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EMS responses and non-transports during the COVID-19 pandemic

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ABSTRACT

Introduction: The COVID-19 pandemic may affect both use of 9–1-1 systems and prehospital treatment and transport practices. We evaluated EMS responses in an EMS region when it experienced low to moderate burden of COVID-19 disease to assess overall trends, response and management characteristics, and non-transport rates. Our goal is to inform current and future pandemic response in similar regions.

Methods: We performed a retrospective review of prehospital EMS responses from 22 urban, suburban, and rural EMS agencies in Western Pennsylvania. To account for seasonal variation, we compared demographic, response, and management characteristics for the 2-month period of March 15 to May 15, 2020 with the corresponding 2-month periods in 2016–2019. We then tested for an association between study period (pandemic vs historical control) and incidence of non-transport in unadjusted and adjusted regression. Finally, we described the continuous trends in responses and non-transports that occurred during the year before and initial phase of the COVID-19 pandemic from January 1, 2019 to May 31, 2020.

Results: Among 103,607 EMS responses in the 2-month comparative periods of March 15 to May 15, 2016–2020, we found a 26.5% [95% CI 26.9%, 27.1%] decrease in responses in 2020 compared to the same months from the four prior years. There was a small increase in respiratory cases (0.6% [95%CI 0.1%, 1.1%]) and greater frequency of abnormal vital signs suggesting a sicker patient cohort. There was a relative increase (46.6%) in non-transports between periods. The pandemic period was independently associated with an increase in non-transport (adjusted OR 1.68; 95%CI 1.59, 1.78). Among 177,194 EMS responses occurring in the year before and during the early period of the pandemic, between January 1, 2019, and May 31, 2020, we identified a 31% decrease in responses and a 48% relative increase in non-transports for April 2020 compared to the previous year's monthly averages.

Conclusion: Despite a low to moderate burden of infection during the initial period of the COVID-19 pandemic, we found a decline in overall EMS response volumes and an increase in the rate of non-transports independent of patient demographics and other response characteristics.

1. Introduction

On March 11, 2020, the World Health Organization declared COVID-19, the disease caused by the SARS-CoV-2 virus, to be a global pandemic [1]. The first presumptive positive cases in Pennsylvania were identified on March 7th [2]. Within two weeks, the governor ordered Pennsylvania schools and all non-essential businesses to close [3]. In parallel, emergency medical services (EMS) agencies began to plan and mobilize for the treatment and transport of COVID-19 patients. During the next few months, our region had a low incidence of COVID-19 patients, with a total of 130 cases per 100,000 residents reported in the largest county by May 15th, compared to an average of 474 cases per 100,000 residents across the Commonwealth of Pennsylvania [4,5]. Nevertheless, local EMS managers and medical directors developed policies and procedures, and implemented education, to address safely caring for patients with suspected or known COVID-19 and for a potential surge in call volume. How these measures, as well as lay press and public perception, changed EMS provider care is uncertain.

Alterations in emergency care utilization identified during the early part of the pandemic suggest changes in public behavior and their willingness to engage with the healthcare system in this environment. Multiple reports identified a decrease in ED encounters and hospitalizations for patients during the early period of the pandemic in areas with a low incidence of COVID-19 [6-9]. Using national hospital data, for example CDC researchers found ED visits declined by 42% in April 2020 compared

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to one year prior [10]. Other studies have identified parallel findings in other countries [11,12], and in specific patient populations [13-19]. Emergency department visits were also identified to not only be of lower volume, but lower acuity cases demonstrated the largest proportional decrease [20,21].

A preliminary report of trends in EMS incidents during the early portion of the pandemic using the National EMS Information System (NEMSIS) identified a general decrease in EMS activations in the United States compared to the prior weeks and the same time period in previous years [22]. Concurrently, there was a doubling in the rate of EMS-attended death. However, these preliminary data provided limited information with respect to patient-level factors. Other smaller studies have investigated the incidence and outcomes of out-of-hospital cardiac arrest (OHCA) during the pandemic, showing worse short-term outcomes associated with decreases in bystander CPR. Concurrently, a surge in telemedicine delivery has had the potential to decrease EMS utilization and increased rates of non-transports [23,24]. These findings and related changes in ED utilization suggest potential concurrent changes in EMS utilization and acuity of patients encountered in the out-of-hospital setting. Obtaining additional patient-level information on general EMS encounters with a focus on non-transports would better inform the EMS community of the impact on EMS utilization during the early portions of a pandemic.

