Methicillin-Resistant Staphylococcus Aureus (MRSA) Infections in California Across Community Type and Years

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M71C Seminar: Health Before, During, and After Pregnancy

M71C Seminar Final Paper

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Abstract

Background: Methicillin-resistant Staphylococcus aureus (MRSA) infection is caused by a type of bacteria that is resistant to several types of antibiotics[1]. Hence, it is most commonly found in healthcare settings such as hospitals where the usage of antibiotics is high[1]. MRSA infections cause skin infections and pneumonia while leading to sepsis if left untreated[2].

Purpose: We sought to determine a possible correlation between community type and number of reported MRSA infections over the years in California.

Methods: The data we analyzed was accessed through the California Health and Human Services Open Data Portal which was collected through self reporting from healthcare centers across California[3]. More specifically, we examined the data sets from 2015, 2017, and 2020 which contained the number of reported MRSA infections by healthcare facility and county[3]. We began by consolidating all of the reported MRSA infections by the county each healthcare facility was located in. Using an independent source, we determined the population density of each county at the time of each respective data set[4]. Then each of the 58 counties were recategorized into its respective community type (urban: 1, suburban: 2, rural: 3) with delineated population density cutoffs. We performed linear regression on the community type and the respective number of reported MRSA infections separately for each year.

Results: There was a negative correlation determined between community type and number of MRSA infections. However, this correlation was very weak as the adjusted R-square was 0.031 for 2015, 0.0268 for 2017, and 0.0167 for 2020.

Conclusion: Although there was a correlation determined, its strength was not high and further data collection/statistical analysis is required to support this correlation.

Introduction

Staphylococcus is a bacteria that causes staph infections[5]. These infections are often resolved by the body fairly quickly, but certain staph infections require the assistance of antibiotics[5]. This provides staphylococcus the opportunity to become methicillin-resistant Staphylococcus aureus (MRSA) as only the staphylococcus bacteria with a genetic mutation to resist the antibiotics can survive. This process can be repeated with multiple types of antibiotics which eventually leads to multiple types of antibiotics being ineffective. Therefore, a majority of MRSA infections occur in people who are in healthcare settings as invasive procedures allow easier access to the human body coupled with the high usage rates of antibiotics[1]. Furthermore, for decades the healthcare sector has prescribed and pushed the use of antibiotics for simpler infections, even after the discovery of MRSA in 1961[6], making it easier for MRSA to evolve as only the bacteria with resistance to the specific antibiotics could survive. Methicillin-resistant Staphylococcus aureus (MRSA) infections often result in a fever along with swollen, painful red bumps on the skin that could be warm to the touch and full of pus[1]. The bacteria can burrow deeper into the body and infect the bones, joints, bloodstream, heart, or lungs causing life-threatening scenarios[1]. Next, sepsis can set in triggering inflammation throughout the body, possibly even leading to multiple organ failure and ultimately death[2].

MRSA infection treatment in the U.S. amounts to about $10 billion a year with an average of $60,000 per patient as of 2016[7]. In addition, hospitals in the U.S. invest in MRSA prevention measures with the implementation of MRSA screenings, surveillance, and other prevention methods such as upgraded air filtration systems[7]. Furthermore, hospitals in the U.S. have a financial incentive to decrease the number of MRSA infections contracted at their hospital as the federal government began to penalize and fine hospitals where patients contract MRSA infections in 2017[7]. In the U.S. alone, MRSA infections have a massive economical footprint as

hospitals pay for all of the preventative measures mentioned previously, the federal government pays for MRSA patients through Medicare, and some patients pay out of their own pocket for treatment. Without proper prevention and intervention, the number of MRSA infections reported will continue to increase while the economical footprint will inevitably rise even further in the coming decades.

