Degree of Change in Bystander Cardiopulmonary Resuscitation Rate During the Onset of the Global COVID-19 Pandemic in the State of Michigan

by

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Dedication

I dedicate my thesis work to my family. I have a special feeling of gratitude for my loving parents, Yong Pan and Jian Zhou ,whose words of encouragement and push for tenacity ring in my ears. I thank my husband, Kyle Potts, who never left my side and always supports me. I appreciate all he has done.

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Abstract

The purpose of this study is to understand how COVID-19 has affected bystander performance of cardiopulmonary resuscitation (CPR) for out-of-hospital cardiac arrest (OHCA) patients. Studies have shown that bystander CPR can double or triple a person's chance of survival. However, during the onset and aftermath of the global COVID-19 pandemic, the risk for COVID-19 exposure during CPR for OHCA is a significant concern for bystanders. I hypothesize that, as a result of COVID-19 pandemic, the rates of bystander CPR have decreased significantly.

To test this hypothesis, I conducted a quantitative research study by using data from the Cardiac Arrest Registry to Enhance Survival (CARES) registry - a nationwide central registry of OHCA data collected from emergency medical services (EMS) agencies. For this study, Michigan CARES data from January 1 to June 30, 2019 and from January 1 to June 30, 2020 were compared.

In a comparison of 844 OHCA in 2019 and 8591 in 2020, the proportion of cases receiving bystander CPR was lower in 2020 (25% vs 28%, $p = 0.78$); An increased proportion of OHCA occurred in the home (86% vs. 82%, $p = 0.44$), and decreased proportion in public spaces (14% vs 18%, $p = 0.16$). There were more monthly OHCA cases overall on average (143 vs 141, $p = 0.79$) and the survival to hospital admission rate was lower during pandemic period (25% vs 28%, $p = 0.24$). Per my analysis, the decrease in the rate of bystander CPR in 2020 during the pandemic is not statistically significant. However, it is reassuring that the COVID-19 pandemic did not seem to significant impact the rate of bystander CPR as we know that early CPR is critical to optimal outcomes for people experiencing OHCA and for the professionals who work to maximize the rate of bystander CPR during OHCA.

Chapter 1 Introduction

In 2018, American Heart Association published a report that indicates more than 350,000 cardiac arrests occur outside of hospitals each year. Sadly, approximately 90 percent of people who experience out-of-hospital cardiac arrest (OHCA) do not survive[1]. If, however, cardiopulmonary resuscitation (CPR) was performed immediately for persons experiencing OHCA, the survival rate can potentially double or triple. Unfortunately, only about 46% of people who experience an OHCA receive bystander CPR before emergency medical services (EMS) arrives[1].

To study OHCA and improve patient outcomes the Cardiac Arrest Registry to Enhance Survival (CARES) registry was created in 2004. CARES data includes arrest information such as arrest location, resuscitation attempted by 911 responders, and who initiated CPR[2]. Scholars have previously conducted many research studies in resuscitation science using the CARES registry.

For example, Abrams developed a composite multivariate logistic regression model by using CARES data[3]. This model yields survival rate projections for various improvement scenarios, such as the use of bystander AED can increase the survival rate by 14 percent. Others, like McNally, generated the first report that summarizes surveillance OHCA data in the United States[4]. McNally's study found that approximately 36.7 percent of OHCA events contain bystander witnesses. However, only 33.3 percent of all patients received bystander CPR, and only 3.7 percent were treated with an Automated External Defibrillator (AED) before the arrival

of EMS providers. Another study conducted by May found a 73% improvement in survival for OHCA patients in Detroit, MI, over three years by reviewing 2,359 non-traumatic OHCA cases.[5]

This thesis presents a study of bystander CPR in OHCA during the 2020 onset of the global COVID-19 pandemic. SARS-CoV-2 (COVID-19) is an infectious respiratory illness caused by a newly discovered coronavirus. The virus is primarily transmitted through respiratory droplets and routes of droplet contact. It was first identified in Wuhan, China in December 2019. Despite previous scholarly research in COVID-19 and CPR, including the development of CPR guidelines to resuscitate potential COVID-19 patients[6], and identification of potential transmission risk associated with chest compression, defibrillation, and cardiopulmonary resuscitation[7], the potential impacts of COVID-19 on bystander CPR remain unclear.

As one of the recurring 'epicenters' of COVID-19 disease in the United States, the State of Michigan has 723,700 confirmed cases and 17,047 total COVID-19 deaths as of March 28, 2021. Being exposed to COVID-19 while providing CPR to others experiencing OHCA is a reasonable concern for bystanders who might provide CPR. Initial evidence from Italy suggests that the number of patients who received CPR from bystanders decreased 15.6 percent compared with the same time in 2019[8]. However, this Italian study has a relatively small dataset and a short time period.