We performed a detailed evaluation of EMS trends in Western Pennsylvania as a case example that may be useful for EMS agencies in other areas with low COVID-19 prevalence that must prepare for future waves of this or another pandemic. First, we describe overall trends in EMS responses in comparison to pre-pandemic baselines. Second, we describe differences in patient demographics, response characteristics, and medical management. Finally, we evaluate the impact of the COVID-19 pandemic on EMS non-transport rates, a specific disposition addressed in COVID-19 related EMS protocols. This information could be of use in current and future pandemic planning.

2. Methods

2.1. Study design and setting

We performed a retrospective review of prehospital electronic health records from 22 urban, suburban, and rural EMS agencies in Western Pennsylvania between March 15, 2016, and May 31, 2020. These EMS agencies receive medical oversight from a single academic health system, including both online and offline medical direction. The EMS agencies operate within a 12-county region of Southwestern Pennsylvania comprised of 8790 mile^2 with 2.7 million inhabitants [25]. The average population density across these counties is 308 people per square mile (range by county of 63 to 1666 people per square mile). Most ambulances are advanced life support (ALS) units, staffed by a paramedic and an emergency medical technician (EMT), though some are staffed with an advanced EMT instead of a paramedic. Basic life support units with two EMTs are less common. Medical management is outlined in statewide EMS protocols developed by the Commonwealth of Pennsylvania Bureau of EMS [26]. Operational guidance and EMS personnel education is supplemented by system EMS medical directors who provide unified guidance for all agencies under their medical oversight. This study was approved by the University of Pittsburgh Human Research Protection Office.

In this study setting, initial state and regional guidance for infection control focused on identification of patients at risk of COVID-19 and appropriate use of personal protective equipment (PPE). To limit airborne transmission of the virus related to aerosolizing procedures [27], health system medical directors provided interim recommendations to avoid aerosol generating procedures including intubation, avoid non-invasive positive pressure ventilation (e.g. CPAP or BVM), and nebulized medications when possible and to wear PPE for airborne transmission if these procedures were performed. Suggested alternatives included the use of bronchodilators via metered dose inhaler and intramuscular epinephrine or terbutaline for patients exhibiting bronchospasm. These recommendations were consistent with guidance from the Centers for Disease Control and Prevention (CDC), the American Heart Association, and the Commonwealth of Pennsylvania [28-30].

In response to an anticipated surge in call volume, we also developed medical advisories that emphasized non-transport with in-home care for mildly ill patients who were suspected of having a viral syndrome. The goal was to reduce EMS and emergency department (ED) utilization for asymptomatic or minimally ill patients. EMS personnel were required to contact a medical command physician when crews felt a patient could be managed at home based on specific guidelines. EMS agencies transported any patient still requesting hospital evaluation. These guidelines are similar to those implemented by other states [31,32].

2.2. Data source and abstraction

All participating EMS agencies use the same electronic prehospital health care record software (Zoll EMSCharts, Zoll Inc., Warrendale, PA). We excluded cases classified as interfacility transports and duplicate records generated due to scene assists by a secondary unit. Data were obtained in XML format and compiled into a research dataset using Matlab (MathWorks, Natick, MA) for extraction and Stata (StataCorp, College Station, Texas) for synthesis. We used automated electronic data abstraction to collect patient demographics, medical complaint, call date and response times, prehospital disposition, scene zip code, initial vital signs, mental status abnormalities, and interventions. To explore trends related to the pandemic, we first summarized monthly EMS call volume from January 1, 2019, to May 31, 2020. For the main comparative analysis, we included EMS encounters from five two-month time periods: March 15th to May 15th of 2020 compared to the same two-month periods from 2016 to 2019. Patient demographics included age, sex, race (white, black or other/unknown), and ethnicity (Hispanic, not Hispanic or unknown). TS, SR, and CM aggregated documented medical complaints from the medical category field within Zoll EMSCharts into nine categories: medical, cardiac arrest, cardiac, psychiatric/behavioral, respiratory, stroke, toxicological, trauma, and other/unknown. Based on data from custom cardiac arrest reporting fields in the chart as well as documented procedures or outcomes, we included in the cardiac arrest category all cases with compatible cardiac rhythms (asystole, pulseless electrical activity, ventricular fibrillation, or pulseless ventricular tachycardia), patient interventions (e.g. chest compressions, defibrillation), or patient outcomes (e.g. death on scene, pronounced on scene, and transport by coroner or funeral home). We classified the time of dispatch into four 6-h time categories and defined as weekday or weekend. We abstracted the zip code of each included encounter and identified the corresponding median income for the corresponding zip code tabulation area using data provided by the 2014–2018 American Community Survey [33,34]. We then categorized these by quartile.