MRSA is actually far more prevalent than the general population realizes as 2% of people carry MRSA in the U.S.[2]. In addition, a third of the general population carries staphylococcus in their nose[2]. Hence, there was a push to reduce MRSA infections in the U.S. from 2005-2012[2]. This campaign was accompanied with a decrease of MRSA infections by 17.1% each year[2]. There continued to be a decline until 2015 where the number of MRSA infections increased for the first time in certain states across America[2]. The impact of these reductions and increases cannot be summarized in just numbers as each case of MRSA decreases the trust the surrounding community has in the healthcare center. Imagine a family member goes to the hospital to resolve an ailment they have, but they end up contracting a MRSA infection and facing life-threatening symptoms. This would inevitably decrease the trust other family members, friends, and community members have in the hospital. This could mean members of the community choose not to visit the hospital out of fear which would be a devastating outcome for an institute created to help people. The impact of MRSA infections extends far beyond the infected or economic ramifications as healthcare facilities require the trust of the surrounding community to be effective and operable.

Methods

According to California Health and Safety Code section 1288.55, hospitals and healthcare facilities must report MRSA infections to the California Department of Public Health

(CDPH)[3]. The data is collected by the CDPH in order to compile an annual public report of healthcare-associated infections[3]. The reported MRSA infections by healthcare facility and county were then uploaded to the California Health and Human Services Open Data Portal by the California Department of Public Health[3]. There were no individuals excluded from the data set as long as they were diagnosed with MRSA. We chose to examine data beginning from 2015 as there was a decrease in MRSA infections from 2005-2015[2]. We also examined data from 2017 and 2020 in order to see trends of MRSA infections over a half decade. Through another data set, we determined the population density of each county in California[4]. Then each of California's 58 counties were recategorized into its respective community type (urban:1, suburban:2, rural:3). The community type was determined through population density cutoffs with the urban community type having a population density of 1000 people per square mile or more, the suburban community type having a population density between 500 and 1000 people per square mile, and the rural community type having a population density 500 people per square mile or less. We determined measures of central tendency for the number of MRSA infections for each community type using Google Sheets and SAS. We also examined the total number of MRSA infections per community type over the years using Google Sheets and SAS. Finally, we performed linear regression on the community type and the respective number of reported MRSA infections separately for each year using SAS.

Results

Table 1:

Year	2015	2017	2020
Urban Case Avg	34.42857143	33.28571429	38.85714286
Suburban Case Avg	40	35	37
Rural Case Avg	9.468085106	10.91304348	10.54166667

Figure 1:

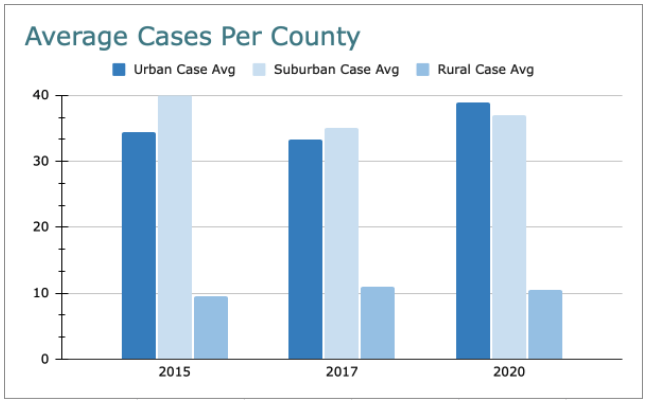

Table 1 and Figure 1 both display a decrease in the average number of cases per county in the urban and suburban community types between 2015 and 2017. Meanwhile, there is an increase in the average number of cases per county in the rural community type between 2015 and 2017. This is followed by a slight decrease in the average number of cases per county in the rural community type between 2017 and 2020. Conversely, there is an increase in the average number of cases per county in the urban and suburban community types between 2017 and 2020.

Table 2:

Year	2015	2017	2020	COMTYPE
Urban Cases	445	502	506	1
Suburban Cases	80	70	74	2
Rural Cases	241	233	272	3

Figure 2:

