online survey software, was utilized in this year-long research study in order to gain demographic information about the case study participants as well as their initial opinions on how the COVID-19 pandemic affected their perinatal mental health. Some questions asked were: "What is your current occupation? "How many times do you read or watch news about the COVID-19 pandemic?". Once the case study participants completed the Qualtrics survey, Zoom meetings were conducted in order to gain deeper insight into the case study participants' prenatal and postnatal experiences during the peak of the COVID-19 pandemic. A few questions asked were "Have you experienced any significant mood changes while pregnant during the COVID-19

pandemic? If so, what kind of emotions? Has your partner, family members, or friends been supportive of you and your baby during the COVID-19 pandemic?".

Results

From the data collected, 45% of the case study participants felt an intense amount of stress as the spread of COVID-19 increased. The case study participants recounted stress surrounding the spreading of COVID-19 to their family members, as the majority of the case study participants work in the medical field. Furthermore, 60% of the case study participants felt heightened levels of anxiety, depression, and/or loneliness as new mothers due to the strict social distancing protocols that took effect during hospital visits/births. Lastly, 35% of the participants experienced

increased levels of stress, anxiety, and/or depression due to the rise of Asian hate crimes during the peak of the COVID-19 pandemic. The case study participants were fearful for their lives as well as the lives of the elderly family members.

Discussion

This research study is just the tip of the iceberg exploring the impact of the COVID-19 pandemic on the perinatal mental health of Asian women. The COVID-19 pandemic brought a unique set of circumstances that the case study participants had to adapt courageously to. As we emerge from the COVID-19 pandemic, it is important to continually provide accessible counseling to Asian women of all socioeconomic

backgrounds due to the various levels of trauma that were experienced these past two years. Moreover, safe spaces for Asian women who have experienced similar perinatal mental health issues should be encouraged as a way to build community and provide support to one another. Lastly, raising awareness about the rise of perinatal mental health among Asian communities could help save the lives of many women and encourage healthy coping mechanisms for those who have been heavily impacted by the COVID-19 pandemic.

References

O'Hara MW, Wisner KL. Perinatal mental illness: definition, description and aetiology. *Best Pract Res Clin Obstet Gynaecol*. 2014 Jan;28(1):3-12. doi: 10.1016/j.bpobgyn.2013.09.002.

Trials of Triage: A Look into the Implicit Biases Prevalent in the American Medical System

By Patrick Ting, Aayaan Sahu, Nishad Wajge, Vineet Rao, Hires Poosarla, and Dr. Phil Mui

In light of the COVID-19 pandemic and the health crisis left in its wake, our goal is to develop extensive machine-learning techniques to provide a clear picture of the treatment, and possible mistreatment, of specific patient demographics during hospital triaging.

We aim to reveal whether a patient's treatment and hospital disposition is related to the following attributes - Emergency Severity Index (ESI), gender, employment status, insurance status, race, or ethnicity. We define ESI as a five-level emergency department triage algorithm that provides clinically relevant stratification of patients into groups from 1 (most urgent) to 5 (least urgent) on the basis of acuity and resource needs.

Our work is separated into two parts - the classification task and data analysis. As part of the classification task, we train a model to classify patients as either "Admitted" or "Discharged," given the aforementioned attributes. We then analyze the data using SHapley Additive exPlanations (SHAP) values to determine the importance of each attribute.

Our findings show that significance varies for each attribute. Notably, we found that patients with private insurance programs receive better treatment compared to patients with federal-run healthcare programs (e.g., Medicaid). Furthermore, our results suggested that a patient's ethnicity has a greater impact on treatment for patients under 40 years of age than that for patients over 40 years of age for any given ESI level.

We, therefore, conclude that although hospitals may not be doing so intentionally, there is a systemic bias in hospital triaging for specific patient demographics. We would suggest eliminating or greatly reducing the consideration of a patient's medical insurance status or other non-condition-related factors that our current healthcare system factors in. For future works, we hope to aggregate additional patient data from hospitals to find whether specific demographics of patients receive better healthcare in different parts of the United States. We also plan to implement a decision-making algorithm to predict a patient's ESI given factors such as previous health problems, current condition, and other condition-related factors. Moreover, our algorithm will be blind to factors such as insurance status, race, and religion.

Background

Ever since the advent of hospital triaging, and now prominently within the past few years of the COVID-19 pandemic, bias, implicit or not, has affected how patients of different demographic groups are prioritized for emergency room admissions and how medical supplies are allocated. Understanding the underlying causes of this phenomenon

and exactly how this can favor select demographics over others is crucial to creating a fair, effective, and beneficial method of triaging patients, especially in underserved communities.

Currently, over 80% of hospitals employ the use of the Emergency Severity Index (ESI), a five-level triage tool used to help medical practitioners allocate resources.

The ESI takes into account acuity (the level of nursing care needed by the patient) and resource needs. Previous studies found that certain minorities receive a higher ESI level (thereby fewer medical resources) than Caucasians, leading to unfair treatment of patients despite the same symptoms [1-2]. In 2009, the American Hospital Association reported the following survey data in which hospitals reported which triage system they used: ESI (57%), 3-level (25%), 4-level (10%), 5-level systems other than ESI (6%), 2-level or other triage systems (1%), no triage (1%) [3].

Methods

Data Preprocessing

We utilized a dataset from Kaggle, which consisted of de-identified patient data at a triage facility [4]. Each patient had 972 features associated with them, including “ESI,” “Age,” “Gender,” “Ethnicity,” “Race,” “Employment Status,” and “Insurance Status.” We condensed the original dataset to include the features described above and some significant others. In order to prevent creating any data points artificially, we excluded any patients that contained a null value for any feature. We then trained models that could predict whether or not a patient is admitted to a hospital. Subsequently, we incorporated SHAP values to interpret which features the model prioritized when making a prediction.