For my work, the primary aim is to understand the degree to which COVID-19 has changed bystander performance of CPR for OHCA patients in the State of Michigan at the onset of the pandemic. According to American Heart Association News, the crucial role that bystanders play has not been changed by the COVID-19 pandemic. Furthermore, for cardiac arrests at home, bystanders who are also cohabitating family members and who perform CPR may have more information about the patient and be at lower risk for COVID-19 transmission [9].

Sayre's study has found that bystanders' likelihood of performing CPR during OHCA had not decreased significantly during the first few months of pandemic in their study population/region[10]. However, it remains unclear whether COVID-19 may make it harder to motive bystanders to perform CPR. Thus, the aim of this research is to clarify the impacts of COVID-19 on rates of bystander-provided CPR in Michigan.

I hypothesized that the rates of bystander CPR decreased significantly during the onset of the global COVID-19 pandemic. To test this hypothesis, I extracted and analyzed data from the Cardiac Arrest Registry to Enhance Survival (CARES). Data about CPR in cases of OHCA were compared for two six-month periods. The first study period, which passed before the COVID-19 pandemic, is from January 1 to June 30, 2019. The second study period, which passed as the pandemic was taking hold across Michigan and the globe, is from January 1 to June 30, 2020.

Chapter 2 Research Design and Methods

OVERVIEW

The first positive cases of COVID-19 in Michigan were confirmed on March 10, 2020. By March 16, 2020 Michigan's Governor issued an order to close most public places and limit gatherings of more than 50 people as the COVID-19 cases increased to more than 50. To explore the impact of the COVID-19 pandemic on the rates of bystander CPR for OHCA in the State of Michigan, I conducted a quantitative research study. A bystander CPR event includes an attempted resuscitation by a bystander of a victim suffering an apparent OHCA. Comparisons of bystander CPR events during these two periods were made using descriptive statistics.

DATA SOURCES AND DEFINITIONS

Data for the study was obtained from the Michigan Cardiac Arrest Registry to Enhance Survival (CARES) registry. This study was reviewed by the University of Michigan Institutional Review Board (IRB) as exempt. I conducted a comparison of patients with non-traumatic OHCA during the COVID-19 period in 2020 to the same time period in the previous year. The first timeframe pre-COVID-19 includes OHCA data from January 1, 2019 to June 30, 2019. The second time frame covers matching months one year later, at the outset of the COVID-19 outbreak. It includes OHCA events and data from January 1, 2020 to June 30, 2020. The first national confirmed case of COVID-19 was reported in January 2020. There were concerns in the state of Michigan during that time though there has no confirmed case until March. Because the purpose of this study is to understand how COVID-19 has affected bystander CPR performance,

it is important to include the first two months of data from 2020 to test my hypothesis. Since the focus is on bystander CPR exclusively, each event in the data set occurred before Emergency Medical Service (EMS) arrived on the scene.

CARES is a nationwide central registry of OHCA data from emergency medical services (EMS) agencies. The Centers for Disease Control and Prevention (CDC) collaborated with Emory University School of Medicine to develop CARES in 2004. CARES was developed to help communities determine standard outcome measures for OHCA, allowing for local improvement efforts and benchmarking capability to improve care and increase survival[11]. Data elements related to OHCA from emergency "9-1-1" dispatch centers, EMS providers, and receiving hospitals are provided by EMS agencies and partner hospitals. In 2020, CARES combined 28 state-based registries. The registry represents a catchment area of 145 million people (45% of US population)[11].

To begin my work with CARES registry data, I applied a filter to extract bystander CPR related data from home and public locations. I restricted the role of the person who initiated CPR to bystanders who are not part of the organized EMS system. The definition of location type and the person who initiated CPR are provided in Table 1 and Table 2.

