An Analysis of Uninsurance Rates Among Healthcare Personnel and Associated Losses From COVID-19

Anisha Parsan, Dr. Jody Porrazzo

Modeling the Future Challenge 2021

Contents

1 Executive Summary

In the United States, healthcare insurance is considered to be the main method of affording health services, for both unexpected and preventative care [1]. Numerous studies have detailed the importance of healthcare insurance, as uninsured individuals are known to have less access to care, receive poorer quality of care, and even experience worse health outcomes than that of their insured counterparts [2]. Though national uninsurance trends are fairly well studied, rates of uninsurance within healthcare personnel (HCP) receive much less attention. According to data from the American Community Survey in 2018, approximately 600,000 healthcare workers were uninsured [3]. In the context of the COVID-19, HCP are known to be at a much higher risk of exposure and infection in comparison to the general population. Evidently, investigating the loss of life and health insurance costs from COVID-19 among uninsured populations of HCP is important to understanding the impact of the pandemic on this population.

The main objective of our study is to evaluate trends in uninsurance among HCP and investigate the resulting healthcare costs associated with this population as a result of COVID-19. This mainly consists of predictive models for treatments, various calculations for losses, and trend models to predict rates of uninsurance in current and future years. We utilized data from two main sources in our modeling: The Census Bureau's American Community Survey's PUMS Database, and the COVID-19 Restricted Access Surveillance Data provided by The Center for Disease Control. We also utilized the cost of treatment information from Peterson-KFF Briefs to perform loss calculations, as well as from other credible online sources. We produced a total of six binary classification models, three of which were specific to Healthcare Personnel and three of which were for the general population (all cases). We were able to predict HCP mechanical ventilator use with an accuracy of approximately 92% and HCP ICU Admission with an accuracy of approximately 92%. The hospital admission was predicted with an accuracy of approximately 67%. In the trend analysis, we performed a polynomial regression on two sets of points: the uninsured population of HCP, and the total population of HCP. Our forecasting predicted 1,519,533 uninsured HCP in the year 2020, and 21,536,576 total HCP in the year 2020. This resulted in an uninsurance rate of approximately 7.1% among all HCP in 2020. Using our predictive models, we found that approximately 74 million dollars in losses were incurred from treatment of HCP.

Overall, increasing the insured population of HCP not only benefits them, but also those who they provide care to. Creating and implementing these policies is important, especially under circumstances of infectious disease. Although we may have possibly incurred millions of dollars' worth of healthcare losses from uninsured HCP in COVID-19, this scenario does not have to repeat itself. In the future, implementing the policies and making decisions as detailed above lessen the extent of a major crisis while allowing HCP and those they work with to be safe in their environments.

2 Background Information

In the United States, healthcare insurance is considered to be the main method of affording health services, for both unexpected and preventative care [1]. Numerous studies have detailed the importance of healthcare insurance, as uninsured individuals are known to have less access to care, receive poorer quality of care, and even experience worse health outcomes than that of their insured counterparts [2]. Despite this necessity, approximately 8.0 percent of people, or 26.1 million individuals in the United States did not have health insurance in 2019 [2]. Addressing uninsurance rates has been a focus of many governmental policies in recent years, as the benefits of expanding coverage become increasingly more evident.

Though national uninsurance trends are fairly well studied, rates of uninsurance within healthcare personnel (HCP) receive much less attention. According to data from the American Community Survey in 2018, approximately 600,000 healthcare workers were uninsured [3]. Among this population of health care professionals, over 90% are represented by those in nursing-related or care aide jobs [3]. Given that the rate of health care nurse employment is projected to grow at a faster rate (15%) than all other occupations in 2016 through 2026, addressing HCP uninsurance rates are of utmost urgency [2, 4].

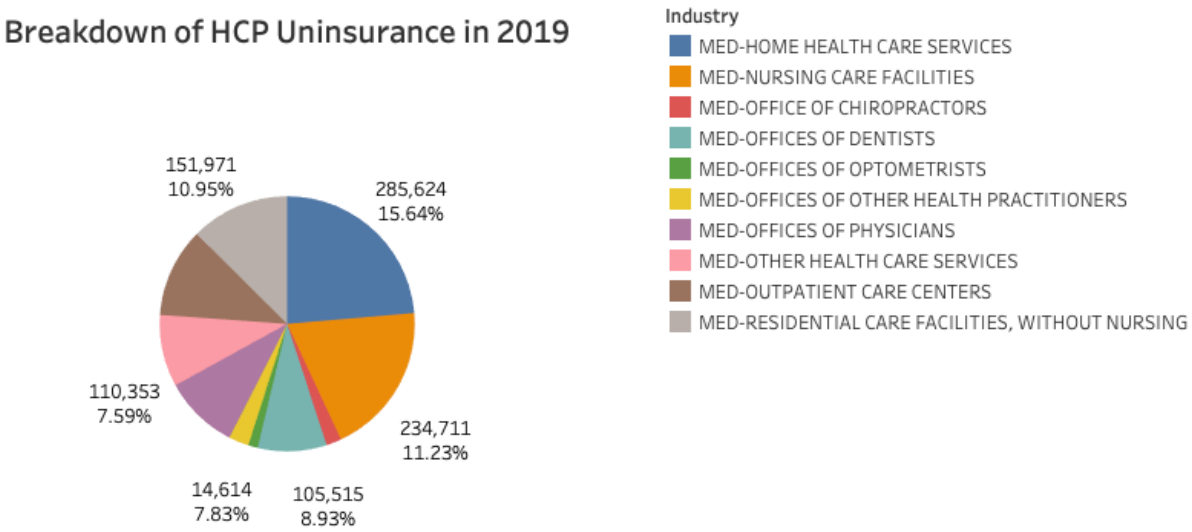

Figure 1: Percentage breakdown of uninsurance among HCP in 2018, the majority of which are involved in nursing-related or care aide jobs.