Random Forest

The random forest algorithm is a classification algorithm categorized under ensemble learning [5,6]. It utilizes multiple decision trees, each weaker than the entire classifier, along with bootstrapping — a sampling technique where individual trees get smaller subsets of the training dataset [7].

Random forest also uses feature randomness, where every tree being trained gets a subset of features to train on. The random forest algorithm takes the predictions from its decision trees and performs a majority vote, outputting a final prediction. We trained a Random Forest Classifier model on the data to determine a patient’s disposition.

Shap Values

Shap Values is an algorithm that identifies features with the highest importance in machine learning models to provide greater transparency as to which factor carried the greatest weight in overall result determination [8,9]. We implemented the algorithm to evaluate the classifications of the random forest model.

Results and Discussion

Interpreting Results

The graphs outputted by the Shap Value computations result in a horizontal bar graph. This bar graph is ranked by the most important features. The feature that is highest on the plot has impacted the model’s decision the most. The blue or red bars represent the average impact on model output for either decision, “Admit” or “Discharge”. While we did control our study for patient identity factors such as race, gender, and age, we found the most significant results in examining the effect of one’s insurance status and employment status on hospital triaging.

Insurance Status

For patients with private insurance, their insurance status was the most important factor, even toppling ESI, that the model considered when making a prediction for a patient. This suggests that hospitals mainly

consider a person's ability to pay for their own medical treatment in the patient's admission or discharge, as shown in [Figures 1 and 2](#).

Employment Status

For full-time employees, their employment status was the third most considered factor; however, for the unemployed patients, their employment status was the fifth most considered factor, indicating that our model primarily weighed based on whether patients were employed. In addition, for unemployed patients, race had more weight in the model's decision compared to the patients who worked full-time. More specifically, for unemployed patients, the model ranked their race as the 6th most important factor, while for the full-time patients, the model ranked their race as the 8th most important factor.

ESI and Age

Consistent through every ESI level, for the age ranges of 18-39, race was a higher considered feature than for patients whose age is 40 or greater. For patients that had an ESI of 3, our model ranked their race as the 6th and 5th important feature for the age ranges of 18-24 and 25-39, respectively, and the 8th and 9th most important feature for the age ranges of 40-64 and 65 plus, respectively.

Discussion

With our analysis, we found a relative positive correlation between our tested factors of the patient's employment and insurance status and their disposition within the hospital's operation theater. Other factors that we tested included patient ethnicity and gender, whose correlation with patient admission and discharge was also strong,

albeit less than that of the aforementioned employment and insurance statuses. To summarize our results, patients with private insurance or who could pay out of pocket for their medical costs prove to be significantly prioritized over those reliant on Medicaid insurance. Overall, our data suggest that, over the past eight years, implicit bias against certain patient demographic groups has been prevalent in the American medical system, which points toward future measures that should be taken to curb the effects of systematic bias.

Conclusion

We believe that the same implicit bias against certain social groups or demographics evident in hospital triaging systems reflects similar causes for the rise of police brutality, which is primarily driven by data of certain racial groups as it pertains to crime rates. Similarly, as hospital triaging software is algorithms based purely on past data and records, it is expected that there should exist some sort of skewness in prioritization programs in deciding which patients to admit or discharge next. Simply put, under-representative or misrepresentative data that is fed into algorithms that are integral to hospital admission processes lead to real consequences for minority groups, leading to potentially decreased quality of patient care or even access to medical resources.

We would suggest eliminating or greatly reducing the consideration of a patient's medical insurance status or other non-condition-related factors that our current healthcare system factors in. In either case, we look towards a future in which hospital admissions factor in the sole factors of need,

urgency, and accessibility into patient care to provide effective treatments to those who require it the most.

For future work, we plan to implement a decision-making algorithm to predict a patient's ESI given factors such as previous health problems, current condition, and other condition-related factors. Moreover, our algorithm will be blind to factors such as insurance status, race, and religion.

Acknowledgments

We would like to thank Dr. Phil Mui for his invaluable support and guidance for our research. We would also like to thank the Aspiring Scholars Directed Research Program for giving us the platform to conduct this research.

Data Availability

The source code for this project, as well as links for our trained models and dataset, are available at https://github.com/pting302/AI_for_Bias_Detection_Healthcare.

References

1. Paulus, Jessica K., and David M. Kent. "Predictably Unequal: Understanding and Addressing Concerns That Algorithmic Clinical Prediction May Increase Health Disparities." *Nature News*, Nature Publishing Group, 30 July 2020, <https://www.nature.com/articles/s41746-020-0304-9>.
2. Vigil, Jacob M, et al. "Patient Ethnicity Affects Triage Assessments and Patient Prioritization in U.S. Department of Veterans Affairs Emergency Departments." *Medicine*, Wolters Kluwer Health, Apr. 2016, <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4998763/>.
3. McHugh, Megan, et al. "More Patients Are Triageed Using the Emergency Severity Index than Any Other Triage Acuity System in the United States." *Academic Emergency Medicine : Official Journal of the Society for Academic Emergency Medicine*, U.S. National Library of Medicine, 2012, <https://pubmed.ncbi.nlm.nih.gov/22211429/>.
4. Mafau, Ma'alona. "Hospital Triage and Patient History Data." *Kaggle*, 3 June 2019, <https://www.kaggle.com/datasets/maalona/hospital-triage-and-patient-history-data>.
5. Lundberg, S. M., Erion, G., Chen, H., DeGrave, A., Prutkin, J. M., Nair, B., Katz, R., Himmelfarb, J., Bansal, N., & Lee, S.-I. (2020). From