We considered a vital sign parameter to be abnormal if it was documented to be outside the normal range at any point in the EMS response, and used age-adjusted normal values for patients ≤10 years old, each defined per American Heart Association Guidelines [35]. We defined low oxygen saturation as SpO_2 <95% based on Pennsylvania statewide EMS protocols. We defined abnormal mental status as “responds to pain” or “unresponsive,” or as Glasgow Coma Score <14 at any point in the EMS response. Loss of consciousness was documented by providers in each chart in a separate yes or no field. We identified if encounters had at least one ALS provider. We calculated response time, scene time, and transport time as the corresponding periods between time of dispatch, arrival on scene, departure from scene, and arrival at hospital. We obtained information on patient interventions from the dedicated categorized procedure fields in the patient care record. We evaluated for performance of advanced airways, endotracheal intubation, and supraglottic airways, use of non-invasive ventilation, oxygen, or nebulized medications, provision of intravenous fluids, use of a cardiac monitor, performance of a 12-lead electrocardiogram, or consultation with an online medical command physician.

2.3. Data analysis

Our primary analysis compared the two-month study period in 2020 to the average from the same dates in the prior 4 years, to eliminate potential effects of seasonal variation. We reported counts with percentages for categorical variables and mean with standard deviation for continuous data. We listed differences in percentages or means, respectively, along with the 95% confidence intervals for that difference.

To explore factors associated with patient non-transport, we first performed univariate regression to evaluate associations between patient demographics, response characteristics, management interventions and study period. We then performed adjusted logistic regression to evaluate the association of study period with non-transports adjusting for predictors with a univariable $p<0.10$. We used multiple imputation using chained equations to address missing data for age, sex, median income, and response time. We used predictive mean matching for continuous variables and logistic regression for categorical variables. Categories for age and median income by zip code were classified after imputation for the regression analysis. For the multivariable analysis, we considered associations significant at the $p<0.05$ level. Analyses were performed using STATA 15.1 (StataCorp, LLC, College Station, TX).

To further explore trends in overall EMS response volumes, we summarized these trends by constructing control charts. These were formed by plotting the monthly data on total scene responses and the non-transport percent from January of 2019 through May of 2020. The upper and lower control limits were set at three times the standard deviation using the average number of responses from the year preceding the pandemic (2019).

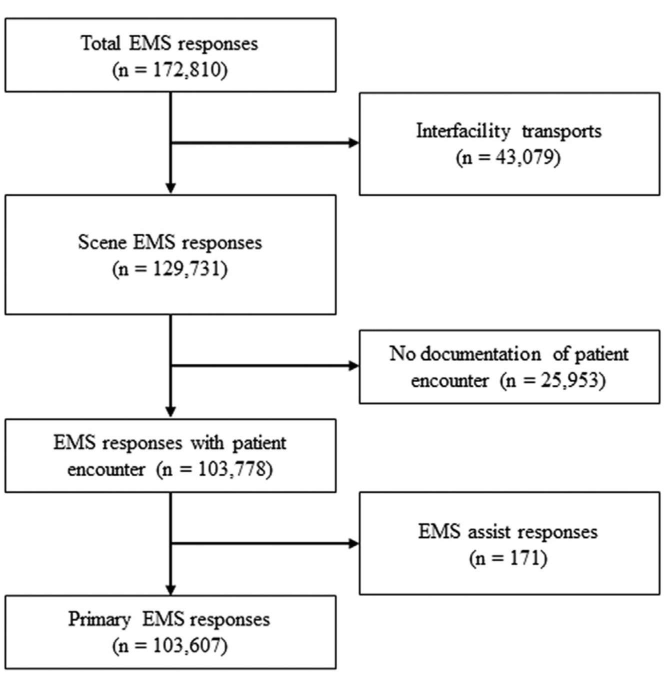

Fig. 1. STROBE Diagram of EMS Responses from March 15 to May 15 during 2016 to 2020.