In the context of the COVID-19, HCP are known to be at a much higher risk of exposure and infection in comparison to the general population. According to a report published by the

Center for Disease Control, nearly 6% of adults hospitalized with COVID-19 were HCP, of which 36% belong to nursing-related occupations [5]. Additionally, approximately 4 million HCP are known to have underlying conditions that place them at a higher risk of mortality upon infection with COVID-19. Evidently, investigating the loss of life and health insurance costs from COVID-19 among uninsured populations of HCP is important to understanding the impact of the pandemic on this population.

While previous studies have noted the disproportionate impact of COVID-19 on HCP, many have not noted the resulting losses that are incurred from the treatment process. Applying the HCP uninsurance rates to these values to determine the amount of losses incurred from COVID-19 in those without coverage is key in emphasizing the overarching issue of uninsurance for healthcare workers.

The main objective of our study is to evaluate trends in uninsurance among HCP and investigate the resulting healthcare costs associated with this population as a result of COVID-19. This mainly consists of predictive models for treatments, various calculations for losses, and trend models to predict rates of uninsurance in current and future years. We then analyze the effectiveness of a benefit based risk reduction plan that could be implemented by federal governments to increase the percentage of insured healthcare personnel. We also investigate the possibility of various risk mitigation strategies to increase the population of insured HCP, at both the employer and governmental levels. Overall, reducing the level of uninsured HCP amidst the pandemic is key to lowering loss of life and healthcare losses associated with COVID-19. We suggest implementation of the evaluated mitigation strategies in this study to the government, in hopes of positively impacting the community of healthcare personnel as well as reducing losses for insurance companies.

3 Data Methodology

We utilized data from two main sources in our modeling: The Census Bureau's American Community Survey's PUMS Database, and the COVID-19 Restricted Access Surveillance Data provided by The Center for Disease Control. We also utilized the cost of treatment information from Peterson-KFF Briefs to perform loss calculations, as well as from other credible online sources.

Using the data from these sources allowed us to gain information about the rates of hospitalization, ICU, ventilation and mortality in HCP with COVID-19 as compared to the general population. We were then able to visualize and predict trends in the prevalence of healthcare uninsurance among HCP, and applied these calculations to the total losses incurred from HCP derived earlier. This allowed us to gain information regarding the losses of life and healthcare costs associated with that of uninsured HCP for COVID-19.

In the following section, we provide a description of each dataset and explain the usage, reliability, and shortcomings of the data utilized and what we would have initially preferred to have in our study.

Center for Disease Control: COVID-19 Restricted Access Surveillance Data [6]

- Description and Information: Deidentified individual-level COVID-19 diagnosed patient data from the United States and associated territories. The data provided includes various demographic characteristics (e.g. age, gender, race, ethnicity), exposure, symptomatic information, hospitalization information.

- Usage: This data provided us with information on how patient information (demographic and symptomatic) correlated with their probability of ICU use, ventilation, hospitalization, and mortality. Using this information, we trained predictive models to perform the function listed above, and were able to perform an analysis to compare results between the general population and those who are listed as healthcare personnel.

- Reliability and Shortcomings: We acknowledge the shortcomings of the data reported to CDC and listed on the surveillance data, in that cases are underreported and may contain invalid reports or information. However, CDC is the main location for patient-by-patient COVID-19 information, and we made the assumption of validity to move forward with our work.

Census Bureau: American Community Survey [7]

- Description and Information: Counts of uninsured and insured populations based by industry. Available through the PUMS Database, with data utilized from years 2009 - 2019.

- Usage: This data was utilized to predict the rates of uninsurance among HCP in upcoming years based on historic trends. Data compiled from this dataset was directly used to train the trend model.

- Reliability and Shortcomings: While we would have preferred to have more in depth monthly information, this survey is conducted annually and monthly information was not available online. As a result, we were unable to evaluate trends in terms of seasonality, and lacked as many data points as we would have preferred in our model. However, considering this was the main unrestricted source on uninsurance rates by occupation, we utilized this data under the assumption that it is valid and accurately represents the population of the United States.

Peterson- KFF Briefs [7]

- Description and Information: Estimates of costs of treatments (ICU, ventilation, hospital admission) for COVID-19, extracted from the MarketScan Research Database provided by IBM.

- Usage: This data was used to calculate losses in terms of COVID-19 treatments by multiplying each treatment incurred with the amount of predicted treatments within HCP.

- Reliability and Shortcomings: While we would have liked to work directly with healthcare claims data, we did not have access to this information and therefore had to make assumptions in order to work with an average. These average values will not provide an exact in terms of losses, but will provide a rough estimate assuming no considerable differences between the treatment cost information used and the real treatment cost.

4 Mathematics Methodology

4.1 Overview

The primary goal of our predictive treatment models was to evaluate the risk of incurring various treatments as a HCP based on demographic and symptomatic information. We then evaluate the total costs associated with these COVID-19 HCP cases using the predicted data from our model, and average treatment costs found online. Lastly, we evaluate trends in uninsurance within HCP and predict the future and current rates of uninsurance to determine the amount of losses from COVID-19 that were a result of uninsurance.