- local explanations to global understanding with explainable AI for trees. *Nature Machine Intelligence*, 2(1), 56–67. <https://doi.org/10.1038/s42256-019-0138-9>
6. Dietterich, Thomas G. "Ensemble Learning." *CSE446: Machine Learning*, 4 Sept. 2002, <https://courses.cs.washington.edu/courses/cse446/>.
 7. Hesterberg, Tim. "2011 - Wires Computational Statistics - Wiley Online Library." *Bootstrap*, 3 Sept. 2011, <https://wires.onlinelibrary.wiley.com/doi/abs/10.1002/wics.182>.
 8. Futagami, Katsuya, et al. "Pairwise Acquisition Data Science, Elsevier, 9 Mar. 2021, <https://www.sciencedirect.com/science/article/pii/S24059n>
 9. Prediction with Shap Value Interpretation." *The Journal of Finance and* 18821000015.
 9. Trevisan, Vinícius. "Using Shap Values to Explain How Your Machine Learning Model Works." *Medium, Towards Data Science*, 5 July 2022, <https://towardsdatascience.com/using-shap-values-to-explain-how-your-machine-learning-model-works-732b3f40e137>.

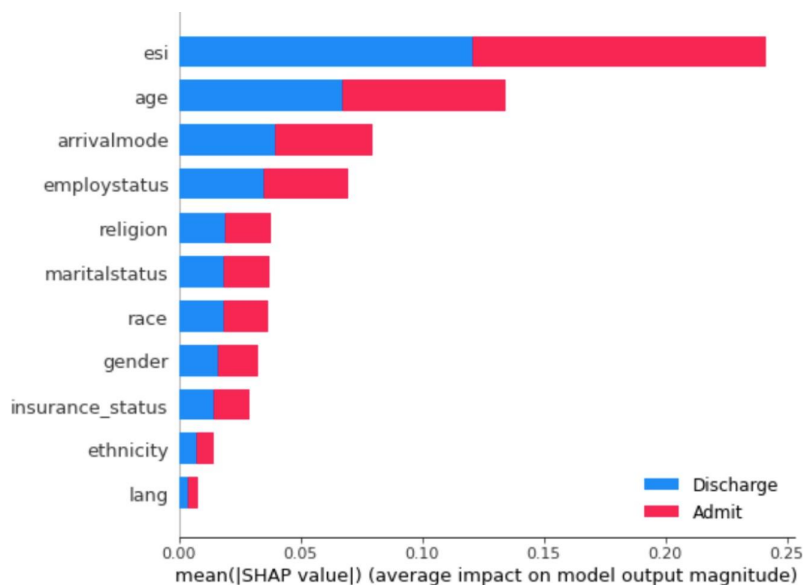


Figure 1: Feature importance of patients with Medicaid (public insurance) using 500 samples (SHAP)

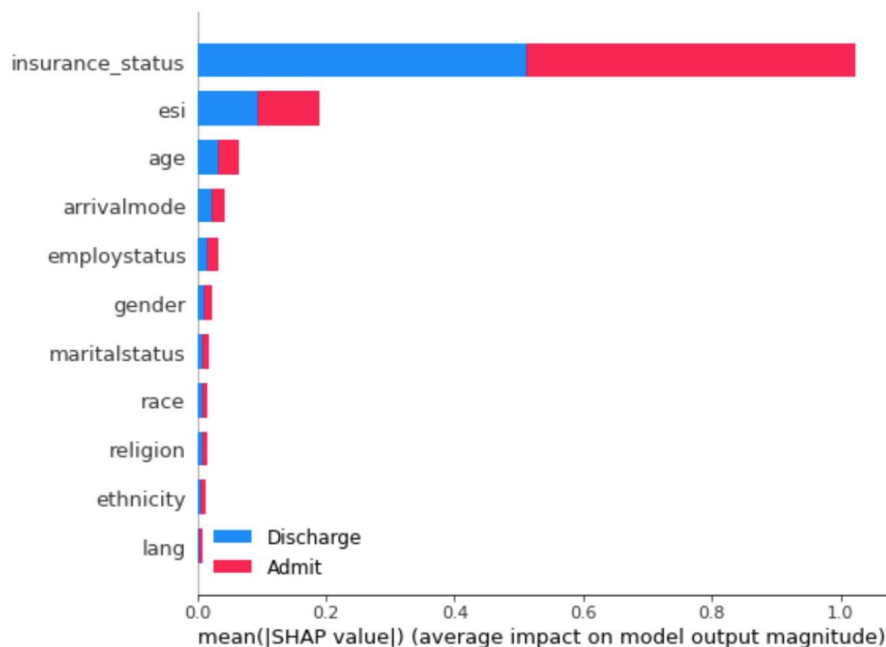


Figure 2: Feature importance of patients that chose to self-pay (private insurance) using 500 samples (SHAP)

Sickle Cell Disease Pain Management in California

By Brandon Aguilar, B.S., Elizabeth McCarthy, B.S., Alejandra Moreno, M.S., Dominique Villaseñor, B.S., Xueyi Yang, B.S.

Policy brief addressed to CA Legislators: Pain crisis is the most common reason for sickle cell disease (SCD) patients to visit the emergency department (ED). The sickle-shaped red blood cells can disrupt oxygen delivery and blood flow, resulting in mild to severe pain lasting for any length of time. SCD affects Black or African-Americans disproportionately, with occurrences of about 1 in 365. Chronic pain accompanied by frequent visits to urgent care leads to poorer quality of life and can reduce life expectancy by 30 years. This policy brief shows that California can minimize the barriers to SCD patients' access to effective pain management by facilitating acute pain management training in the ED, increasing the number of SCD treatment specialists, and allocating state funding for SCD treatment and research.

Introduction

Sickle cell disease (SCD) is an inherited, genetic red blood cell disorder. The sickle-shaped red blood cells affect oxygen delivery and blood flow. Symptoms of SCD include swelling of hands and feet, jaundice, frequent infections, and pain crises. SCD mainly affects people of color, specifically Black or people of African descent and Hispanics [1].

