Structural Racism as a Barrier to Influenza Vaccination Uptake during Pregnancy in the Americas
(Technical Paper)

The Extent to which Physician Mistrust held by Minority Patients Exacerbates Racial Health Disparities in the United States
(STS Paper)

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Kunaal Sarnaik
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Technical Project Team Members
Simone Herron
Hunter Newland

On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

Introduction

More than 150 years have elapsed since Abraham Lincoln issued the Emancipation Proclamation, yet the effects of slavery continue to harm millions of Americans in the form of structural racism (*Emancipation Proclamation*, 2020). The healthcare system is not exempt to these aftershocks, as it is replete with several racial disparities that permeate hospitals, clinics, and private practices across the nation (Hostetter & Klein, n.d.). Whether the pathologies are strokes, heart attacks, pain management, or infections, the United States of America has a longstanding history of minorities experiencing poorer health outcomes relative to white patients. When it comes to the factors causing these racial health disparities, experts commonly cite the lack of health education among minority populations, unconscious bias held by healthcare providers, and the lack of diversity within the nation's physician workforce. However, a factor that does not gain much attention is mistrust, or the resentment that minorities have held towards the healthcare system due to unethical investigations and clinical atrocities (Ellis, n.d.). Such mistrust of physicians is also a substantial reason why there are racial health inequities in inactivated influenza vaccination (IIV) coverage rates among the nation's pregnant population (Bleser et al., 2016).

The technical project outlined in this portfolio will quantify the extent to which racial health disparities in IIV coverage among pregnant women in Virginia lead to poor birth outcomes. The project also seeks to develop a vaccination schedule that can be utilized to predict the optimal time at which pregnant Virginians should receive IIVs in order to mitigate these complications. On the other hand, the STS research paper focuses on the extent to which the mistrust held by minority patient populations towards physicians exacerbates racial disparities in the United States healthcare system. The STS paper aims to address this question by analyzing the origins of physician mistrust, discussing how it affects and is affected by other factors of racial health

disparities, and explaining why solutions to physician mistrust are necessary in order to mitigate the existing state of racial health inequities in the United States.

Technical Topic: Structural Racism as a Barrier to Influenza Vaccination Coverage

Immunological changes during pregnancy increase the risk of influenza infection, which may result in numerous complications for both the mother and the fetus; these complications include hospitalizations, preterm births, and low birth weights (Buchy et al., 2020). In order to mitigate such poor birth outcomes, widespread protection of pregnant women and properly timed IIV coverage campaigns must be achieved. However, according to the Center for Disease Control, IIV coverage among America's pregnant population during and after pregnancy was a mere 35.6% in the United States in 2017 (*Pregnancy and Vaccination*, 2019). In Virginia alone that same year, the IIV coverage rate was calculated to be 62.6% among pregnant women who were 18 years of age or older. Considering that pregnant women accounted for 24-34% of Virginia's influenza-associated hospitalizations during the 2017-2018 season alone, it is clear that current IIV coverage campaigns possess substantial room for improvement when it comes to protecting pregnant women (*Are Vaccines Safe for Pregnant Women?*, 2019). Specifically, shortcomings of current IIV campaigns include the inability to promote awareness regarding the effectiveness of IIVs, a lack of healthcare provider recommendations, and a lack of evidence-based investigations pertaining to the causalities between influenza infections during pregnancy and adverse birth outcomes (Marshall et al., 2016).

However, the issues do not stop there—recent studies have also suggested that pregnant African-American women are 19% less likely to be offered an IIV by their healthcare providers and 30% less likely to be immunized overall relative to their white counterparts (Arnold et al., 2019; Lindley et al., 2006). Thus, when it comes to IIV coverage among the nation's pregnant

population, substantial racial health disparities exist. Moreover, the effects of such disparities on adverse birth outcomes, specifically whether incidences of preterm birth, low birth weight, and hospitalization are higher among minority patient populations as a result of lower IIV coverage, have neither been elucidated nor quantified.

Over the course of the coming year, a biomedical engineering capstone research and design team will first seek to investigate this causality, primarily aiming to identify the effects of racial health disparities in IIV coverage among pregnant women on birth outcomes in Virginia. In doing so, several public health databases, including TriNetX, Natality, the Pregnancy Risk Assessment Monitoring System, and EPIC SlicerDicer, will be utilized to gather information regarding IIV coverage, birth complications, and IIV recommendations from a healthcare provider among Virginia's pregnant population. These factors will then be analyzed in the R statistical programming environment to determine whether the lack of IIV uptake among minority pregnant patients leads to a higher quantity of adverse birth outcomes. The primary goals of this portion of the technical project are to elucidate these findings and disseminate the results to both patients and providers alike regarding the importance of IIV uptake during pregnancy. The findings will also increase the public's general awareness of the substantial racial health disparities that currently exist when discussing IIV coverage among the pregnant population, motivating additional researchers, public health experts, and healthcare professionals to find solutions accordingly.