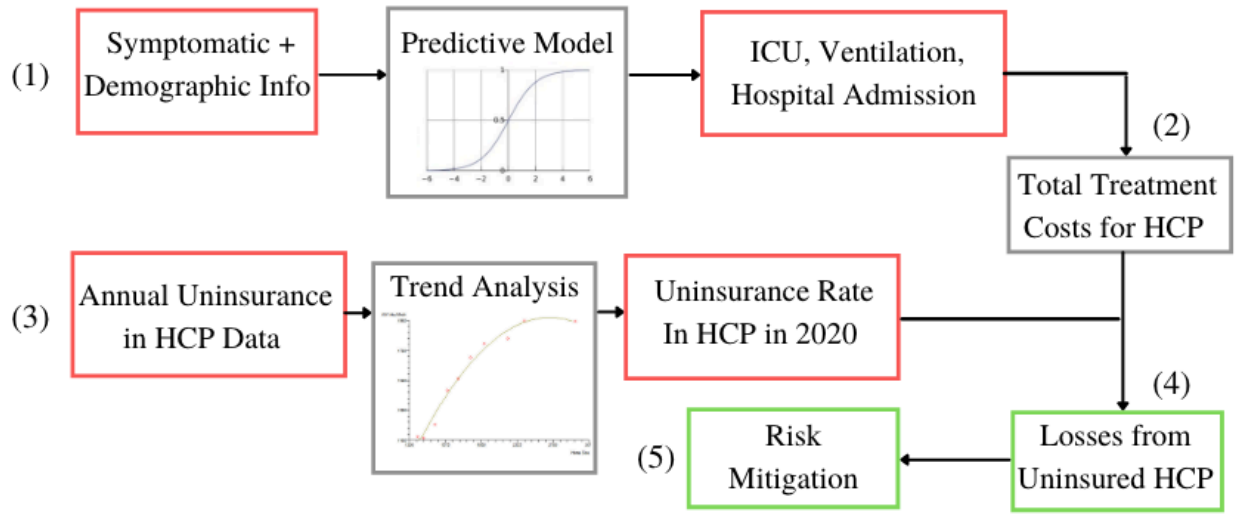

Figure 2: Workflow of methodology to predict losses of uninsured HCP in the context of COVID-19.

In further detail, after preprocessing and cleaning our data, we use a series of steps to finally determine the losses incurred by uninsured healthcare personnel as a result of COVID-19, and use this measure to evaluate the effectiveness of a possible risk mitigation strategy to provide recommendations to the government. Our initial step (1) is to use a predictive model to determine which treatments would be used by HCP based on symptomatic and demographic information. The next step (2) was to determine the total cost of all HCP treatments from COVID-19 based on averages provided through online research. The third step (3) was to perform a trend analysis on historical data to determine the percentage of uninsured HCP in upcoming years. In (4), this percentage for the year 2020 was applied to the losses calculated in (2) to determine the amount of losses that result from uninsured HCP in the context of the pandemic. Finally, in (5), we will evaluate the cost of implementing a benefit in which a percentage of monthly premiums are covered for a certain amount of years with the promise that the individual will continue the plan for a certain amount of years afterwards. We compare this cost to the reduction in cost that would have occurred from implementing this plan prior to

COVID-19 to emphasize the importance of increasing the rate of insurance within healthcare personnel.

To summarize, our methodology can be seen in the following steps:

1. Treatment modeling in HCP (logistic regressions)
2. Calculations of losses incurred from HCP
3. Trend analysis on rate of uninsurance in HCP (polynomial regression)
4. Calculate cost of uninsured HCP in context of COVID-19
5. Evaluate cost of implementing benefit

4.2 Assumptions and Justifications

1. *Case information is accurate:* We assume that the information provided by CDC on surveillance information encompasses the actual cases in the United States. Total number of cases are currently under question in certain states, and inconsistencies and irregularities are being tested. The assumption of accuracy is necessary to move forward in predictions on losses.

2. *The inaccuracy of predictive models when calculating losses is negligible:* Within the case surveillance data, for many HCP the treatment information was missing or not provided. In order to calculate losses from HCP, we used our model to predict the likely treatments these individuals would undergo based on demographic and symptomatic factors. The model was trained on reported cases of HCP which had the treatment information listed. Although the model is not representative of reality, we had to make this assumption to be able to predict total cost.

3. *Average costs represent actual costs:* We assume that the average costs of treatments as provided in the Peterson-KFF brief is representative of the actual costs of treatment. Although we were initially pursuing actual healthcare claims data (FAIR Health), unfortunately we were unable to gain access to this information. In order to move forward with calculating losses, we make this assumption of validity.

4. *Vaccine rollouts had not begun:* The projected losses are calculated for 2020 and early 2021. For the sake of simplicity, we are unable to consider the effects of vaccine rollouts on reduction in healthcare costs.

5. *Treatments were the only losses:* Due to the data provided, we are unable to consider alternative costs outside of the following treatments: ICU admission, mechanical ventilation use, and hospital admission. These were the only treatments recorded by CDC on the case report form.

6. *No governmental policies are implemented:* In our trend analysis to predict rates of uninsurance in upcoming years, we base our analysis on historical data and therefore cannot account for any new governmental policies that are implemented.