Pain crises arise from blocked blood flow that can last for any period of time. Standard pain management includes over-the-counter analgesics, such as ibuprofen or acetaminophen, or in more severe cases, opioids. Healthcare professionals are cautious in prescribing opioids for pain treatment due to a concern for opioid addiction and overdose; however, only about 10% of SCD patients become addicted, which is comparable to other patient populations with chronic illnesses [2].

Opioids are an effective treatment for severe pain, but SCD patients are forced to endure the pain due to stigma and healthcare professionals' fear of opioid addiction. SCD patients often resort to ED for pain relief

because their current prescriptions are not strong enough. Pain and disease management with SCD is limited within our current healthcare system, with only a few FDA-approved drug therapies readily available [3].

Statement of organization interest

SCD was the first described disorder with known molecular and genetic components [1]. The initial knowledge of its molecular mechanism was channeled into newborn screenings that have helped with early detection and treatments [4]. In addition to being genetically predisposed, the Black and Brown communities are affected unequally based on institutional racism and socioeconomic factors, which leads to generations of adverse experiences in the healthcare settings and further reinforces the existing health disparities [5]. As a result, lower quality care, less clinical preventative care, and decreased participation in clinical trials have all impacted the sickle cell community's treatment plans and quality of life. Despite the many barriers that impact equitable healthcare, people of color still are

inclined to participate in clinical trials if they are asked [6]. However, limited research funding has restrained further advances in diverse treatment options, disease management, and SCD-related education.

Policy Recommendations

Recommendation 1: Yearly training and refresher courses for Emergency Department (ED), internal medicine, family physicians, and healthcare staff about SCD and pain management

Strengths: Individuals with SCD mainly rely on EDs for pain management. On average, the annual healthcare resource utilization and cost for SCD individuals were \$20,206. Patients with more than three episodes of pain crises in a year account for an average of \$58,950 [7]. An established curriculum would become an investment in preventative care services. A curriculum with a focus on preventive care would decrease the frequency of individual visits for patients seeking pain management by providing the appropriate resources and services at the first encounter. By equipping patients with the suitable resources and knowledge to manage their health, they are able to avoid recurring healthcare costs to the patient and our overall healthcare system. Refresher courses would be more cost-effective because the same modules could be utilized multiple times across healthcare systems with new updates yearly. A well-rounded understanding of SCD and sickle cell trait can better help address patient complaints, symptom management, and reduce the economic impact on the ED.

Weaknesses: Implementing a broad spectrum of courses will require time and a budget. A

training course will need to be developed with experts in SCD and pain management to avoid implicit bias. Facilitators will require additional training to administer the training courses. Nonetheless, these coordinating efforts and costs are small compared to the benefit to those with SCD and sickle cell traits.

Recommendation 2: More hematologists in treatment and care management dedicated to SCD patients

Strengths: Specialists are a vital component of the patient care of SCD patients. Particularly, hematologists are equipped to address SCD-related issues such as iron overload from chronic red cell transfusion and chronic pain management. Patients will be able to build trusting relationships with their providers and establish chronic care management to avoid sole reliance on the ED for their care.

Weaknesses: The high demand for specialists, especially for SCD-related issues, often results in delayed care. Other healthcare barriers, such as insurance coverage, further condense the pool of available providers to SCD patients. Despite 65% of SCD patients being covered by Medicaid and Medicare, only 10% of Medicaid patients have access to a specialist [1]. Even though specialists have limited accessibility, SCD patients can still benefit greatly from their other healthcare teams to manage their symptoms and improve their quality of life.

Recommendation 3: Increase funding for treatment and research for SCD

Strengths: Hydroxyurea is a chemotherapy medication used to treat individuals with SCD since the 1980s [8]. In 2017, Endari (L-glutamine) became the second

FDA-approved medication for sickle cell [9]. Together with Adakveo (Crizanlizumab) and Oxbryta (Voxelotor)'s approval in 2019, there are currently a total of four FDA drug therapies for SCD. More research to develop new pain treatments and SCD treatment will allow for more therapeutic options.

Weaknesses: Improvement of healthcare infrastructure requires legislative authorization. Increased funding will dedicate grants for research to enhance SCD treatment and care management further. However, recruiting experienced personnel to conduct the research would require significant time and effort.

References

2019-ATCS-Full-Summary-of-Proceedings-.Pdf
<https://www.gbt.com/wp-content/uploads/2020/03/2019-ATCS-Full-Summary-of-Proceedings-.pdf>. Accessed 6 Apr. 2022.

Opioid Crisis Adds to Pain of Sickle Cell Patients | NHLBI, NIH.
<https://www.nhlbi.nih.gov/news/2017/opioid-crisis-adds-pain-sickle-cell-patients>. Accessed 6 Apr. 2022.

What Medications Are Used for Sickle Cell Disease? Sickle-Cell.com. Published 2020. <https://sickle-cell.com/medications>

Feuchtbaum L, Dowray S, Lorey F. The context and approach for the California newborn screening short- and long-term follow-up data system: Preliminary findings. *Genetics in Medicine*. 2010;12:S242-S250. doi:10.1097/gim.0b013e3181fe5d66

Mccormick M, Osei-Anto HA, Martinez RM, eds. Board on Population Health and Public Health Practice, Health and Medicine Division. In: Committee on Addressing Sickle Cell Disease: A Strategic Plan and Blueprint for Action. National Academies Press; 2020.

Committee on Addressing Sickle Cell Disease: A Strategic Plan and Blueprint for Action, Board on Population Health and Public Health Practice, Health and Medicine Division, National Academies of Sciences, Engineering, and Medicine. Addressing Sickle Cell Disease: A Strategic Plan and Blueprint for Action. (McCormick M, Osei-Anto HA, Martinez RM, eds.). National Academies Press; 2020.