Location Type	Definition
Home/Residence	Includes apartment, boarding house, dormitory, group home, institutional place of residence, halfway house, military barracks, mobile home, private home, residential house, and home premises (private driveway, garage, garden, walkway, swimming pool within private residence or garden, and yard of home.)
Public/Commercial Building	Any building used by the general public including a bank, café, casino, church/place of worship, courthouse, dance/music hall, daycare center, farm, fire station, gas station, hotel/motel, jail/prison, library, market, movie cinema, museum/art gallery, nightclub, office building, parking garage/parking lot, post office, restaurant, school, shop/store, and theater. *Excludes* home garage (see Home/Residence), industrial building/workplace (see Industrial Place), and physician's office (see Healthcare Facility).
Street/Hwy	Includes all public roadways, sidewalks, or roads not associated with a residence or business.
Nursing Home	Includes all medical residential institutions that are licensed by the state as nursing homes or assisted-living centers.
Healthcare Facility	Includes doctor/dentist office, dialysis clinic, free standing clinic, and rehabilitation facility (unless meeting the definition of a Hospital, as in-hospital arrests do not qualify as CARES cases).
Place of Recreation	Includes athletic court/field/grounds, amusement park, beach, campsite, golf course, gymnasium, hike/bike trail, holiday camp, lake resort, mountain resort, playground, public park, racetrack, resorts of all types, riding school, rifle range, skating rink, sports grounds, stadium, public swimming pool, and zoo. *Excludes* occurrence in private house, garden, swimming pool, or yard (See Home/Residence).
Industrial Place	Includes building under construction, dock or shipyard, factory, loading platform in factory or store, industrial plant, mine or pit, oil rig, quarry, railway yard, and warehouse.
Transport Center	Includes airport, bus station/terminal, ferry terminal, highway rest stop, and train/subway station.
Other	To be used when location is not included in the above categories. When this option is selected, please indicate/describe the location type in the free text field. Includes homeless camp/tent city, general outdoors, vehicle in transit (i.e. ferry/boat on a body of water) and wilderness area (desert, forest).

Table 1: Location Types Recored in the CARES Registry

Who Initiated CPR	Definition
Not Applicable	CPR was not initiated by lay person or 911 Responder.
Lay Person	Bystander not responding to the medical emergency in an official capacity (i.e. not part of the 911 response team). Known family members and medical providers are excluded from this group. *(See "Lay Person Family Member" and "Lay Person Medical Provider" below.)*
Lay Person Family Member	Lay person who is known to be a family member of the patient.
Lay Person Medical Provider	Physicians, nurses, or paramedics who are not part of the organized rescue team.
First Responder (non-EMS)	Personnel who respond to the medical emergency in an official capacity as part of an organized medical response team, but are not the designated transporter of the patient to the hospital.
Responding EMS Personnel	Organized responding personnel who are the designated transporter of the patient to the hospital.

Table 2: Role of the Person Who Initiated CPR (First responders are part of the organized EMS response system and therefore they were not included as bystanders)

FINAL STUDY POPULATION

In addition to limiting the location where CPR was performed and who performed it, I selected the State of Michigan as the study region. To provide context for the number of CPR and OHCA events studied, according to the Michigan Department of Health and Human Services, Michigan's population approaches ten million people. More precisely, there were estimated to be 9,984,000 and 9,986,000 Michigan residents in 2018 and 2019, respectively.

STATISTICAL ANALYSIS

I initially extracted a total of 6,542 OHCA cases from the CARES registry. For the first time period from January 1 to June 30, 2019, 3,042 cases were found. From the second COVID-19 time-period from January through June 2020, 3,500 cases were found.

Adding detail to what was mentioned above, to study specifically how OHCA bystander CPR may be affected by COVID-19, I removed some cases from the analysis. I restricted the event location to home or residence, public or commercial building, street or highway, recreation, industrial place, transport center, and any other places that are not a medical facility

or nursing home. I also limited the CPR provider to layperson, layperson family member, and layperson medical providers the first person to initiate CPR. After applying these limitations, I included 844 cases from 2019 and 859 cases from 2020 with non-traumatic OHCA.

To compare changes in rates between the two time-periods studies, I used a two-sided T-test. A two-tailed test is appropriate for this study is because I want to determine if there is any difference, both positive or negative, between the groups of data. I assumed equal variances for discrete variables such as OHCA monthly cases. Data were analyzed using Microsoft Excel, and Python 3 software code that I wrote and executed using the Jupyter Notebook platform. Prior to doing the analysis, P values of < 0.05 were considered to be statistically significant. Six-month incidence rates with 95 percent confidence intervals (CIs) were calculated for each time-period. For the numerators, the relevant number of bystander CPR events for each time period was used. For the denominators, the Michigan Department of Health & Human Services population estimate for Michigan for the year 2018 or 2019 were used to estimate Michigan's population in 2019 and 2020, respectively.