4.3 Model Development and Design

The first step in our methodology consisted of a prediction of the likely treatments that HCP would undergo after COVID-19 diagnosis, based on demographic (e.g. age range, ethnicity, sex, etc.) and symptomatic information (e.g. fever, pneumonia, chills, cough, etc.). We developed models to predict probability of ICU admission, mechanical ventilation use, and hospital admission in HCP as well as the general population for the sake of comparison. We decided to utilize a logistic regression for binomial classification in each of the treatments. Logistic regression (logit model) is a statistical model that determines the probability of falling into a certain class based on calculated coefficients of the provided dependent variables. We utilize a logistic regression model over other models due to its simplicity and effectivity in our particular scenario. The equation for a binary logistic regression is provided below:

$$\ln\left(\frac{P}{1-P}\right) = a + bX \qquad P = \frac{\exp(a+bX)}{1+\exp(a+bx)} = \frac{e^{a+bx}}{1+e^{a+bx}}$$

We used the Restricted Access COVID-19 Case Surveillance data provided by the CDC to train and test our treatment prediction models. We utilized python to perform the logistic regression (sklearn), and outputted the coefficients for each dependent variable for analysis on the significance of certain symptoms and demographic characteristics. In order to strive for maximum accuracy and robustness with our model, we performed a grid search and recursive feature elimination. The grid search functioned to fine tune our model to each treatment, and outputted the most optimal model variation of logistic regression (includes regularization, size of penalty and solver). Recursive feature elimination allowed for selection of features in our training dataset that were the most relevant in predicting our target variable. Table 1 shows the major variables present in the COVID-19 Restricted Access Dataset inputted into the recursive feature elimination algorithm.

Table 1: Important Variables In COVID-19 Restricted Access Surveillance Data

Variables	**Description**
Treatments	ICU, Hospital Admission, and Mechanical Ventilation

Demographics	Age Range, Sex, Race/Ethnicity
Healthcare Work	If the reported case was from a Healthcare Personnel
Comorbidities	Prescence of one or more underlying diseases
Symptoms	Pneumonia, Respiratory Distress, Abnormal X-ray, Fever, Chills, etc.

After training and testing, we utilized our model to predict the treatments for each of the HCP reported cases in which the information was not already provided (marked as missing or unknown). Hospitalization, ICU and ventilator usage was predicted for each of those reported cases in HCP. The total number of each treatment was tabulated from our predictions and the provided information using the average cost values taken from the Peterson-KFF Briefs. The resulting value represented the predicted costs associated with HCP as a result of COVID-19 treatments.

In the following paragraphs, we describe the trend analysis which was used to find the rate of uninsured HCP in 2020. The trend information for rates of healthcare uninsurance was relatively limited, due to the fact that the majority of the data was collected through annual surveys. We utilized information from the American Community Survey's PUMS Database with information on the insured, uninsured, and total population by industry. The data from 2009 to 2019 was used to produce Figure 3, which displays the increase in uninsured population starting in 2016.

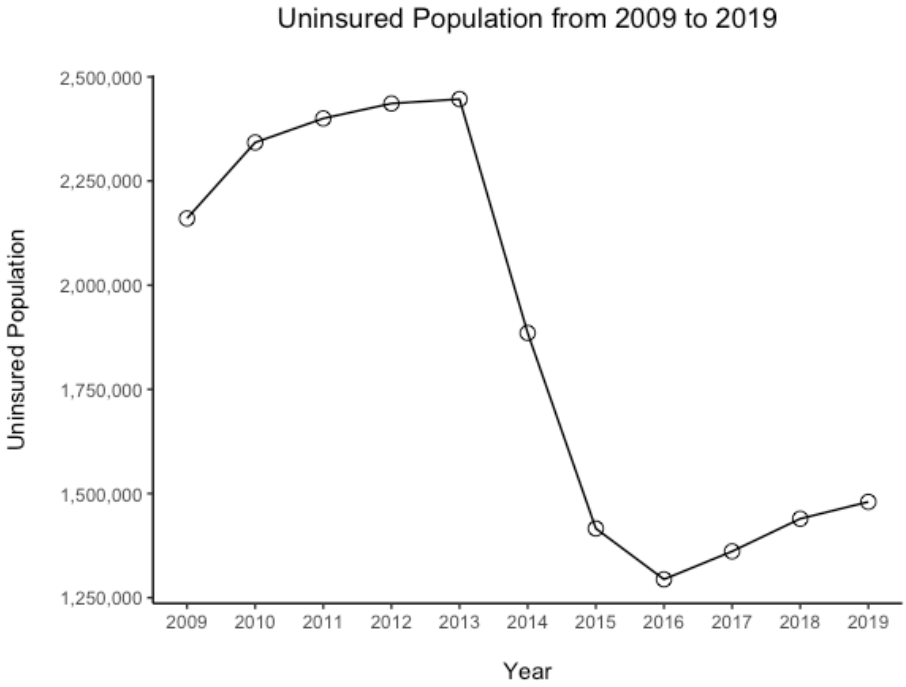

Figure 3: Uninsured Population of HCP from 2009 to 2019 from the American Community Survey PUMS Database.

Our analysis was performed two times: one to predict the number of uninsured HCP in 2020, and the other to predict the overall number of HCP in 2020 if the historical trend is followed. This would allow us to derive the rate of uninsured HCP from these values. The trend analysis for the population of uninsured individuals was performed in R using a polynomial regression with degree 2, using the poly function within lm. Polynomial regressions are utilized to represent relationships between independent and dependent variables as a non-linear relationship, modeled as an nth degree polynomial. The equation for a two degree polynomial regression is displayed below. We decided to work only with data from 2016 and above after our visualization of the uninsured population, since a visible trend appeared at that point onwards.

$$y = \beta_0 + \beta_1 x + \beta_2 x^2 + \varepsilon$$

To predict the number of total HCP in 2020 we utilized a polynomial regression with degree 2. In this we were able to use all the data, because our visualization demonstrated an overarching trend over all of the years.