Shah N, Bhor M, Xie L, Paulose J, Yuce H. Medical Resource Use and Costs of Treating Sickle Cell-related Vaso-occlusive Crisis Episodes: A Retrospective Claims Study. *J Health Econ Outcomes Res*. 2020;7(1):52-60. Published 2020 Jun 15. doi:10.36469/jheor.2020.12852

Hydroxyurea-Booklet.Pdf.
<https://www.hematology.org/-/media/Hematology/Files/Education/Hydroxyurea-Booklet.pdf>. Accessed 6 Apr. 2022.

Evidence-Based Management of Sickle Cell Disease: Expert Panel Report, 2014 | NHLBI, NIH.
<https://www.nhlbi.nih.gov/health-topics/all-publications-and-resources/evidence-based-management-sickle-cell-disease-expert-0>. Accessed 6 Apr. 2022.

The American Healthcare System is Failing Rural America

By Ethan Beltrand

Healthcare serves as a necessity for all Americans. However, for rural Americans, many healthcare-related disparities affect the way some citizens go about receiving such care. Citizens living in rural regions of the United States face some of the largest disparities within various healthcare systems. Eliminating these disparities is fundamental to the success of equitable treatment for every patient in the United States. The purpose of this study was to examine the different healthcare-related disparities associated with the communities of rural Minnesota and to analyze these disparities to determine potential solutions to this ongoing epidemic. The data in this project was pursued through an extensive literature review of current scientific publications. The findings of this study displayed that rural Americans are at a disadvantage in terms of receiving adequate healthcare.

Access to healthcare services is critical to good health, yet rural residents face a variety of barriers to getting those services. Community residents should be able to conveniently access affordable healthcare services such as primary care, dental care, behavioral health, emergency care, and public health services. Access to healthcare is important for many reasons, including overall physical, social, and mental health status, disease prevention, detection, diagnosis, treatment of illness, quality of life, avoiding preventable deaths, and life expectancy. Rural residents often encounter barriers to healthcare that limit their ability to obtain the care they need. In order for rural residents to have sufficient access, necessary and appropriate healthcare services must be available and obtainable in a timely manner. Even when an adequate supply of healthcare services exists in the community, there are other factors to consider which may hinder patients from getting the care they need and deserve.

Rural populations have more limited access to primary care physicians compared to their urban counterparts. For example, travel

to reach a primary care provider may be costly and become a burden for patients living in such areas, especially because subspecialty care is often located even further away. As a result, these patients may decide to postpone or completely forego care. These barriers to healthcare options result in unmet needs, including a lack of preventive and screening services and treatments. While access to medical care does not guarantee great overall health or treatment, access to healthcare is critical. The many challenges that rural residents face in accessing healthcare services significantly contribute to the health disparities that these communities face [1]. Direct barriers for rural communities include the distance needed to travel to obtain healthcare services, healthcare workforce shortage, inaccessibility to health insurance coverage, lack of broadband access, and lack of health literacy. These direct barriers are further addressed and discussed throughout this review.

Distance

The distance rural populations need to travel to obtain access to healthcare services,

particularly subspecialized services, serves as a primary factor in the inability of rural populations to receive adequate healthcare services. This can be a significant burden in terms of travel time, cost, and time away from work. In addition, the lack of reliable transportation is also a barrier. In urban areas, public transit is generally an option for patients to get to medical appointments; however, public transportation services are often unseen in rural areas [2]. To aid in resolving this barrier, some larger healthcare systems provide transportation services for patients in rural communities. The Mayo Clinic Health System connects patients and community members to free or low-cost programs and services to find transportation [3]. The University of California San Francisco provides free transportation to and from health care appointments for individuals that have no way to get to an appointment and are covered by a Medi-Cal plan [4].

Workforce Shortages

Healthcare workforce shortages impact healthcare access in rural communities. A shortage of healthcare professionals in rural areas of the U.S. can restrict access to healthcare by limiting the supply of available services. As of March 2021, 61.47% of Primary Care Health Professional Shortage Areas (HPSAs) were located in rural areas. One thing that medical schools are implementing to help solve this issue is the design of programs intended to produce a greater number of primary care physicians for rural areas. The University of Illinois compiled a database of all the graduate rural medicine programs in the United States [5], that includes the University of California at Davis medical school rural Program In Medical

Education (PRIME), a program that supplements standard training with additional curriculum tailored to meet the needs of various underserved populations [6]. Another notable program is the Jefferson Medical College Physician Shortage Area Program. This is an educational program designed to increase the supply and retention of physicians in rural areas and small towns, with a focus on Primary Care doctors for Pennsylvania and Delaware. There are many other medical colleges across all regions of the United States that are beginning to implement these rural health programs to assist in eliminating the healthcare worker shortage in rural communities.

Why primary care is important for rural residents:

Primary care is one of the most vital services needed in rural communities. Primary care providers offer a broad range of services and treat various medical issues. Some benefits of primary care access include [1]:

- Preventive services, including early disease detection
- Care coordination
- Lower cancer and heart disease mortality rates
- Reduction in low birth weight
- Improved health behaviors

Health Insurance Coverage

Individuals without health insurance have less access to healthcare services. A U.S. Census Bureau report found that 9.1% of the population living outside metropolitan statistical areas (MSAs) did not have any type of health insurance in 2018, compared to 8.4% of the population within MSAs [7]. 2011-2015 data revealed that 19.9% of infants in rural

households did not have health insurance, which was greater than the 16.8% of infants in urban households who lacked insurance [8].