Chapter 3 Results

As noted above, overall, for both periods studied, a total of 6,542 OHCA cases were identified. A total of 1,703 cases of OHCA met the study's inclusion criteria. During the pre-pandemic period (Jan 1 to Jun 30, 2019), 844 cases were examined (525 males [62%] and 319 females [38%]; mean age 58.8). During the pre and peri COVID-19 pandemic period (Jan 1 to Jun 30, 2020), 859 cases were examined (548 males [64%] and 311 females [36%]; mean age 60.2). Compared with 2019, 2020 had slightly higher OHCA incidence rate. (8.45/100,000 vs 8.60/100,000).

Table 3 displays the characteristics of patients with out-of-hospital cardiac arrest (OHCA) who underwent bystander resuscitation during each period. The patients with OHCA arrest in 2020 were slightly older (mean years of age 60.2 vs 58.8); and more likely to have patients who are 80 years old or above (14% vs 11%).

Table 4 below displays bystander CPR information and survived to hospital admission outcomes for OHCA patients who underwent resuscitation during each period. Bystander CPR rate is lower in 2020 (25% vs 28%, $p = 0.78$). Asian (1.67/100,000 vs 0.55/100,000) and Native Hawaiian/Pacific Islander (2.19/100,000 vs 1.08/100,000) are less likely to receive bystander CPR compared to other race and ethnicity groups in 2020. An increased proportion of OHCA occurred in the home (86% vs. 82%, $p = 0.44$), and decreased proportion in public spaces (14% vs 18%, $p = 0.16$). There are more monthly OHCA cases overall on average (143 vs 141, $p = 0.79$) and total survived to hospital admission rate was lower during pandemic period (25% vs

28%, p = 0.24). Additionally, average survived to hospital admission case by month is lower in 2020 (16.6% vs 16.8%, p = 0.24). Survived to hospital admission cases in 2020 has lower mean per month for both compression only and ventilation and compression performed by bystander (27 vs 30, p = 0.37; 9 vs 10, p = 0.45, respectively). Survived to hospital admission were lower in 2020 among all race and ethnicity group except Hispanic/Latino (0.95 vs 0.77) in 2020.

OHCA Pre-Pandemic Versus COVID - 19 Pandemic			
	Pre-Pandemic January - June 2019 (n= 844)	Pandemic January - June 2020 (n=859)	p value
Mean age, yrs	58.8	60.2	
Age categories, yrs (%)			
0-40	141(17)	122(14)	
41-80	605(72)	613(71)	
81-120	97(11)	123(14)	
Gender			
Male	525(62)	548(64)	
Female	319(38)	311(36)	
Demographic			
White	514(61)	536(63)	
Black/African-American	213(25)	226(27)	
Hispanic/Latino	7(0.83)	13(1.51)	
Asian	2(0.24)	2(0.23)	
Native Hawaiian/Pacific Islander	4(0.48)	0	
Amerian - Indian/Alaska	2(0.24)	1(0.12)	

Table 3 The Characteristics of Patients with OHCA 2019 Versus 2020

OHCA Pre-Pandemic Versus COVID - 19 Pandemic			
	Pre-Pandemic January - June 2019 (n= 844)	Pandemic January - June 2020 (n=859)	p value
Bystander CPR % rate	28	25	0.78
OHCA patients received bystander CPR by race per 100k			
White	6.4	6.67	
Black/African-American	14.25	15.09	
Hispanic/Latino	1.35	2.46	
Asian/Pacific Islander	1.67	0.55	
Native Hawaiian/Pacific Islander	2.19	1.08	
Bystander CPR by location			
Home/Residence	695(82)	742(86)	0.44
Public	149(18)	117(14)	0.16
Avg OHCA case by month	141	143	0.79
% of total who survived to hospital admission	28 (n = 238)	25 (n = 211)	0.24
Avg survived to hospital admission case by month	40(16.8)	35(16.6)	0.24
Avg case by month for compression only	30	27	0.37
Avg case by month for compression and ventilation	10	9	0.45
OHCA patients survived to hospital admission by race per 100k			
White	2.05	1.98	
Black/African-American	3.41	2.47	
Hispanic/Latino	0.77	0.95	
Asian/Pacific Islander	0.28	0	
Native American	0	0	

Table 4 Bystander CPR Information and Survived to Hospital Admission Outcomes for OHCA Patients 2019 Versus 2020

Chapter 4 Discussion

During the global COIVD-19 pandemic period which began in the United States in early 2020, raw numbers indicate that the incidence of OHCA increased, bystander use of CPR decreased in public places, increased at home, and survival to hospital admission for OHCA declined compared to the same period the year before. However, none of these slight changes reached statistical significance. I interpret these results to mean that the rate of bystander CPR for OHCA in Michigan did not decrease in the first half of 2020 compared to the first half of 2019.