Once we found the predicted population of uninsured HCP and the predicted total population of HCP for 2020, the rate of uninsured HCP was derived. We then multiplied this percentage by the total costs resulting from COVID-19 treatments to calculate the losses incurred by the uninsured population of HCP in the context of the pandemic.

5 Model Results and Calculations

5.1 Predictive Model Results

We produced a total of six binary classification models, three of which were specific to Healthcare Personnel and three of which were for the general population (all cases). We were able to predict HCP mechanical ventilator use with an accuracy of approximately 92% and HCP ICU Admission with an accuracy of approximately 92%. The hospital admission was predicted with an accuracy of approximately 67%. The ROC/AUC curves for each of the models is displayed in the following figures.

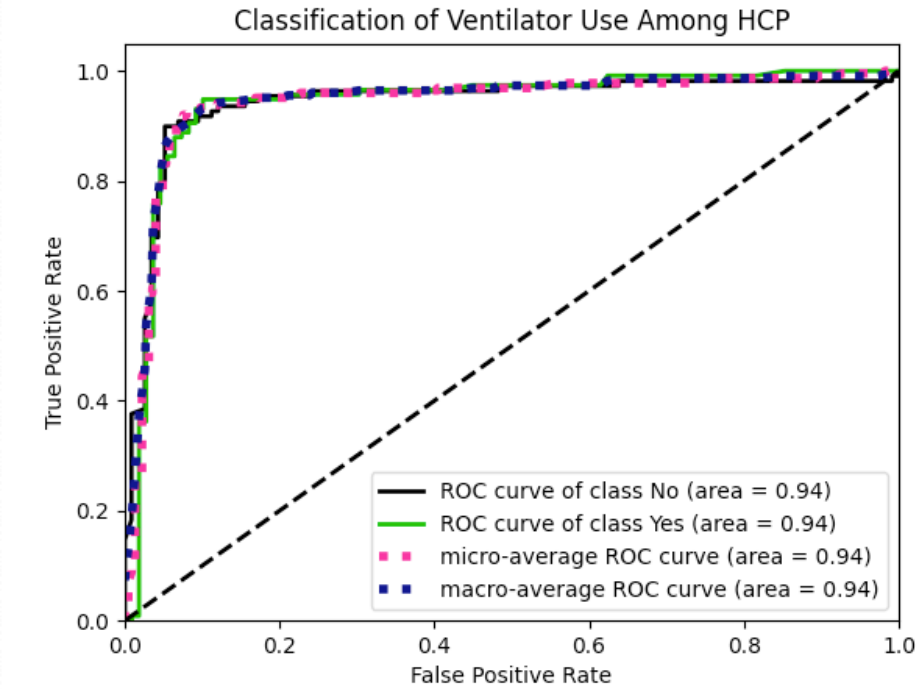

Figure 4: ROC/AUC curve for prediction of Ventilator Use Among Healthcare Personnel

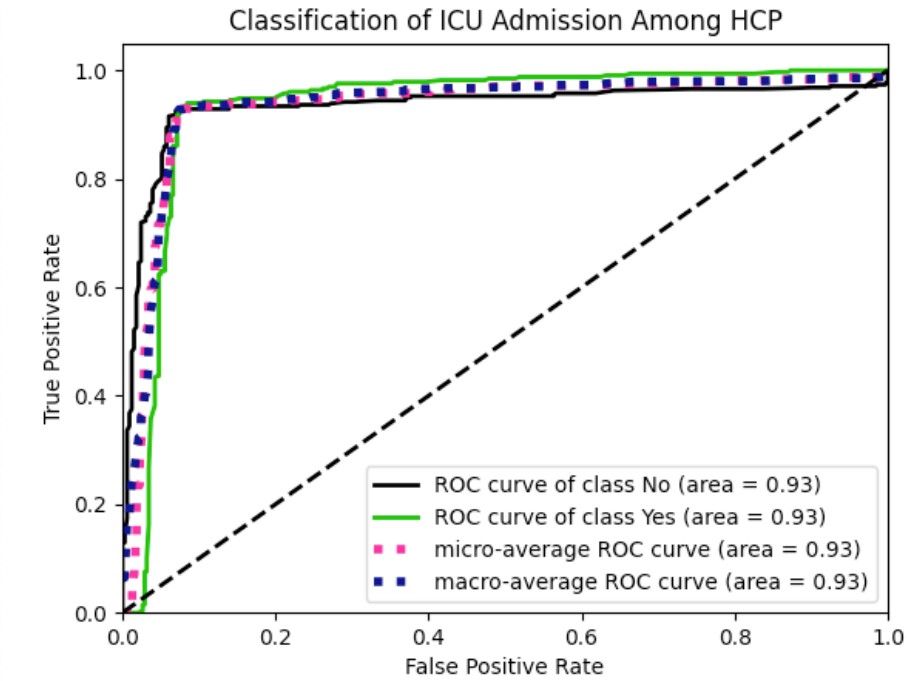

Figure 5: ROC/AUC curve for prediction of ICU Admission Among Healthcare Personnel