3. Results

3.1. Comparison of EMS encounters between study (March–May 2020) and control (March–May 2016–2019) periods

We identified 172,810 patient encounters from March 15 and May 15, 2016 to 2020, of which 103,607 met inclusion criteria (Fig. 1). Data were missing in <2% of cases for age, sex, median income, and response time, and we performed 20 imputations to address these missing data.

Table 1
Response characteristics

	Control Period Mar15-May15, 2016–19	Study Period Mar15-May15, 2020	Change % Diff (95% CI)
Total	87,525 (21,881 / year)	16,082	−26.5 (−27.1, −25.9)
Age Category			
Adult (18–64 years)	45,313 (51.8)	8135 (50.6)	−1.2 (−2.0, −0.3)
Pediatric (0–17 years)	4856 (5.6)	635 (4.0)	−1.6 (−1.9, −1.3)
Geriatric (≥65 years)	36,720 (42.0)	7160 (44.5)	2.6 (1.7, 3.4)
Unknown	636 (0.7)	152 (1.0)	0.2 (0.1, 0.4)
Sex			
Male	39,397 (45.0)	7419 (46.1)	1.1 (0.3, 2.0)
Female	47,207 (53.9)	8422 (52.4)	−1.6 (−2.4, −0.7)
Unknown	921 (1.1)	241 (1.5)	0.4 (0.2, 0.6)
Race			
White	40,327 (46.1)	6882 (42.8)	−3.3 (−4.1, −2.4)
Black	13,794 (15.8)	2271 (14.1)	−1.6 (−2.2, −1.0)
Other/Unknown	33,404 (38.2)	6929 (43.1)	4.9 (4.1, 5.8)
Ethnicity			
Non-Hispanic	53,776 (61.4)	9112 (56.7)	−4.8 (−5.6, −4.0)
Hispanic	636 (0.7)	85 (0.5)	−0.2 (−0.3, 0.1)
Unknown	33,113 (37.8)	6885 (42.8)	5.0 (4.1, 5.8)
Medical Category			
Medical	45,838 (52.4)	8401 (52.2)	−0.1 (−1.0, 0.7)
Cardiac Arrest	2029 (2.3)	503 (3.1)	0.8 (0.5, 1.1)
Cardiac	5578 (6.4)	1017 (6.3)	0.0 (−0.5, 0.4)
Psychiatric/Behavioral	2290 (2.6)	461 (2.9)	0.3 (0.0, 0.5)
Respiratory	8433 (9.6)	1648 (10.3)	0.6 (0.1, 1.1)
Stroke	1162 (1.3)	247 (1.5)	0.2 (0.0, 0.4)
Toxicological	859 (1.0)	225 (1.4)	0.4 (0.2, 0.6)
Trauma	16,759 (19.2)	2900 (18.0)	−1.1 (−1.8, −0.5)
Other/ Unknown	4577 (5.2)	680 (4.2)	−1.0 (−1.3, −0.7)
Day period			
00:00–05:59	11,847 (13.5)	2331 (14.5)	1.0 (0.4, 1.5)
06:00–11:59	23,895 (27.3)	4294 (26.7)	−0.6 (−1.3, 0.1)
12:00–17:59	29,372 (33.6)	5432 (33.8)	0.2 (−0.6, 1.0)
18:00–23:59	22,411 (25.6)	4025 (25.0)	−0.6 (−1.3, 0.2)
Day of week			
Weekday	63,119 (73.3)	11,952 (74.3)	1.1 (0.3, 1.8)
Weekend	23,406 (26.7)	4130 (25.7)	−1.1 (−1.8, −0.3)
Median Income by ZIP code			
Fourth quartile (lowest income)	28,787 (32.9)	5371 (33.4)	0.5 (−0.3, 1.3)
Third quartile	19,192 (21.9)	3637 (22.6)	0.7 (0.0, 1.4)
Second quartile	21,163 (24.2)	3861 (24.0)	0.2 (−0.9, 0.5)
First quartile (highest income)	17,053 (19.5)	2898 (18.0)	−1.5 (−2.1, −0.8)
Unknown	1330 (1.5)	315 (2.0)	0.4 (0.2, 0.7)
Non-Transports	11,678 (13.3)	3135 (19.5)	6.2 (5.5, 6.8)