These findings contrast somewhat with the results from Baldi et al. study and also with the Michigan CARES Coronavirus Impact January to May 2020 Report. Baldi et al. used the Lombardia Cardiac Arrest Registry (Lombardia CARe) to examine the relationship between COIVD-19 and OHCA at the Lombardy region of Italy. Baldi et al. study reported a 58 percent increase in the OHCA incidence for the first 40 days of COVID-19 outbreak. The OHCA incidence at home was 7.3 percent higher compared with the same period in 2019. The team also found that the bystander CPR was 5.6 percent lower than the year before.

Meanwhile, in the Michigan CARES Coronavirus Impact Report, bystander CPR in public places decreased from 45.1 percent to 34.7 percent from March to May 2020. Interestingly, bystander CPR rate for home and residence in the state of Michigan also increased from 31 percent to 36.8 percent during the same time frame.

I observed that more OHCA occurred at home starting in April during the pandemic. This may be due to a stay-at-home order announced by the Michigan Governor on March 23rd, 2020 and may also explain part of the decline in bystander CPR in public places, although bystander response declined in all locations (Figure 1) (Figure 2). I also noticed that the public place only CPR rate increased back up in May, residential CPR rate decreased, respectively. I believe this increase could be associated with an increase in outdoor activities and public gatherings as Michigan's weather improved and as political events unfolded which tended to push back on virus-related restrictions, such as some public protests held in Michigan.

