Analysis of Associations Between COVID-19 on EMS Calls

Introduction and Data

On March 13, 2020, President Trump declared a national emergency (1). As the COVID-19 pandemic progressed throughout the United States, early reports came back showing lower emergency department (ED) visits following week 11 (2,3). This drop in ED visits in the USA follows trends seen in other countries that showed similar drops in ED visits (3).

Transport to definitive care, usually an ED, is one of the primary goals of an EMS (emergency medical services) system (4). If fewer people are going to the emergency department, does that also correlate to lower EMS calls? And if people are more wary to call EMS, when they did call, would it be in more dire circumstances? Analysis of EMS call data can shed light on these questions.

The National Emergency Medical Services Information System (NEMSIS) is a national database that collects patient care records (PCRs). As of 2020, there is data available from 47 states, two territories, and the District of Columbia, with 44 states, two territories, and the District of Columbia consistently submitting data (5). Public data sets are accessible from the NEMSIS data cube. Call volume data and cardiac arrest classifications of calls were analyzed to gain insight into how the COVID-19 pandemic affected the calls that EMS was dispatched to.

Methodology

Datasets were downloaded from the NEMSIS data cube during the 30^{th} week of 2020 as comma-separated values files. The data downloaded was v3 data from 2017-present. When analyses were performed, data after the 28^{th} week were discarded as they were incomplete, due to the lag time of uploading data. For all hypothesis tests performed, alpha is 0.05. Before week 11 and after week 12 are classified as "pre pandemic" or "post pandemic" respectively. This period is chosen for the boundary due to the national emergency being declared in week 11 of 2020.

Two separate datasets were downloaded. The first dataset consisted of the call volumes for each week. A two-sample t-test was performed comparing the mean call volume between weeks 1-11 and 12-28 of 2020. Additionally, an analysis comparing the call volume of weeks 12-28 of each year was performed. An ANOVA test was ruled out after determining that there was not homoscedastic variance or normal distribution of call volume within each year. A Kruskal Wallace test was performed in its place. Wilcoxon rank sum tests were performed for step down tests, and a Bonferroni correction was performed as well.

The second dataset consists of the cardiac arrest (SCA) classifications and count, which consisted of five classes: no, not applicable, not recorded, yes after EMS arrival, and yes before EMS arrival. The classes "not applicable" and "not recorded" were filtered out prior to analysis, and the counts for both yes classifications were pooled to create one general yes classification. A ratio of yes's to no's was then created to standardize the data.

A two-sample t-test was performed comparing the mean SCA ratio between weeks 1-11 and 12-28 of 2020. Additionally, an analysis comparing the ratios between weeks 12-28 of each year was performed. After ruling out an ANOVA due to homoscedastic variance and normal distribution within each year not being present, a Kruskal Wallace test was performed in its place. Wilcoxon rank sum tests were performed for step down tests, which also compares medians, and a Bonferroni correction was performed as well.

Results

The call volume two-sample t-test yielded a test statistic of 4.639, which follows a t distribution with 12.422 degrees of freedom. This corresponds to a p value of 0.0005, meaning that there is enough evidence to suggest a difference in mean call volume exists. The Kruskal-Wallis test gave a p value of 2.964e-12, meaning that there is enough evidence to suggest at least one of the medians is different. The

Wilcoxon rank sum tests gave p-values of 8.57e-10 for each comparison except for 2019 to 2020, which yielded a p-value of 0.4332. The Bonferroni corrected p-value is 0.0083. Therefore, the evidence suggests that median call volumes are different between each year except between 2019 and 2020, for which the evidence does not suggest that they are.

Figure 1 shows the call volumes for the first 28 weeks of each year. Call volume increased between each year, though 2020 shows a drop down to the level of 2019 after week 11.