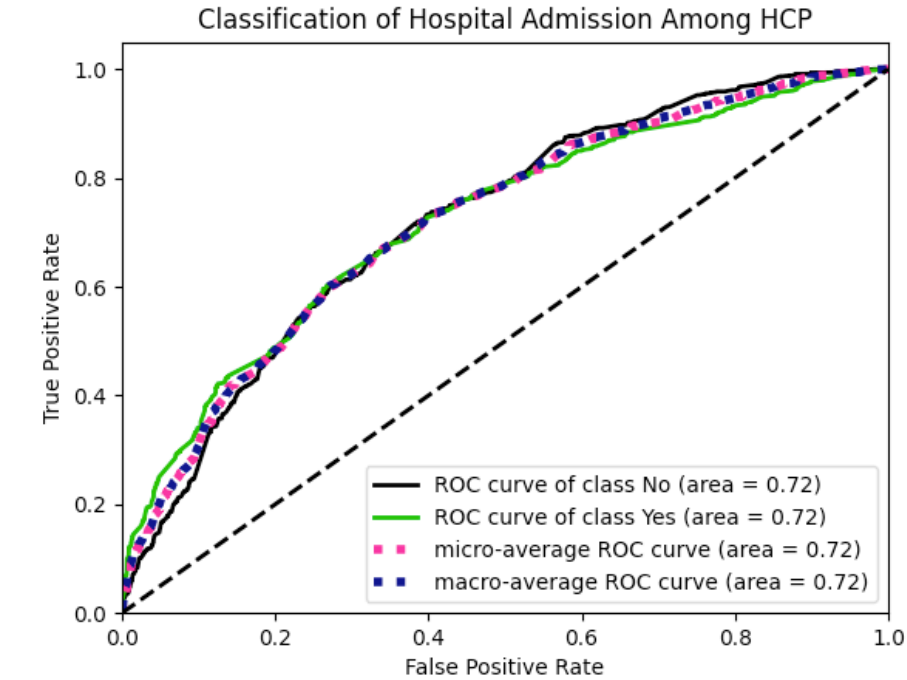

Figure 6: ROC/AUC curve for prediction of Hospital Admission Among Healthcare Personnel

5.2 Trend Analysis Results

In the trend analysis, we performed a polynomial regression on two sets of points: the uninsured population of HCP, and the total population of HCP. Our forecasting predicted 1,519,533 uninsured HCP in the year 2020, and 21,536,576 total HCP in the year 2020. This resulted in an uninsurance rate of approximately 7.1% among all HCP in 2020. The results of the trend analysis are plotted in the figures below. As seen below, the number of uninsured individuals increases from 2019 to 2020 according to our predictions. Additionally, the total number of HCP increased from 2019 to 2020 – suggesting continuing increases in both groups in upcoming years as well. Although 2018 to 2019 demonstrated a decrease in HCP, we base our estimation on all of the historical data and therefore continue with the overarching increase in HCP.

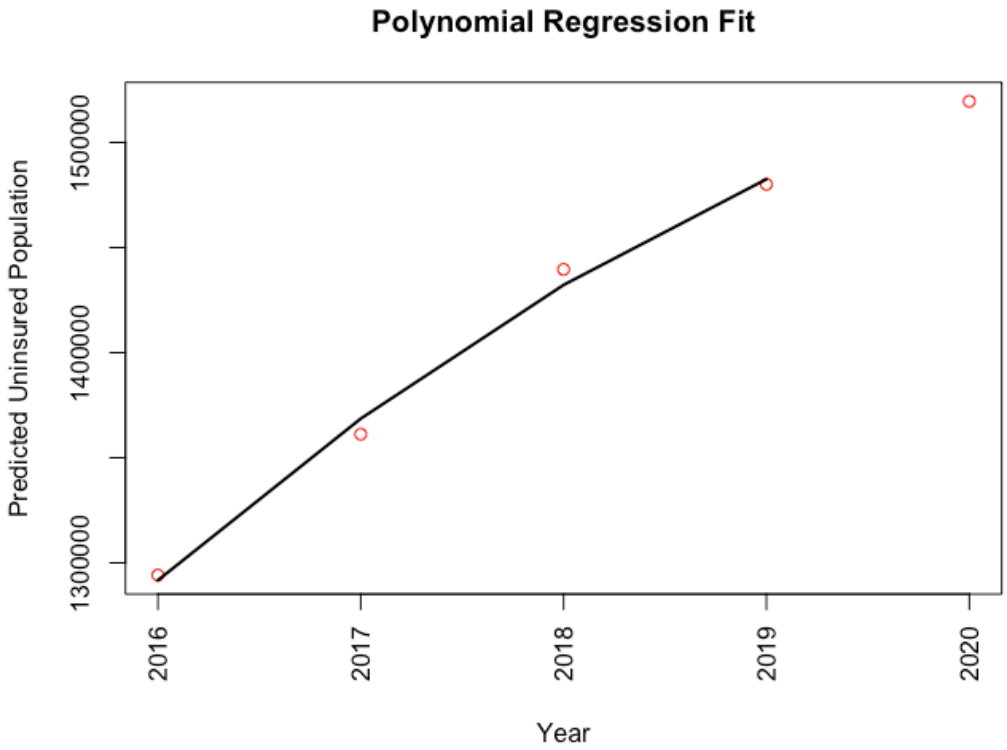

Figure 7: Trend analysis to predict uninsured population of HCP in 2020. The point on the far right is the predicted value for 2020 according to the polynomial regression fitted on the data.