In June 2016, an issue brief from the Office of the Assistant Secretary for Planning and Evaluation found that 43.4% of uninsured rural residents reported not having a usual source of care, less than the 52.6% of uninsured urban residents reporting not having a usual source of care [9]. The brief reports that 26.5% of uninsured rural residents delayed receiving healthcare in the past year due to cost [9]. Solutions to resolving the inability to afford health insurance are quite complicated. Simply making health insurance less expensive is unlikely due to factors that exist in regard to administrative costs, rising prescription drug costs, and lifestyle choices, as all play a factor in ballooning healthcare expenses [10]. However, programs such as the Affordable Care Act currently help rural households gain access to healthcare by expanding Medicaid and providing affordable options for insurance through the marketplace [11]. Although the Affordable Care Act allows many rural Americans the opportunity to obtain affordable healthcare, not every rural American has the ability to take advantage of this program. The Affordable Care Act is determined by the size and structure of an employer's workforce. For example, If an employer has 50 or more full-time equivalent employees, the Affordable Care Act requires that they offer affordable coverage to at least 95% of their full-time employees [12]. To help solve the problem of unaffordable healthcare, the Affordable Care Act should alter its requirements to serve a greater number of individuals.

Broadband Access

While the use of telehealth services was already becoming more popular and widespread at the beginning of 2020, measures implemented in response to the COVID-19 pandemic accelerated this growth. Unfortunately, many areas lack access to broadband internet and experience slow internet speeds, both of which are barriers to accessing telehealth services. Compared to their urban counterparts, rural individuals are nearly two times more likely to lack broadband access [13]. A 2019 report stated that 7% of people in metropolitan areas did not have access to the internet at home, while 13% of people in nonmetropolitan areas lacked access [13]. This can be addressed by simply increasing broadband coverage. By increasing broadband coverage, more rural Americans would be able to take advantage of telehealth visits.

Health Literacy

Health literacy concerns the knowledge and competencies of persons to meet the complex demands of health in modern society [14]. Health literacy can also be a barrier to accessing healthcare. Health literacy impacts a patient's ability to understand health information and instructions from their healthcare providers. This can be especially concerning in rural communities, where lower educational levels and higher incidences of poverty often impact residents [1]. Low health literacy can make residents reluctant to seek healthcare due to fear or frustration related to communicating with a healthcare professional. Additionally, navigating the healthcare system can be difficult without health literacy skills.

Why Rural Healthcare Facilities Fail:

Rural healthcare facilities are often more difficult to get to, making them harder to sustain from a business perspective. The closure of rural healthcare facilities and services has an impact on access to healthcare in rural communities. There are many contributing factors that can lead to the closure of a rural hospital, these include failure to recover from a recession, population demographic trends, market trends, decreased demand for inpatient services, and new models of care [15]. When a facility closes, it can impact care and access throughout the community. There are multiple factors that can affect the severity and impact of a hospital or healthcare facility closure, these include:

- Distance to the next closest provider
- Availability of alternative services
- Transportation services

A concern for rural communities closing a hospital is the loss of emergency services. In emergency situations, a delay in care can lead to serious consequences on patient outcomes and can be potentially deadly. Potential impacts on healthcare access due to facility or service closure include:

- Unstable health services
- Rising EMS costs
- Residents not receiving needed care or services
- Greater impact on access for the elderly, racial/ethnic minorities, the poor, and people with disabilities

What can be done to improve access to care in rural communities?

There are multiple strategies being used to improve access to healthcare in rural areas.

Examples include affiliation with larger healthcare systems, such as joining healthcare networks or affiliating themselves with larger healthcare systems as a strategic move to maintain or improve healthcare access in their communities. These affiliations or joining of healthcare networks may improve the financial viability of the rural facility, provide additional resources and infrastructure for the facility, and allow the rural healthcare facility to offer new or expanded healthcare services they could not otherwise provide. The benefits of hospital system affiliation have on a rural hospital, include access to:

- Technology
- Staff recruitment and retention
- Group purchasing
- Increased access to healthcare and operational services

Ending the Workforce Shortage

In order to increase access to healthcare, rural communities need to use their healthcare providers in an efficient and strategic way. This may include using new types of providers, working in interprofessional teams, and creating schedules to offer clinic time outside of regular work hours. However, offering clinic times outside of regular hours can create a burden for providers, as offering additional hours may lead to provider burnout associated with excessive work hours.

Better Telehealth Access

Telehealth continues to be seen as a key tool to help address rural healthcare access issues. Through telehealth, rural patients can see specialists in a timely manner while staying in the comfort of their homes or local facility. Local healthcare providers can also benefit from subspecialists' expertise provided

via telehealth. However, the temporary changes to telehealth policy in response to the COVID-19 pandemic have made visible the potential for unequal access to these services due to a lack of broadband internet access in some rural areas.

The healthcare-related disparities outlined are detrimental to the health of Americans in rural communities. By identifying these disparities, areas of improvement can be identified, and change can be implemented. By implementing these changes, overall health in rural communities could improve significantly.

References

"Rural Health Information Hub." Healthcare Access in Rural Communities Overview, 18 Aug. 2021, <https://www.ruralhealthinfo.org/topics/healthcare-access>

Syed ST, Gerber BS, Sharp LK. Traveling towards disease: transportation barriers to healthcare access. *J Community Health*. 2013;38(5):976-993. doi:10.1007/s10900-013-9681-1

Transportation and Food. Mayo Clinic Health System. (n.d.). Retrieved November 12, 2022, from <https://www.mayoclinichealthsystem.org/community-health-worker/transportation-and-food-resources>

UCSF Health. (2022, June 24). Medi-Cal Free Transportation Benefit. [ucsfhealth.org](https://www.ucsfhealth.org/education/medi-cal-free-transportation). Retrieved November 12, 2022, from <https://www.ucsfhealth.org/education/medi-cal-free-transportation>

Harvard University. (2022). Rural Medicine Programs (compiled by University of Illinois). Retrieved November 13, 2022, from <https://hwpi.harvard.edu/files/ocs/files/graduate-medicine-rural-medicine-programs.pdf>

UC Programs in Medical Education (UC PRIME). University of California Office of the President. <https://www.ucop.edu/uc-health/functions/prime.html>. Accessed October 29, 2022.