The SCA ratio two-sample t-test yielded a test statistic of -4.396, which follows a t distribution with 18 degrees of freedom. This corresponds to a p value of 0.0003, meaning that there is enough evidence to suggest the SCA ratio is different between weeks 1-11 and 12-28 of 2020. The Kruskal-Wallis test resulted in a p-value of 6.157e-09, meaning the evidence suggests at least one of the medians is different. The Wilcoxon rank sum tests gave p-values of 0.092, 0.005, and 0.586 for the comparisons between 2017 and 2018, 2017 and 2019, and 2018 and 2019, respectively. The p-values for the comparisons between 2020 and 2017, 2018, and 2019 are 8.57e-10, 3,428e-09, and 8.57e-10, respectively. The Bonferroni corrected p-value is 0.0083. Therefore, the evidence suggests that there is a difference in the median SCA ratio between 2020 and all other years, but not enough evidence to show a difference between the years 2017-2019.

Figure 2 shows the ratio of cardiac arrests for the entire year for years 2017-2019, and for the first 29 weeks of 2020. For years 2017-2019, the ratio creates a flat parabolic shape, peaking at weeks 1 and 52 and reaching a trough between weeks 20 to 40. For 2020, the ratio had a small peak at week 1 before slowly declining, until spiking after week 11. After a peak at week 15, the ratio began to decline.

Discussion

From 2017 through 2020, more states began submitting v3 data to NEMSIS at the beginning of each year, so the increase of call volumes between each year is not surprising. What is telling then is in 2020, the call volume drops back to 2019 levels after week 11 (showcased by both figure 1 and the Wilcoxon rank sum test). During the time after the national emergency, call volume data is at the same level as the previous year during the same time frame, despite more states reporting data. This drop in EMS calls is most likely due to individuals delaying medical care because of the COVID-19 pandemic. Although this is a retrospective observational study, and therefore no causal statements can be proved, a Kaiser Family Foundation poll showed that almost half of adults or one of their family members delayed medical care due to the outbreak (6). And with the drop in call volume coming after the national emergency was declared, a correlation can be seen between the COVID-19 pandemic and people delaying medical care.

Looking at the rise in the SCA ratio suggests that the drop in call volume is due to delayed care. Multiple studies over the years have shown that delaying medical care leads to poorer health outcomes (7)(8)(9). In previous years (2017-2019), the SCA ratio holds steady, with a slight increase in winter weeks due to cardiovascular diseases being more prevalent during wintertime (10)(11). In 2020 however, there is a spike in the SCA ratio after week 11(fig.2). This increase, being statistically significantly different from the previous years, could be indicative of the effects of lower EMS call volume, which may be the result of individuals delaying care.

Although formal statistical hypothesis tests were performed, a numerical and graphical interpretation of the data would be more intuitive and easier to understand for a wider audience. Such hypothesis tests only tell you if there is enough evidence to suggest a difference or not, while it is the direct numerical and graphical interpretations, such as “average call volume dropped by about 100000 after the pandemic,” that can say how it changed and by how much. In this instance, formal hypothesis tests are a more roundabout way to portray less information, and perhaps they are not needed to properly analyze the data.

The removal of the “not applicable” and “not recorded” classifications from the cardiac data was done because the classifications were due to missing data. Had the missing data not been there, or not been present to such an extent (the two classifications made up a significant amount of the total counts, usually a third of the number of “no’s”), the analysis would have been stronger.

Total call volume is a very surface level analysis, and SCA ratio is only one variable. More specific variables, such as the amount of motor vehicle crash calls or work-related injury calls could not only shed light on how the pandemic affected EMS calls, but also the broader population. Additionally, should this study be performed again, a better way to classify pre- and post-pandemic should be used. Perhaps a binary classification system should not be used at all, but instead, the total number of cases in a week, or perhaps the number of new cases in a week, to classify “strength” of the pandemic.