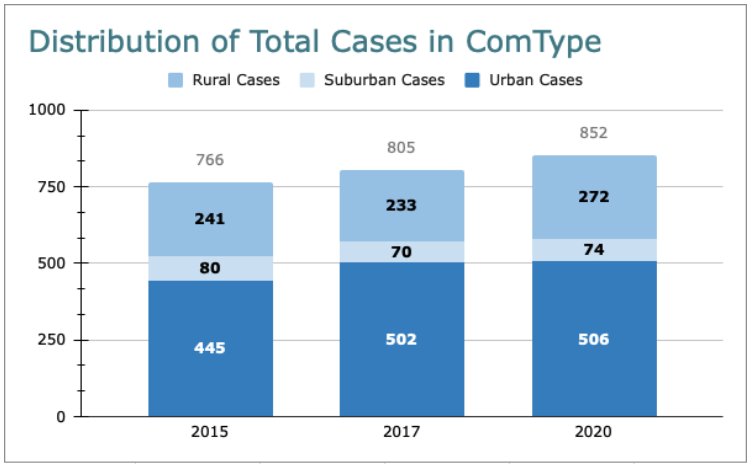

Table 2 and Figure 2 both demonstrate a decrease in the total number of cases in the suburban and rural community types between 2015 and 2017. However, there is an increase in

the total number of cases in the suburban and rural community types between 2017 and 2020. Likewise, there is an increase in the total number of cases in the urban community type between 2015 and 2020.

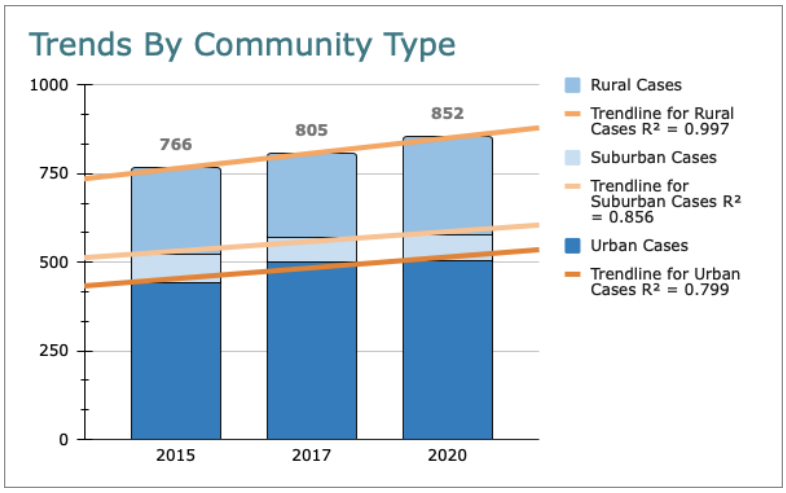

Figure 3:

Figure 3 contains the increasing trendlines for all three community types in terms of MRSA infection cases over the years. Rural has the highest R-square of 0.997 and suburban has a R-square of 0.856. Urban has the lowest R-square of 0.799.

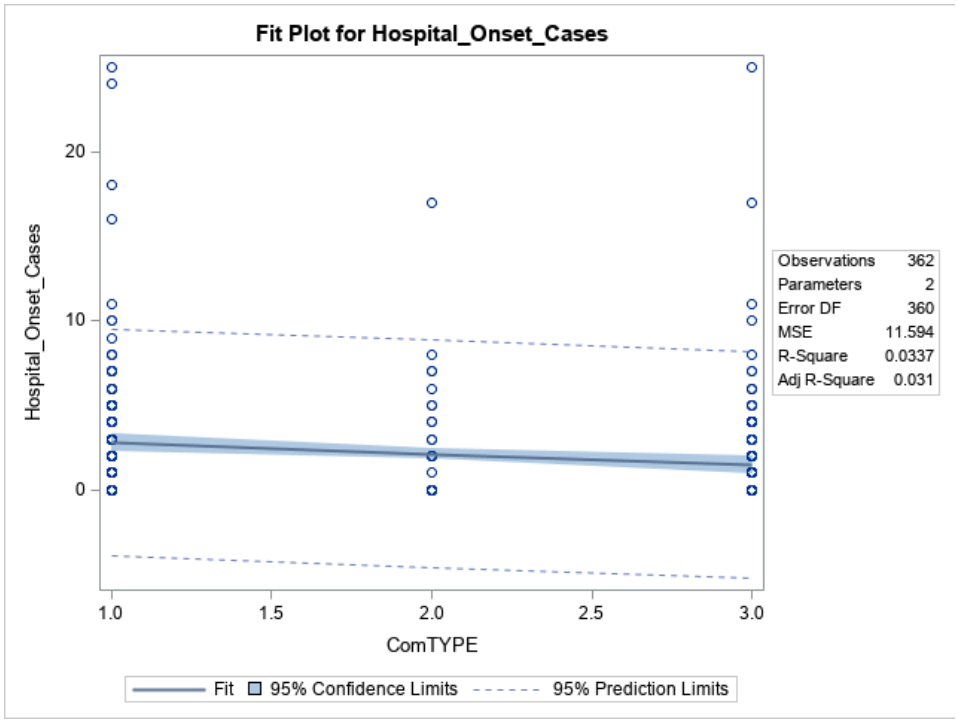

Figure 4:

In Figure 4, the linear regression between the community type and the respective number of reported MRSA infections in 2015 revealed a negative correlation with an adjusted R-Square of 0.031.

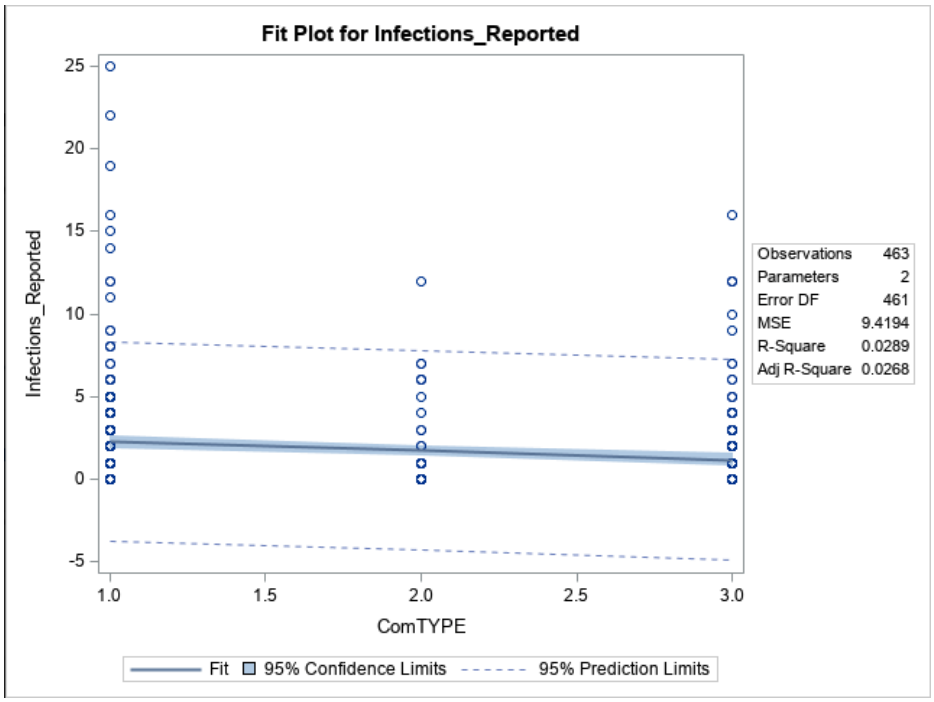

Figure 5:

In Figure 5, the linear regression between the community type and the respective number of reported MRSA infections in 2017 revealed a negative correlation with an adjusted R-Square of 0.0268.