Furthermore, building off of previous work conducted by the University of Virginia Biocomplexity Institute, which used biomedical and computational modeling techniques to simulate the spread of the Zika virus in the United States in 2017, a preliminary agent-based model characterizing the spread of influenza during any given season in Virginia will be designed (Kuhlman et al., 2017). In carrying out this task, the capstone team will also leverage relevant

models previously implemented by the Moore Laboratory at the University of Virginia which characterized the epidemiological, spatial, and temporal distributions of influenza during any given season in regions of Brazil. Additionally, the team will employ various machine learning and information theory principles in the R environment to create experimental vaccination schedules for both Virginia and Brazil, a country in which similar racial health disparities involving IIV coverage among the pregnant population have also been observed (Filho et al., 2020). Simulations of the seasonal spread of influenza using these experimental vaccination schedules will be compared to the base influenza spread models for validation of their timeliness in both locales.

By the end of the academic year, the capstone team will have: 1) quantified racial health disparities surrounding IIV coverage during and after pregnancy in Virginia and Brazil, and 2) created a computational model that predicts the optimal time at which pregnant women should receive IIVs in both locales. If successful, the team hopes to leverage both portions of the technical project to help mitigate current racial health disparities surrounding pregnancy by: 1) elucidating their effects on adverse birth outcomes, and 2) designing a novel vaccination schedule that will effectively address the deficiencies in IIV coverage during pregnancy in Virginia and Brazil.

STS Topic: Exacerbating Effects of Physician Mistrust on Racial Health Disparities

The effects of ancient institutions rooted in structural racism and slavery continue to pervade virtually all aspects of the healthcare system in the United States (Bassett & Graves, 2018). For example, a 2019 study conducted by the Department of Health & Human Services found that African-American patients were 20% more likely to die prematurely from heart disease relative to their white counterparts (*Heart Disease and African Americans - The Office of Minority Health*, n.d.). Moreover, although overall stroke, diabetes, kidney disease, hypertension, and liver cirrhosis death rates have been decreasing in the nation, the inequities characterizing these rates between

the African-American and non-Hispanic white patient populations continue to widen (Williams & Mohammed, 2009). These racial disparities ultimately result in minority patients experiencing unfair, unjust, and overall poorer health outcomes, which undermines several key ethical tenets of an ideal healthcare system: autonomy, beneficence, and justice.

Several explanations for the existence of these astonishing racial health disparities have been previously cited. The most popular among these factors are unconscious bias exhibited by healthcare providers, minorities presenting to less experienced professionals due to lower rates of insurance coverage, and minorities holding resistant attitudes or beliefs toward the healthcare system as a whole (Bleser et al., 2016). The lattermost factor, specifically the deeply rooted distrust and resentment minorities have been observed to exhibit towards the nation's physician workforce, is believed to be a direct byproduct of structural racism at the population-level (Jacobs et al., 2006). Since trust between a patient and their provider is an important indicator of care quality, efficiency, and accuracy, the fact that higher physician mistrust rates have been found among the Hispanic and African-American patient populations relative to those of the white patient population in the United States is both alarming and a pertinent problem that warrants more awareness (Armstrong et al., 2007). Thus, conducting an in-depth analysis of why these physician mistrust rates are higher among minorities may not only shine substantial light on why racial disparities continue to ravage the nation's healthcare system, but also provide new insights behind the severity of these inequities. Furthermore, this analysis may open avenues for future research concentrated in finding solutions to the current state of racial health disparities in the United States, potentially restoring the nation's healthcare system back to upholding the key ethical tenets of medicine.

The sociotechnical framework that will be utilized in the analysis, organization, and discussion portions of the research paper is Wicked Problem Framing. As originally defined by

design theorists Horst Rittel and Melvin Webber in 1973, “wicked problems” are those which do not have consistent formulations, those which lack the inherent logic that signals when typical problems are solved, and those which do not generally have testable solutions, in contrast to the “tame”, eminently solvable problems of subjects such as mathematics and biology (Head & Alford, 2015; *What’s a Wicked Problem?*, n.d.). Additional characteristics of “wicked problems” include the possibility of the problem never being definitively solved, the constraints of the problem changing over time, radically different ways to approach, understand, and solve the given problem, and continual cycles of the problem definition depending on the solution and vice-versa. Ever since Rittel and Webber introduced the notion of a “wicked problem”, it has been repeatedly utilized as a sociotechnical framework for drawing attention to, understanding, and analyzing complex and dynamic problems in society (e.g., climate change, education policy, and public health). The Framing aspect of the methodology involves gathering and assembling numerous sources of evidence that reveal indirect, often hidden connections between the symptoms and root causes of the “wicked problem” of interest, which can in turn lead to potential solutions.