Berchick, Edward R, et al. "Health Insurance Coverage in the United States: 2013 - Census.gov." United States Census Bureau, Nov. 2019, <https://www2.census.gov/library/publications/2014/demographics/p60-250.pdf>.

Sanders, Scott R, et al. "Infants without Health Insurance: Racial/Ethnic and Rural/Urban Disparities in Infant Households' Insurance Coverage." *PloS One*, Public Library of Science, 24 Jan. 2020, <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6980480/>.

Avery, Kelsey, et al. "Impact of the Affordable Care Act Coverage Expansion on Rural and Urban Populations." Department of Health and Human Services, 10 June 2016, https://aspe.hhs.gov/sites/default/files/private/pdf/204986/ACA_Ruralbrief.pdf

Porretta, A. (2022, October 28). Why is Health Insurance so Expensive? *eHealth*. Retrieved November 12, 2022, from <https://www.ehealthinsurance.com/resources/affordable-care-act/obamacare-premiums-unaffordable-for-many-middle-income-people-in-2019#:~:text=There%20are%20a%20number%20of,in%20your%20control%2C%20others%20are>

President, J. C. V., Cusick, J., President, V., Shepherd, Director, M., Shepherd, M., Director, Director, E. L. A., Lofgren, E., Director, A., Weller, C. E., Waldrop, T., Bedekovics, G., Richards, R., Spitzer, E., & Simpson, E. (2022, November 1). Repealing the ACA would devastate an already struggling rural America. Center for American Progress. Retrieved November 12, 2022, <https://www.americanprogress.org/article/repealing-aca-devastate-already-struggling-rural-america/>

Affordable care act requirements. Paycor. (2019, March 7). Retrieved November 12, 2022, from <https://www.paycor.com/resource-center/hr-glossary/affordable-care-act/#:~:text=Affordable%20Care%20Act%20requirements%20are,of%20their%20full%2Dtime%20employees>.

Twitter, Krutika Amin, et al. "How Might Internet Connectivity Affect Health Care Access?" Peterson-KFF Health System Tracker, 14 Dec. 2020, <https://www.healthsystemtracker.org/chart-collection/how-might-internet-connectivity-affect-health-care-access/>.

Sørensen K, Van den Broucke S, Fullam J, et al. Health literacy and public health: a systematic review and integration of definitions and models. *BMC Public Health*. 2012;12:80. Published 2012 Jan 25. doi:10.1186/1471-2458-12-80

RevCycleIntelligence. (2022, September 13). Low reimbursement, staffing shortages lead to rural hospital closures. RevCycleIntelligence. Retrieved November 13, 2022, from <https://revcycleintelligence.com/news/low-reimbursement-staffing-shortages-lead-to-rural-hospital-closures#:~:text=September%2013%2C%202022%20%2D%20Low%20reimbursement,explains%20in%20a%20new%20report>.

Biodegradable Cacti-based plastic; The new solution to limited availability and high operating costs of medical tools and devices

By Jakeline Cuadra

Medical tool and device shortages are a direct threat to public safety. Supply chain interruptions due to climate change and other crises are also confounding variables to these shortages. We are nearing more unpredictable times in healthcare; sustainable practices must be designed and implemented in real-time.

Background and Current Outcomes

According to The U.S. Census, populations who suffer the most from health disparities are those with inaccessibility to a livable income and employment, which can be further compounded by barriers to education and health insurance coverage. Ultimately, these four contributing factors are worsened by a complete lack of transportation and internet access [1]. The prognosis of many diseases for Black and LatinX communities is worse compared to non-POC, as they are most likely to seek care for ongoing conditions in the ER as opposed to preventative care in a focused clinic. Visits to the ER are preventable if these communities can access resources to acquire basic care with a primary care provider. As more people frequent the ER for visits that should have been performed in a clinic, more resources are utilized.

Our Story

Last summer, my mother was diagnosed with cervical cancer after enduring months of pelvic pain and internal bleeding. She was afraid her immigration status would affect her access to care therefore she pledged to only go to the doctor when she was feeling the worst pain imaginable. When she finally received a biopsy to determine whether her cervical tissue was cancerous, she bled in the ER for about 4 hours [2]. So much, in fact, doctors warned us she might need a blood

transfusion. It is fairly uncommon for a biopsy to cause so much hemorrhaging, so why did this happen?

The Reality of Medical Tool and Device Shortages

I believe that she bled uncontrollably for hours in the ER because the medical tools required for a biopsy were not readily available. This belief is supported by a systematic review article in *Frontiers in Public Health* which assessed medical equipment reliability and how operating costs affect said device's availability [3]. I am aware that hospitals regulate the allocation of resources per demand and risk to patients in order to save lives, time, and costs [4]; however, they should not have to. When my mother was receiving her biopsy, the aforementioned resourcing decision led to the necessary tool not being available in the ER. A follow-up visit to an oncology department clinic led my mom to panic, as she needed a second biopsy. She feared she would hemorrhage like the first time in the ER. Fortunately, the more favored tool required for biopsy was there. I had several conversations with the ambulatory chief of OB/GYN who treated my mother the first night. She confirmed that the ER often does not have the specialized tools available in more specialized clinics.