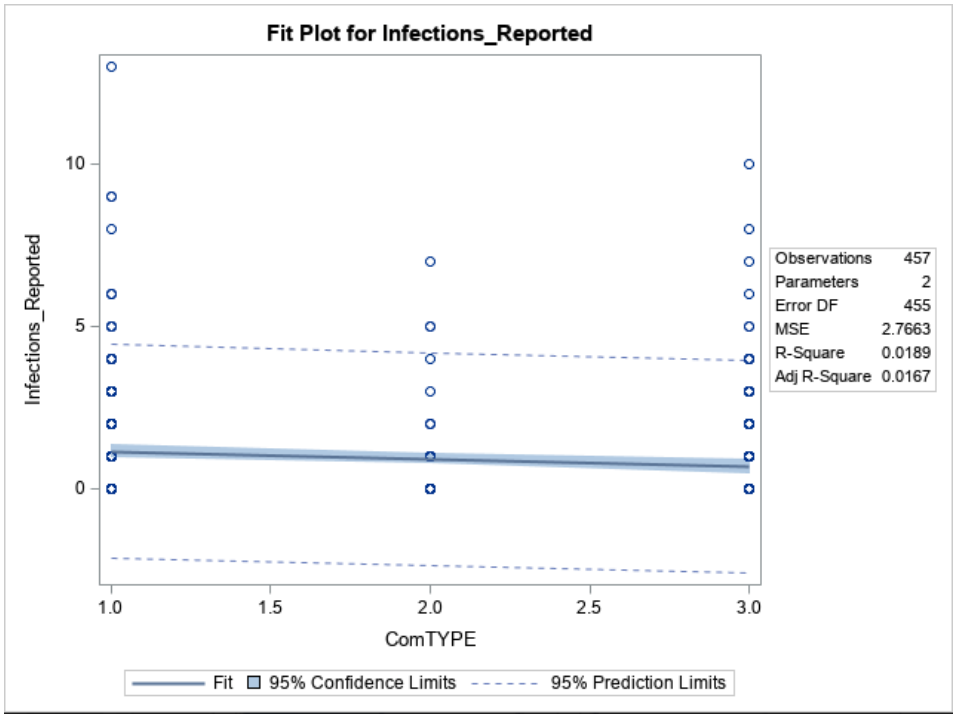

Figure 6:

In Figure 6, the linear regression between the community type and the respective number of reported MRSA infections in 2020 revealed a negative correlation with an adjusted R-Square of 0.0167. The adjusted R-square for each of the linear regressions excluded outliers in each data set.

Conclusions

The relatively large increase in the average number of cases per county in the rural community type between 2015 and 2017 is due to the loss of one county in 2017.

Table 3:

Year	2015	2017	2020
# of Counties			
Rural	47	46	48
Suburban	2	2	2
Urban	7	7	7
	56	55	57

Table 3 indicates that the number of rural counties in 2017 was only 46 compared to 47 in 2015. The loss of this county caused the average number of cases for each rural county to

increase dramatically. The county that was not reported in 2017 could be due to the closure of the only hospital in the county or the lack of any MRSA cases in the county that year. The increase in the average and total number of cases per county in the urban and suburban community type between 2017 and 2020 could be attributed to the COVID-19 pandemic. The pandemic made healthcare workers overworked like never before and caused lax MRSA prevention across California as the focus shifted to COVID-19. This storm could have increased both the average and total number of cases in both urban and suburban community types in 2020. The strong positive correlation between years and the number of MRSA infections for each community type suggest the increase of MRSA cases over the years. Conversely, the negative correlation between community type and number of MRSA infections in each year was very weak regardless of the year. While a negative correlation would suggest the number of MRSA infections is the highest for the urban community type, in the middle for the suburban community type, and the lowest for the rural community type, we cannot support this correlation with just this statistical analysis alone. In order to support such a weak correlation, further data collection/statistical analysis is required.

There are quite a few strengths of this study along with a couple weaknesses. The MRSA infection data set from the California Health and Human Services Open Data Portal is a complete data set for California and includes all confirmed MRSA cases for each year. The data set is also relatively large as it includes a massive population and geographical area. There is less bias in the collection of data as all confirmed MRSA infection cases in California are included with no exclusions. This also means that this data set is cross regional as it includes people of multiple socioeconomic, ethnic, and religious backgrounds. The largest weaknesses in the study comes from the statistical analysis as the cutoffs for the community types are very rigorous. For

example, a very populous city like San Diego is considered a suburban community type under our guidelines due to the lower population density. The large amount of unpopulated land in San Diego decreases its population density causing it to be considered suburban instead of urban. In addition, the suburban category was too small and selective, containing only 2 counties out of the 58. Another limitation comes from the data set as it only contains California instead of incorporating other parts of the U.S. or the world. Most importantly, the data set does not include the severity of the MRSA infections. As mentioned previously, some MRSA infections will only result in swollen bumps on the skin, but some MRSA infections will ultimately lead to death. Understanding the severity of infection is important to determine the allocation of energy and resources towards specific counties or community types. This statistical analysis suggests the allocation of resources and attention should be shifted over to the rural counties of California due to the largest increase of MRSA cases in proportion from 2015 to 2020. Further, more specific data collection is necessary to support possible correlations discovered within this study.

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