Opponents of the Wicked Problem Framing methodology primarily claim that the concept of a “wicked problem” itself has no coherent conceptual basis due to: 1) the framework’s lack of clarity when classifying any given social problem as “wicked” or “tame”, the distinction of which is largely perspective-dependent, and 2) the framework’s inherent and rather unjustifiable effort to analytically define types of problems separately from the relationships between relevant social actors (Turnbull & Hoppe, 2019). Proponents of the Wicked Problem Framing methodology, however, refute such claims, stating that they are limitations of the methodology’s specific implementation rather than the methodology itself (Reinecke & Ansari, 2015). Thus, for a social problem as complex and dynamic as the widespread mistrust of physicians held by minorities

across the United States, the Wicked Problem Framing methodology will serve as an invaluable tool to not only analyze the problem's root causes and disastrous symptoms, but also elucidate its effect on racial health disparities and offer potential downstream solutions.

STS Research Paper Question and Methodologies

Research Question: To what extent does the mistrust that minority patients hold towards physicians exacerbate racial health disparities in the United States?

In order to address this question, the Wicked Problem Framing methodology will first be implemented to provide background information characterizing the origin of, severity of, and factors behind the physician mistrust held among minority patient populations. Since physician mistrust is a complex and dynamic problem, the utilization of Wicked Problem Framing will allow for the elucidation of indirect and hidden connections between its symptoms and root causes (Rittel & Webber, 1973). Evidence that will be utilized to reveal such connections includes but is not limited to inhumane medical investigations exploiting minority patients such as the Tuskegee Syphilis Study from 1937 to 1972, previous clinical atrocities such as those of which occurred to black patient Henrietta Lacks, and the lack of diversity and inclusion within the nation's physician workforce (Fillon, 2016; II, 2016). Tracing these historical events and trends to the current rates of physician mistrust among minority patient populations will elucidate not only why such mistrust exists, but also why it is a vital issue to address in order to mitigate racial health disparities.

After the background behind higher rates of physician mistrust among minority patient populations is sufficiently laid out using Wicked Problem Framing, the Historical Case Studies approach will be leveraged to determine how such physician mistrust continues to exacerbate racial health disparities in the United States. The Historical Case Studies approach involves gathering and systematically organizing primary and secondary sources, as well as directing them towards

an interpretation that will allow for a deeper understanding of the problem itself—racial health disparities (Doussot, 2020). Direct explanations of how physician mistrust leads to the exacerbation of these inequities will then be achieved through analysis of historical trends such as cardiovascular disease, palliative care, and stroke death rates between minority and white patient populations. Furthermore, a documentary research analysis of more recent findings, one of which includes a discussion of how mistrust has been shown to detrimentally affect preventative care even during the current coronavirus pandemic, will also be performed to show why physician mistrust is such a pertinent problem when analyzing modern racial health disparities (Morrison & Reeves, n.d.). This approach will not only allow for a connection to be made in regard to how physician mistrust among minority patient populations exacerbates current racial health disparities in the United States, but also open up avenues of future research investigating how possible solutions can be found to address both these mistrust rates and racial health inequities overall.

Conclusion

This prospectus covers technical design projects involving racial health disparities in IIV coverage among pregnant women and their quantitative effect(s) on birth outcomes, as well as computational models of IIV coverage schedules that will predict the optimal time at which pregnant women should be immunized against influenza. The biomedical engineering capstone team will analyze whether racial health disparities in IIV coverage lead to a higher quantity of adverse birth outcomes among minority pregnant populations, and the team will also create a vaccination schedule to mitigate these poor birth outcomes in both Virginia and Brazil. The overarching goal of this technical project is not only to disseminate information regarding the current state, severity, and effects of racial health disparities in IIV coverage among pregnant women to patients and healthcare professionals, but also to provide these actors with a possible

solution in the form of a timely IIV coverage schedule specifically targeting pregnant women.

Similarly, this prospectus covers a sociotechnical investigation into physician mistrust rates among minority patient populations and how they may exacerbate racial health disparities. The United States' healthcare system is alarmingly replete with such racial inequities, which is why elucidating the intricacies behind one of their primary factors, physician mistrust, may lead to the downstream discovery of potential solutions. Physician mistrust among minority patient populations is a pertinent issue, and if it is not addressed soon, avoidable clinical atrocities and adverse health outcomes will continue to occur. Thus, finding solutions to the higher rates of physician mistrust held by minorities, in addition to racial health disparities overall, is an urgent priority in order to restore the healthcare system's adherence to key ethical tenets of modern medicine: autonomy, beneficence, and most importantly, justice. After all, if a healthcare system's actions contradict the ethical ideals of medicine, how can any patient trust it?

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