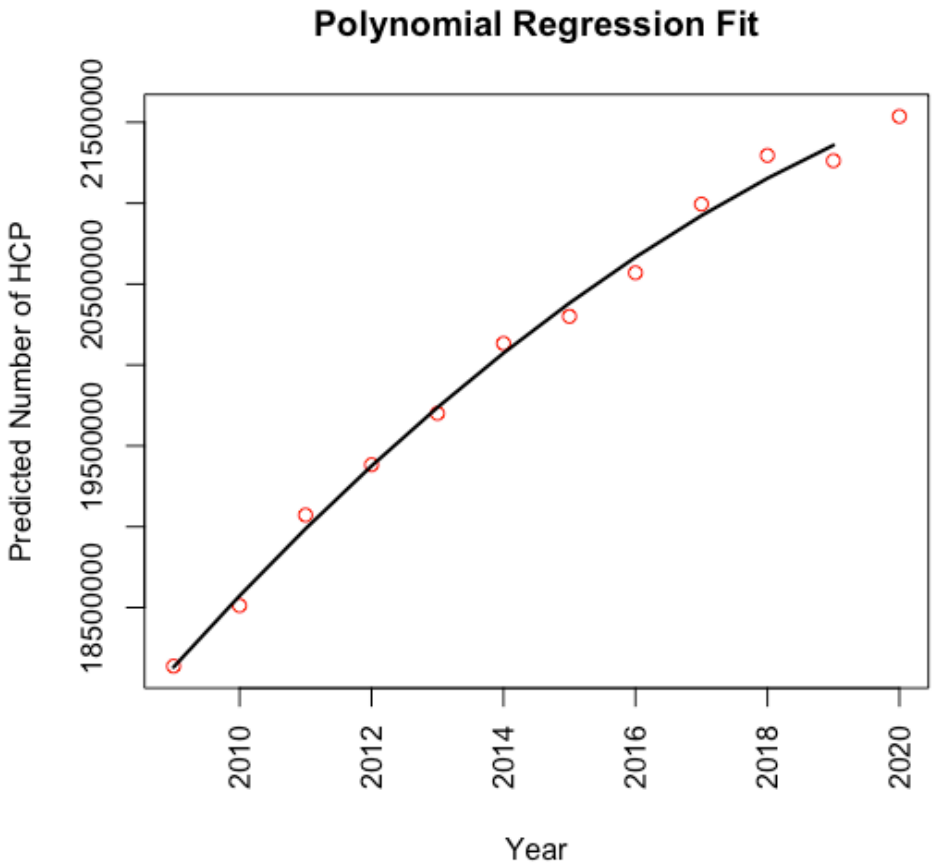

Figure 8: Trend analysis to predict total population of HCP in 2020. The point on the far right is the predicted value for 2020 according to the polynomial regression fitted on the historical data.

5.3 Cost Associated Results

Our methodology to estimate total healthcare losses in HCP from COVID-19 treatments began with the estimation of the treatments (ICU, Hospital Admission, Ventilation) used by each reported case. After our calculations, we found that approximately 74 million dollars in losses were incurred from treatment of HCP.

The next step of our cost associated results combined our prediction for the rate of uninsured HCP in 2020 with the results above to find the losses incurred from uninsured HCP as a result of COVID-19. We estimated that approximately 6 million dollars' worth of losses were incurred from treatment of uninsured HCP during the pandemic.

6 Analysis and Conclusions

6.1 Risk Analysis

According to our trend analysis, the amount of uninsured healthcare personnel will continue to increase in upcoming decades, as the total amount of healthcare personnel increases. This surmounts in tremendous losses since these individuals are on the forefront of most health crisis. Based on our analysis of the amount of losses resulting from uninsured HCP infected with COVID-19, we can say that in the future, another crisis at the same growth rate of the uninsured population will have an increased amount of losses. Overall, this negatively impacts not only the healthcare personnel themselves, but the governments and hospitals who are forced to deal with these losses.

Risk to the Healthcare Personnel

Healthcare insurance is considered to be the primary method of paying for health-related costs, including both long-term and emergency care. Studies have demonstrated the importance of healthcare insurance, as uninsured individuals are known to have less access to care and even experience worse health outcomes than that of their insured counterparts. Healthcare workers are among the individuals most impacted by COVID-19, as they are known to have a much higher risk of exposure and infection than that of the general population. Additionally, more than 4 million of these HCP are known to have underlying conditions that place them at a higher risk of mortality upon infection with COVID-19, suggesting increased possibility of critical care [5]. Evidently, insuring healthcare personnel should be of utmost importance since the benefits of a healthcare plan be great in their higher risk lives.

The overall uninsured population will increase with time as the population of HCP increases and policies are not implemented to reduce uninsurance rates (Figure 7 and 8). This will negatively affect HCP, because they will receive the poorer quality of care and worse health outcomes characteristic of uninsured groups. Since they are disproportionately affected by pandemics and other sicknesses and their number of uninsured are projected to increase, HCP must be encouraged to take on insurance plans for their own safety.

Ancillary and Associated Risks

With an increase in uninsured individuals among HCP, the associated healthcare costs that must be covered by the government increases as well. When this pressure is placed on states and localities to cover these costs, funding on other aspects of infrastructure will inevitably be cut down. Additionally, the public must contribute to account for such uncompensated care resulting in a higher tax burden at the local level.

Uninsured individuals often receive less long-term care than their insured counterparts [5]. In a community in which many have underlying health conditions, access to long-term healthcare is key in preventing devastating loss of life and emergency treatment costs. Among HCP, a group with an especially population of uninsured are home and nursing care providers. If such individuals are uninsured and face health issues, they may be in worse condition due to reduced access to care and take a longer recovery. This effects the individuals which employ these nursing and home care providers as they must compensate for this absence. Additionally, many of the workers provide hands-on care to vulnerable adults, and could potentially transmit undetected infections disease from their delay in seeking healthcare.

The demographic breakdown of HCP affected by comorbidities demonstrates a disproportionate amount of underlying disease in specific minority groups. In uninsured individuals, reduced access to wellness visits results in more severe emergency outcomes, and higher overall costs for treatment [5]. As a result, high rates of uninsurance among HCP can disproportionately effect marginalized groups.