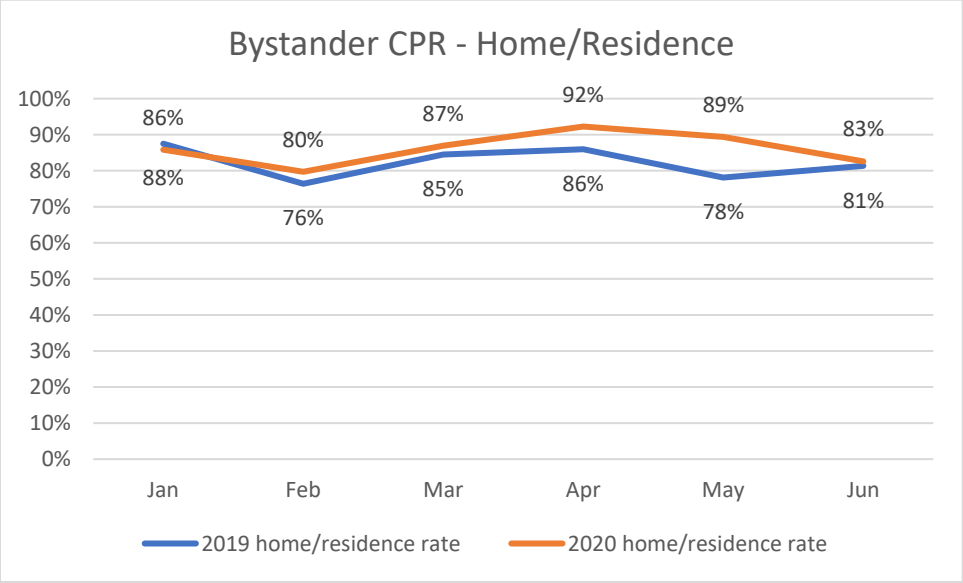

Figure 1 Bystander CPR for Home/Residence Only 2019 Versus 2020

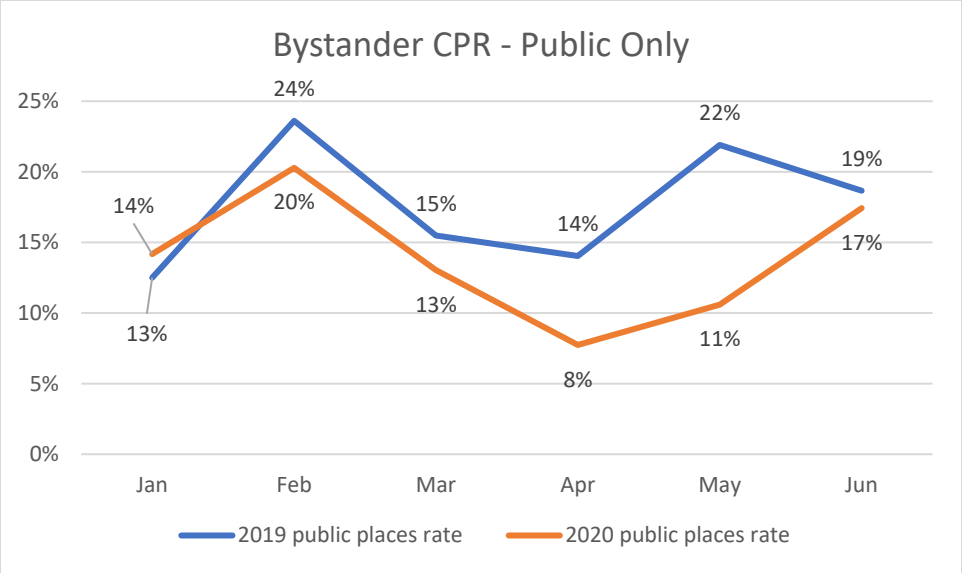

Figure 2 Bystander CPR for Public Places Only 2019 Versus 2020

Overall, bystander CPR rate remained the same in 2020 compared with pre-pandemic period (Figure 3). The declines in bystander CPR have been associated with lower survival from OHCA. My study also raises the possibility that there is a meaningfully lower survival rate to hospital admission for OHCA from March in year 2020 (Figure 4).

