STS Prospectus Draft

Optimized Timing Schedule for Influenza Vaccination During Pregnancy
(Technical Topic)

Racial Health Disparities Surrounding Influenza Vaccination in Virginia
(STS Topic)

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On my honor as a University of Virginia student, I have neither given nor received aid on this assignment.
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Sociotechnical Problem

Physiological and immunological changes in the body occur during pregnancy that increase the risk of influenza infection, putting the mother and the fetus at risk for serious adverse effects (Munoz & Long, 2020). Providing timely inactivated influenza vaccinations (IIVs) and increasing vaccination uptake rate among pregnant women is necessary to mitigate the effects of influenza infection and prevent adverse birth outcomes (Buchy et al., 2020). Optimizing the timing schedule of IIV uptake for pregnant women is especially important for minority sub-groups who experience racial health disparities that negatively impact health outcomes in regard to pregnancy. In the semiarid regions of Ceará, Brazil and Virginia, U.S.A. we have seen a lack of IIV coverage in pregnant women and specifically pregnant women of color. There are existing models for predicting influenza spread across the regions of Brazil and some successful campaigns that educate the pregnant Brazilian population about IIV efficiency and necessity. These models will be studied and expanded upon for cases in Virginia (Almeida et al., 2018).

According to the Center for Disease Control (CDC), IIV coverage among pregnant women during pregnancy in the United States was a mere 35.6% in 2017, compared to the national target of 70% (2010-11 through 2016-17 Influenza Seasons Pregnant Women Vaccination Coverage Trend Report | FluVaxView | Seasonal Influenza (Flu) | CDC, 2019). The IIV coverage percentages in 2017 suggest that over 35,000 pregnant women in Virginia, as well as half of the overall pregnant population in the United States was not vaccinated against influenza. Additionally, PRAMS data from 2011-2015 demonstrated that non-Hispanic Black pregnant women were 30% less likely to receive an influenza vaccination than non-Hispanic white pregnant women; this is an obvious disparity based on race in America (Arnold et al., 2019). Without receiving an IIV, the pregnant mother and growing fetus are increasingly more vulnerable to influenza, which increases the probability of undesirable outcomes such as maternal hospitalization during pregnancy, low fetal birth weight, preterm births, stillbirths, and various neonatal respiratory diseases (Rasmussen et al., 2012). Since there are less pregnant women of color receiving an IIV, there are higher incidences of adverse birth effects in minority pregnant populations than in white pregnant populations. Subsequently, there is a need to target the minority pregnant populations when considering community campaigns regarding influenza vaccinations. This project will address the need for proper IIV timing and quantify racial health disparities by employing biomedical and computational methods to create an optimized influenza vaccination timing schedule for pregnant women in Virginia. This timing schedule will improve IIV uptake rates by providing healthcare providers with an optimal recommendation to relay to pregnant patients. The increase in IIV uptake in pregnant women will reduce aforementioned adverse birth outcomes, since the mother and fetus will have developed protective antibodies.

This model alone will not be adequate enough to improve IIV uptake and reduce poor birth outcomes. Without addressing the social aspects of this problem, the model will not have any effect on the complications related to IIV uptake during pregnancy. If only the technical problem is solved, there is a loss of qualitative data that provides insight into the racial health disparities that surround influenza vaccinations and pregnancy. If the social and economic inequalities of race are not considered, there is a high chance that this model would be inaccurate and only benefit those already receiving influenza vaccinations. In what follows, I propose a technical project that addresses the need for improved IIV modeling and elaborate upon an STS research project that examines the racial health disparities underlying the lack of IIV uptake in pregnant women of color. Drawing on Langdon Winner's Theory of Technological Politics, the inequalities can be identified and improved by unveiling the political agendas, conscious or unconscious, behind vaccination recommendation and IIV uptake in the pregnant population. Incorporating quantitative data from previous influenza models and available medical records with qualitative data that describes racial health inequities will allow this project team to develop a more complete, optimal influenza vaccination timing model for pregnant women in Virginia and improve upon health campaigns related to influenza and pregnancy. This model, using both technical and social components, will improve health outcomes for pregnant women and their children.

Technical Problem

Immunological changes during pregnancy increase the risk of influenza infection, which can result in numerous complications for both the mother and the fetus; these include hospitalization, preterm birth, low birth weight, low infant APGAR score, and various neonatal respiratory diseases (Buchy et al., 2020). An analysis conducted by McMaster researchers Mertz et al. (2017) estimated that pregnant women are 2.4 times more likely to be hospitalized due to an influenza infection compared to nonpregnant women (Mertz et al., 2017). Furthermore, influenza infection during pregnancy also leads to a higher likelihood of poor birth outcomes, which is why creating effective vaccination schedules specifically aimed towards protecting pregnant women is an urgent priority (Influenza Vaccination During Pregnancy, n.d.). Currently, there is a model, created by the CDC, that showcases the number of pregnant women that receive a vaccination based on race and age for specific states in the U.S., but this is not a predictive model for vaccination timing (2010-11 through 2016-17 Influenza Seasons Pregnant Women Vaccination Coverage Trend Report | FluVaxView | Seasonal Influenza (Flu) | CDC, 2019). There is currently no available model for predicting the optimal timing schedule at which pregnant women should receive an inactivated influenza vaccine. The existing models do not specifically address the predictive timing of vaccination for pregnant women, and more specifically, they do not address vaccination scheduling for pregnant women in minority populations. Previous recommendations for vaccination timing of pregnant women vary across healthcare professionals. Some recommend the first trimester in order to protect the mother earlier on in the pregnancy, but this requires receiving a secondary IIV later in the pregnancy to ensure full protection in the third trimester (Global Advisory Committee on