6.2 Recommendations

Decision and Insurance Recommendations

The coronavirus pandemic has revealed many faults in the system of health insurance coverage as millions of individuals are left without healthcare coverage having just lost their jobs. Certain governmental policies, such as the Affordable Care Act (ACA) are already in place, and seek to extend Medicaid coverage to low-income individuals and other groups in need [10]. While the number of uninsured non-elderly has dropped consistently, the number of uninsured nonelderly in the United States has continually increased from 2016, consistent with our trend analysis in Figure 7.

The major groups of uninsured individuals state that the reason for their lack of healthcare coverage is due to the high cost of insurance. Our analysis revealed that nurse and home care providers are among the HCP with the highest rates of uninsured. These same groups are often paid the least, often working overtime at minimum wage [9]. While hospital workers are often provided insurance through their hospital, many of these care service providers are unable to gain insurance despite being among the most impacted by high costs.

We propose that the employers of these HCP offer health care coverage to their workers at lowered rates. Ultimately, this choice benefits the employers since uninsured individuals will likely have a more severe outcome from disease due to lack of preventative care. If HCP are insured, they will have a less severe outcome and take less sick days [10], benefiting the care providing company. Additionally, employers could offer coverage solely for wellness visits – allowing for the preventative care that many uninsured HCP lack despite being on the forefront of battling others' sickness. This would also address concerns about workers transmitting

undetected infectious diseases to the vulnerable individuals they may work with. For example, by providing HCP with coverage that allows them to get flu shots, the risk of transmitting the flu from worker to patient is reduced. Encouraging an environment that prioritizes healthcare and wellness within such businesses is key in increasing the number of insured HCP in future years.

Insurance companies are oriented towards lowering their own risk and loss. Offering lowered monthly premium rates to those on the front lines could be incredibly beneficial to the companies and many other groups. Since many HCP are unable to afford private health insurance, lowering premiums could allow them to take up insurance. This increases the use of long term care in HCP, allowing for the preventative care that would address concerns about workers transmitting disease to the vulnerable patients they work with. If those same patients are also on health insurance, this could greatly lower health insurance losses from infectious disease transmission. Additionally, this would benefit the insurance companies since they have more people signed on to their plans.

Public Policy Recommendations

One of the major issues with the current healthcare coverage system is the lack of governmental policy dictating that health care providers offer health insurance coverage to their workers. Federally, nurse and home care workers are grouped as similar to other employees outside the medical field. However, the high risk of exposure in the job and the service of working with vulnerable patients makes them much more unique, and therefore in greater need of health insurance coverage.

To address this issue, states may consider requiring that a proportion of each increase in Medicaid payment rate is directed towards the coverage of health service workers. Other incentives could include offering tax benefits to the health care providers (businesses themselves) for implementing plans to encourage HCP to get healthcare insurance.

Overall, increasing the insured population of HCP not only benefits these individuals, but also those who they provide care to. Creating and implementing these policies is important, especially under circumstances of infectious disease. Although we may have possibly incurred millions of dollars' worth of healthcare losses from uninsured HCP in COVID-19, this scenario does not have to repeat itself. In the future, implementing the policies and making decisions as detailed above lessen the extent of a major crisis while allowing HCP and those they work with to be safe in their environments.

7 Acknowledgements and Closing Remarks

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Finally, thank you to everyone running this challenge, and your unwavering dedication to keep inspiring students. I have genuinely learned so much throughout the process of this project, and I am proud to say I have found a new passion.

8 References

1. Bureau, U. (2020, September 15). Health insurance coverage in the United States: 2019. Retrieved February 12, 2021, from https://www.census.gov/library/publications/2020/demo/p60-271.html

2. Chou, C., Johnson, P., Ward, A., & Blewett, L. (2009, December). Health care coverage and the health care industry. Retrieved February 2, 2021, from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2775769/

3. Covid-19 case surveillance restricted access detailed data. (2021, February 24). Retrieved February 27, 2021, from https://healthdata.gov/dataset/covid-19-case-surveillance-restricted-access-detailed-data

4. COVID-19–Associated hospitalizations among health CARE personnel - covid-net, 13 states, March 1–MAY 31, 2020. (2020, October 29). Retrieved December 24, 2020, from https://www.cdc.gov/mmwr/volumes/69/wr/mm6943e3.htm

5. Giannis, D., Geropoulos, G., Matenoglou, E., & Moris, D. (2020, June 18). Impact of CORONAVIRUS disease 2019 on healthcare Workers: Beyond the risk of exposure. Retrieved February 27, 2021, from https://pmj.bmj.com/content/early/2020/06/18/postgradmedj-2020-137988

6. Haddad, L. (2020, December 14). Nursing shortage. Retrieved January 27, 2021, from https://www.ncbi.nlm.nih.gov/books/NBK493175/

7. Paying Minimum Wage and Overtime to Home Care Workers - A Guide for Consumers and their Families to the Fair Labor Standards Act. (n.d.). Retrieved January 7, 2021, from https://www.dol.gov/sites/dolgov/files/WHD/legacy/files/Homecare_Guide.pdf

8. Price, S. (2020, September 02). Nearly 600,000 health care workers on frontlines of Covid-19 don't have health insurance. Retrieved February 2, 2021, from https://www.valuepenguin.com/health-care-worker-health-insurance#full

9. Twitter, M. (2020, April 14). Potential costs of covid-19 treatment for people with employer coverage. Retrieved February 9, 2021, from https://www.healthsystemtracker.org/brief/potential-costs-of-coronavirus-treatment-for-people-with-employer-coverage/