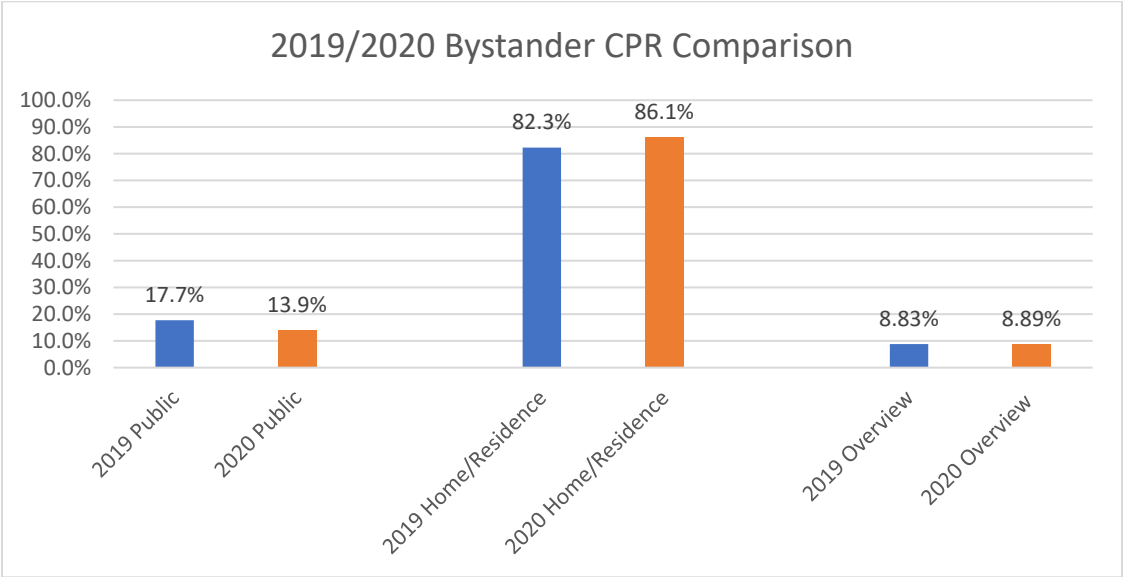

Figure 3 Bystander CPR Rate Comparison 2019 Versus 2020

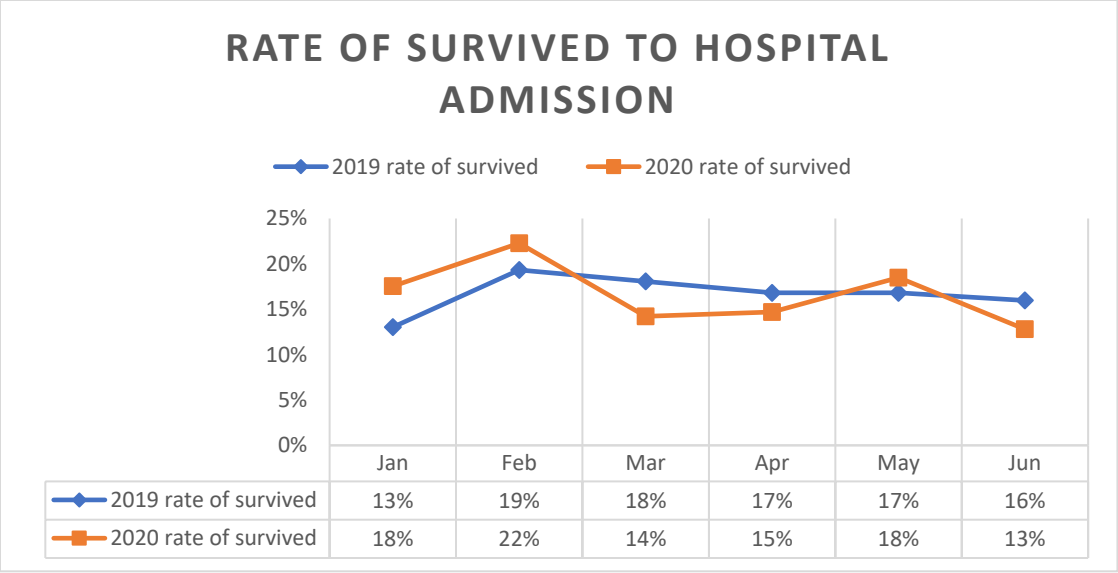

Figure 4 Rate of Survived to Hospital Admission 2019 Versus 2020

Although I observed many slight changes, I did not see any significant changes in the values studied compared with previous year. This result suggests that bystanders are still providing CPR during the pandemic. I believe it is reasonable to assume, that due to stay-at-home orders, CPRs were performed by patients' family members when OHCA occurred at home. It is also important to acknowledge that compression-only bystander CPR was suggested by the American Heart Association during the pandemic. Thus, the person who provided CPR may not fear of contracting the virus during resuscitation or had early exposure of COVID-19 if the lay person was tested COVID positive.

However, in my study, minority race/ethnicity surface as a possible, but unconfirmed, risk factor for not receiving bystander OHCA. Asian patients were at slightly increased risk to not receive bystander CPR, but again this difference is not statistically significant. As race/ethnicity are available in some cases, but not all in CARES, this may be a point of future research. CARES has been used by Hofacker et al. to study CPR racial disparities in the past.

Hofacker et al.'s study found that black and Asian patients who experienced OHCA in dialysis clinics were less likely than white patients to receive CPR initiated by dialysis staff[12].

Future research on bystander CPR racial disparities during pandemic is needed. Since the first report of COVID-19 in the US, Asian Americans, especially Chinese Americans, have experienced additional acts of discrimination by their classmates, neighbors, and fellow citizens. Despite guidance from the World Health Organization, Trump administration officials, including the former president himself, have referred COVID-19 as the "Chinese virus," "Wuhan virus," and even "Kung Flu". The Center for Disease Control pointed out that Asian American, Pacific Islanders and Black or African Americans may experience stigma during the COVID-19 pandemic[13]. Groups who experience stigma may experience discrimination such as social avoidance or rejection, denials of healthcare, and even physical and verbal abuse. These impacts could potentially relate to the provision of bystander CPR.

In this study, overall, 154 individuals were coded as "COVID-19 positive" under the presumed cardiac arrest etiology. After filtering out cases, in the study population only 22 cases were coded as "COVID-19 positive". However, etiology of cardiac arrest was reliant on EMS reporting. It was not definitive to know the COVID-19 status of a patient in the pre-hospital environment unless this diagnosis was established previously by a medical provider (or during hospitalization).

Additionally, OHCA mean age increased slightly from February to April during pandemic period then decreased in May and June. Further investigation is needed to study the relationship between COVID, cardiac arrest and age over time.

Chapter 5 Limitations and Conclusion

There are several limitations to my study that are shared among other reports of out-of-hospital cardiac arrest in the COVID-19 pandemic. First, the study population was limited to those who received resuscitation and was registered in CARES. Additionally, all registry-based data has limitations, which includes potential data entry error, missing data, and other reporting biases from the organizations providing data to CARES. In this study, 10.7% of our study population had race/ethnicity coded as "unknown". Furthermore, patient race/ethnicity in CARES was determined by emergency responders and was not self-identified. Although missing data can be an issue with large databases, CARES has explicit, objective definitions for reporters to record data correctly to mitigate potential biases. Second, because postmortem testing to confirm COVID-19 was rarely performed, the study cannot distinguish between increased OHCA cases directly due to COVID-19 or indirectly due to unattended comorbid disease during the pandemic. Third, I compared only a single timeframe (January – June 2019) to the COVID-19 pandemic period. It is possible that selecting different years as alternative baselines for comparison may have different results.

The unprecedented and rapidly evolving health crisis presents a unique challenge in the pre-hospital setting. Yet, this study suggests that the COVID-19 pandemic had only modest if any real effects on rates of bystander CPR in Michigan. Based on this main finding, there is reason to believe that continued bystander CPR training can help keep improving OHCA survival rate in Michigan's communities during and after the pandemic period. According to

American Heart Association, bystanders should only provide hands-only CPR during COVID-19. It is important for educators to clarify the modification of bystander resuscitation protocol due to the effects of COVID-19 in training.