Figure 1: EMS Call Volume drops after Week 11 of 2020

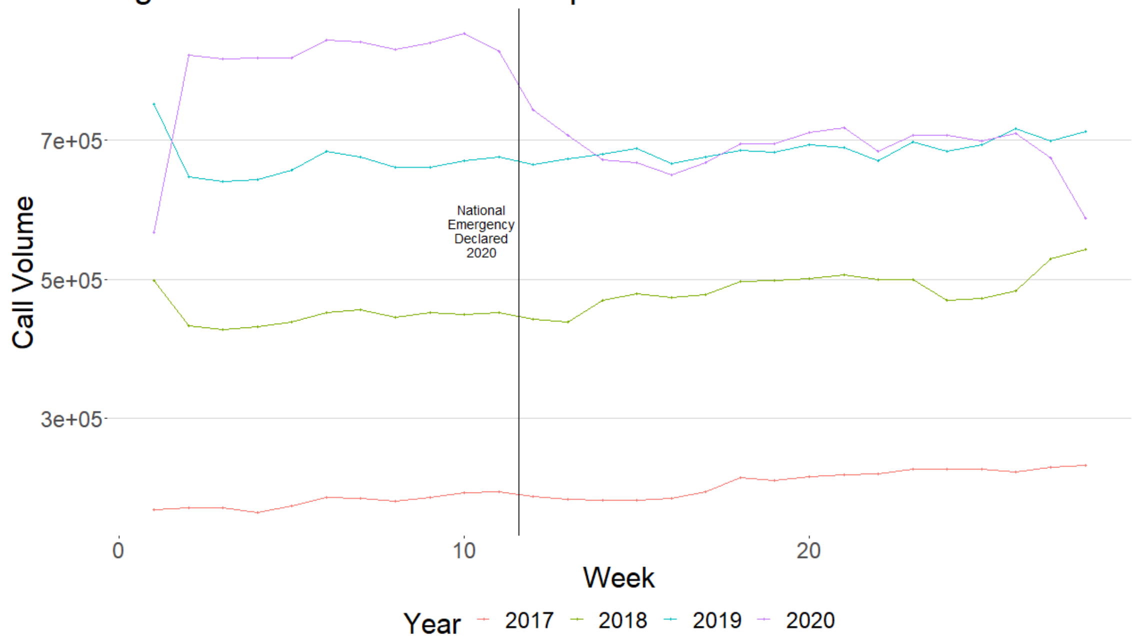
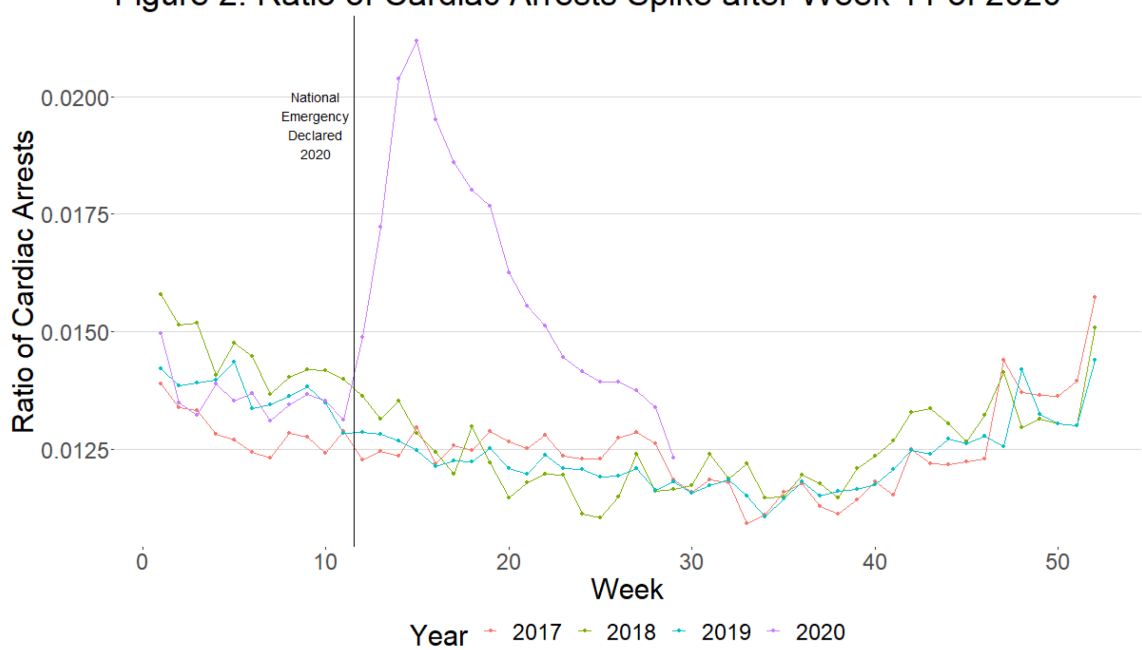


Figure 2: Ratio of Cardiac Arrests Spike after Week 11 of 2020



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