Vaccine Safety, 2014; Munoz & Long, 2020). Others suggest only vaccinating during the third trimester, as the mother passes along 1.74 times more antibodies to the fetus in this period of the pregnancy (Global Advisory Committee on Vaccine Safety, 2014; Munoz & Long, 2020). This is a risky option because it leaves the mother and fetus vulnerable until the last trimester. The technical project aims to predict the proper timing of IIV uptake for the pregnant population and disseminate this information to healthcare providers in order to clarify this discrepancy. This technical project will draw from the agent-based modeling procedures conducted by the Biocomplexity Lab at UVA, using concepts from the epidemiological, spatial, and temporal distribution models to track influenza as it spreads in Virginia during any given season (Kuhlman et al., 2017; Venkatramanan et al., 2019). The proposed work shall utilize census and transportation records, behavioral data, and population data to quantify and simulate the transmission of influenza. The influenza tracking sub-model of the project will be a basis for comparing the spread across the pregnant population and used later for data validation. Using the same principles, the spread of influenza across the pregnant population will also be modeled and compared to the overall population spread model. This model will include breakdowns of race and age groups to better understand the spread across this underrepresented population. The trends across the models are necessary to help understand how influenza spreads across the pregnant population, how specific marginalized groups are negatively impacted in comparison to non-marginalized groups, and where and when to vaccinate the pregnant population. The model will be validated using previous knowledge of pandemic influenza, the number of adverse birth outcomes that can be prevented, and by comparing the population spread model to the vaccination schedule prediction.

STS Problem

Influenza spread models in the United States work by using spatial and temporal population data to predict the epidemic spread of influenza across the total population. The most common modeling approach is the Susceptible-Infectious-Recovered (SIR) model developed by Kermack and McKendrick (Coburn et al., 2009). This modeling technique simulates a closed population where all are susceptible to infection. One infected individual is then dropped into the population where the spread of infection relies on the probability of transmission, β, in each encounter of individuals (Coburn et al., 2009). The model is used to determine how, when, and where the influenza virus will spread across a particular population, in this case, the state of Virginia. Othus and colleagues have developed a state-space influenza spread model based on the overarching model built by the Center for Disease Control (Community Flu 2.0 | Pandemic Influenza (Flu) | CDC, 2018). This state-space program draws on the SIR method previously described to allow government agencies, public health workers, and students in infectious disease to model the spread of influenza in a chosen state population (Osthus et al., 2017). This model functions well technically to model influenza spread and the outcomes of interventions. What it does not include however, are the sociopolitical factors of race and pregnancy status. The exclusion of race and pregnancy status from influenza spread modeling further disadvantages already underrepresented populations, leaving them even more vulnerable to the influenza virus (Mehra et al., 2019). Ignoring the health inequities that occur in regard to pregnant women of minority populations can further worsen health equity gaps, racial injustices, and increase chances of poor health outcomes for the mother and fetus during and after pregnancy. If we continue to only focus on the technical work, we will miss how influenza modeling shapes power relations among racial identity and pregnant populations. Drawing on Langdon Winner's Theory of Technological Politics (1980), I argue that current influenza modeling influences power structures by privileging the white, non-pregnant population and marginalizing the minority, pregnant populations. Technological Politics is a framework that posits that technological artifacts are political in themselves and can fall into one of Winner's (1980) two categories: 1) technological artifacts that are used to solve a communal situation, or 2) technological artifacts that are man-made systems that align very closely with a particular political affiliation (Winner, 1980). I will employ Technological Politics to elucidate the political factors that reside in influenza spread models that benefit white, nonpregnant populations and harm minority, pregnant populations. I will validate my findings against health equity statistics, qualitative surveys of minority pregnant women in Virginia, correlating socioeconomic factors, and IIV uptake of pregnant women by race each year. These primary sources of evidence can help confirm the effects of political agendas on influenza spread models and help solve some of the racial inequalities that lie within the technological artifact itself.

Conclusion

In this paper, the technical and social solutions address the harmful effects of racial prejudices in the healthcare received by pregnant women of color. More specifically, they will increase the uptake of the inactivated influenza vaccines by pregnant women and pregnant women of color by accounting for known racial health disparities. The technical solution, a computational, agent-based optimized timing model will be created and utilized to predict the proper timing for IIV uptake for the pregnant population. This technical deliverable will fill in the gap for influenza vaccinations by accounting for the pregnant population, which other infectious disease models have failed to account for. The technical project can not encompass the sociopolitical factors of the problem without addressing the political agendas contained within the influenza model. Therefore, the STS research paper will focus on analyzing the racial disparities and health inequities experienced by minority pregnant women in regard to influenza spread. The political and social factors derived from this analysis will help elucidate power relations regarding IIV uptake in pregnant women. The combination of these two projects will increase IIV uptake in the pregnant population, and specifically the pregnant populations of color. Increasing IIV uptake will decrease adverse pregnancy outcomes like hospitalization rate, preterm birth rates, low birth weights, stillbirths, and respiratory complications after birth.

Word Count: 1842

Citations

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