Bibliography

1. Benjamin EJ, Virani SS, Callaway CW, et al. Heart Disease and Stroke Statistics-2018 Update: A Report From the American Heart Association [published correction appears in Circulation. 2018 Mar 20;137(12):e493]. *Circulation*. 2018;137(12):e67-e492. doi:10.1161/CIR.0000000000000558
2. McNally B, Stokes A, Crouch A, Kellermann AL; CARES Surveillance Group. CARES: Cardiac Arrest Registry to Enhance Survival. Ann Emerg Med . 2009; 54 (5): 674-683.e2. doi: 10.1016 / j.annemergmed.2009.03.018
3. Abrams HC, McNally B, Ong M, Moyer PH, Dyer KS. A composite model of survival from out-of-hospital cardiac arrest using the Cardiac Arrest Registry to Enhance Survival (CARES). Resuscitation . 2013; 84 (8): 1093-1098. doi: 10.1016 / d.resuscitation.2013.03.030
4. McNally B, Robb R, Mehta M, et al. Out-of-hospital cardiac arrest surveillance --- Cardiac Arrest Registry to Enhance Survival (CARES), United States, October 1, 2005 - December 31, 2010. MMWR Surveill Summ . 2011; 60 (8): 1-19.
5. May S, Zhang L, Foley D, et al. Improvement in Non-Traumatic, Out-Of-HospitalCardiac Arrest Survival in Detroit From 2014 to 2016. J Am Heart Assoc . 2018; 7 (16): e009831. doi: 10.1161 / JAHA.118.009831
6. Edelson DP, Sasson C, Chan PS, et al. Interim Guidance for Basic and Advanced Life Support in Adults, Children, and Neonates With Suspected or Confirmed COVID-

19:From the Emergency Cardiovascular Care Committee and Get With the Guidelines ® -Resuscitation Adult and Pediatric Task Forces of the American Heart Association in Collaboration with the American Academy of Pediatrics, American Association for Respiratory Care, American College of Emergency Physicians, The Society of Critical Care Anesthesiologists, and American Society of Anesthesiologists: Supporting Organizations: American Association of Critical Care Nurses and National EMS Physicians. *Circulation*. September 2020. doi:10.1161/circulationaha.120.047463.

7. Couper K, Taylor-Phillips S, Grove A, et al. COVID-19 in cardiac arrest and infection risk to rescuers: A systematic review [published online ahead of print, 2020 April 20]. Resuscitation. 2020;151:59-66. doi:10.1016/j.resuscitation.2020.04.022
8. Baldi E, Sechi GM, Mare C, et al. Out-of-Hospital Cardiac Arrest during the Covid-19 Outbreak in Italy [published online ahead of print, 2020 April 29]. N Engl J Med. 2020;NEJMc2010418. doi:10.1056/NEJMc2010418
9. What to know about bystander CPR and coronavirus Risk [Internet]. [cited 2021Apr10]. Available from: https://www.heart.org/en/news/2020/05/12/what-to-know-about-bystander-cpr-and-coronavirus-risk
10. Sayre MR, Barnard LM, Counts CR, Drucker CJ, Kudenchuk PJ, Rea TD, Eisenberg MS. Prevalence of COVID-19 in Out-of-Hospital Cardiac Arrest: Implications for Bystander Cardiopulmonary Resuscitation. Circulation. 2020 Aug 4;142(5):507-9.
11. Cardiac Arrest Registry to Enhance Survival (CARES) [Internet]. Cardiac Arrest Registry to Enhance Survival (CARES) - Healthy People 2030. [cited 2021Apr10]. Available from: https://health.gov/healthypeople/objectives-and-data/data-sources-and-methods/data-sources/cardiac-arrest-registry-enhance-survival-cares

12. Hofacker SA, Dupre ME, Vellano K, McNally B, Starks MA, Wolf M, Svetkey LP, Pun PH. Association between patient race and staff resuscitation efforts after cardiac arrest in outpatient dialysis clinics: A study from the CARES surveillance group. Resuscitation. 2020 Nov 1;156:42-50.
13. Reducing Stigma [Internet]. Centers for Disease Control and Prevention. Centers for Disease Control and Prevention; [cited 2021Apr11]. Available from: https://www.cdc.gov/coronavirus/2019-ncov/daily-life-coping/reducing-stigma.html?CDC_AA_refVal=https%3A%2F%2Fwww.cdc.gov%2Fcoronavirus%2F2019-ncov%2Fsymptoms-testing%2Freducing-stigma.html