The Current State of Regulations of Reusable Tools

The tools the hospital has available in the ER consist of metal, and single-use plastic, and those available that can be reused must be properly sterilized. Most medical devices composed of heat-resistant material can be steam-sterilized however, heat-sensitive tools such as transvaginal ultrasound probes require the use of methods such as ethylene oxide sterilization, which can take weeks [5-6]. They must be taken to external facilities and shipped back to the hospital. In the meantime, single-use medical tools, such as scalpels and syringes, are fragile and create tons of medical waste. The timeframe between getting a new shipment of sterilized devices per procedure requiring one of these tools is narrowing. Per the FDA, sterilization of medical devices is an intricate dance between public health safety and state regulations. Depending on each state, different companies may use different chemical methods of sterilization. Innovative designs for this complicated problem are needed in order to reduce emissions caused by high-level sterilization processes. Supply chain disruptions are also being closely monitored by medical device companies to prevent massive shortages.

In order to prevent shortages of tools which impacted my mother, we can and should be more conscience with the way we replace, use, and sterilize all medical devices. We need massive amounts of devices and tools to be readily available and, just as easily, sterilized.

The Solution

I sought to find solutions to the issue of medical device availability in the ER. After researching, I discovered that Chemistry

Professora Sandra Pascoe Ortiz, in Mexico, has begun to solve the issues highlighted. She made the first-ever, cactus-derived biodegradable, sustainable, edible plastic. The plastic can be molded into a desired size and shape [7]. Her plastic easily dissolves in water in one hour and one month in soil. I am a pre-med student working on prototypes of biopsy needles using her technology. I've teamed up with my mother's OB/GYN, and Professora Ortiz, to create biodegradable plastic needles that can be easily used and easily destroyed [8]. Following the proper framework around medical device creation, I am hoping to build a device that can be used with limited resources around the world [9]. I am hoping to find a lab on campus where the professor can ship her plastic. Without the extensive need of sterilization, we can minimize the wait times for devices in the ER as the tools molded out of her plastic could replace the metal ones.

I am grateful for the strong minds of Profesora Ortiz, and my mother's OB/GYN, who are helping me tackle this odyssey. I hope to work closely with mentors, and sustainability teams on campus to create the best-suited device for the emergency room, one that will be readily available, and easily disposed of, with a zero wait time for our communities. This is for my mother, and other mothers who were, or still are sitting in the waiting room.

References

1. Udalova V. Most vulnerable more likely to depend on emergency rooms for preventable care. Census.gov. <https://www.census.gov/library/stories/2022/01/who-makes-more-preventable-visits-to-emergency-rooms.html>. Published April 12, 2022. Accessed November 13, 2022.
2. Jamal L, Saini A, Quencer K, et al. Emerging approaches to pre-hospital hemorrhage control: A narrative review. *Annals of translational medicine*. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8350651/>. Published July 2021. Accessed November 13, 2022.

3. Zamzam AH, Abdul Wahab AK, Azizan MM, Satapathy SC, Lai KW, Hasikin K. A systematic review of Medical Equipment Reliability Assessment in improving the quality of healthcare services. *Frontiers in public health*. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8503610/>. Published September 27, 2021. Accessed November 13, 2022.
4. Permanente K. Allocation of Scarce Critical Care Resources During the COVID 19- Public Health Emergency. <https://thrive.kaiserpermanente.org/care-near-you/northern-california/wp-content/uploads/2021/01/5a4db9133e1ae7adc240.pdf>. Published January 5, 2021. Accessed November 13, 2022.
5. Center for Devices and Radiological Health. Sterilization for medical devices. U.S. Food and Drug Administration. <https://www.fda.gov/medical-devices/general-hospital-devices-and-supplies/sterilization-medical-devices>. Accessed November 13, 2022.
6. Center for Devices and Radiological Health. Sterilization for medical devices. U.S. Food and Drug Administration. <https://www.fda.gov/medical-devices/general-hospital-devices-and-supplies/sterilization-medical-devices>. Accessed November 13, 2022.
7. Medical BMP. What are the benefits of disposable medical supplies vs. reusable? BMPMedical. <https://bmpmedical.com/reasons-to-switch-to-single-use-medical-devices-and-disposable-medical-supplies/#:~:text=Benefits%20of%20single%20use%20medical,savings%20that%20reusable%20devices%20cannot>. Published June 11, 2021. Accessed November 13, 2022.
8. People Fixing The World. *How to Make Biodegradable 'Plastic' from Cactus Juice*. BBC; 2019. <https://www.bbc.com/news/av/stories-48497933>. Accessed November 13, 2022.
9. Piaggio D, Castaldo R, Cinelli M, Cinelli S, Maccaro A, Pecchia L. A framework for designing medical devices resilient to low-resource settings. *Globalization and health*. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8220789/>. Published June 22, 2021. Accessed November 13, 2022.

Acknowledgements



Corrections

N/A

Disclaimer: The views, thoughts, and opinions expressed in the text belong solely to the authors as individuals, and not necessarily to the authors' employers, organizations, committees or other groups or individuals.

JUSTHealth does not contain or provide medical advice. The contents of this website, such as text, graphics, images, and other material are intended for informational and educational purposes only and not for the purpose of rendering medical advice.

The contents of this website are not intended to substitute professional medical advice, diagnosis, or treatment. Due to the nature of the publication, we cannot guarantee that the information provided reflects the most up-to-date research.

Please consult your physician for personalized medical advice. Always seek the advice of a physician or other qualified healthcare provider with any questions regarding a medical condition. Never disregard or delay seeking professional medical advice or treatment because of something you have read in this or any publication or website.

Reliance on any information provided by anyone on this website, whether the authors, editors, community member, Stanford Center of Excellence in Diversity in Medical Education (COEDME) also known as the Office of Diversity in Medical Education (ODME), Stanford Medicine, Stanford University or any of its subsidiaries, other Stanford employees, or others represented on the website by invitation of JUSTHealth or other visitors to the website, is solely at your own risk.

Reference to the products and companies below do not imply endorsement or recommendation and are offered for informational purposes only. ALWAYS consult a health professional regarding your healthcare decisions. ALWAYS consult a health professional.