Race was documented in 38.9% as other/unknown and ethnicity in 38.6% as other/unknown, so we excluded these variables from regression analyses.

During the 2020 pandemic period there were 16,082 EMS responses, in contrast to the average of 21,881 responses in previous years (% change; −26.5% [95% CI -27.1%, −26.9%]; Table 1). We noted a slight increase in the proportions of cardiac arrests (0.8%; 95%CI 0.5%,1.1%), but this only represented 4 more cases per 2-month period compared to historical controls. While total number of respiratory cases decreased from an average of 2108 per year to 1648 in the study period, the proportion of calls coded as respiratory increased by 0.6% (95%CI 0.1%, 1.1%).

In the study period, we identified small increases in rates of tachycardia, tachypnea, and low oxygen saturation (Table 2). Response time was similar, but average scene time increased by 2.6 min (95%CI 2.4 min, 2.7 min). The use of advanced airways per patient contacts increased slightly (0.3%; 95%CI 0.2%, 0.5%). While proportion of patients receiving endotracheal intubation was unchanged, we noted a rise in the rate of supraglottic airway placement (0.3%; 95%CI 0.2%, 0.5%). The proportion of patients receiving nebulized medication administration declined by 3.4% (95%CI 3.1%, 3.6%).

3.2. Non-Transports during the study (March–May 2020) and control (March–May 2016–2019) periods

We evaluated the association of the pandemic period with non-transports. Non-transports represented 19.5% of the calls for service during the pandemic period, compared to 13.3% before (absolute increase of 6.2%; 95%CI 5.5%, 6.8%), a relative increase in non-transports of 46.6% (Table 1). In the univariate regression analysis, all patient, response, and management characteristics, as well as study period, were individually associated with an outcome of non-transport except for level of responder (Table 3). In multivariable analysis, the pandemic period was associated with an increase in patient non-transport (adjusted OR 1.68; 95%CI 1.59, 1.78).

3.3. Overall trends in EMS responses (January 2009 to May 2020)

Finally, to describe the overall trend in EMS Responses over a contiguous period, we identified 294,625 cases from January 1, 2019, to May 31, 2020, of which 177,194 met inclusion criteria. We identified a 31% decrease in responses in April 2020 compared to the previous year's monthly averages (Fig. 2). Additionally, there was a 48% relative increase in the percent of non-transports in April 2020 compared to the average non-transport rate in 2019 (Fig. 3).

4. Discussion

We performed a retrospective analysis to identify changes in EMS utilization and hospital transport during the initial months of the COVID-19 pandemic. Our region saw fewer total scene responses during this period and an increased percentage of calls resulting in non-transport. The use of nebulized medications and non-invasive ventilation decreased while use of advanced airways increased.

Our findings demonstrate a decrease in EMS responses at the onset of the COVID-19 pandemic compared to historical controls. These findings are comparable to a study using nationwide data from the United States provided by the National EMS Information System, which noted a decrease of about 25% in EMS call rates between the 10th and 16th weeks of 2020 [22]. The cause of this decrease in EMS call rates is likely multifactorial. Anecdotally, physicians in other areas have reported that there have been delays in many types of care due to scheduling, hospital capacity issues or patient concerns over being infected in the hospital [15]. Patients in our region may have preferred avoiding the hospital during this period, due to concerns about becoming infected or to avoid burdening the healthcare system. Stay at home orders

Table 2
Patient and management characteristics

	Control Period Mar15-May15, 2016–19	Study Period Mar15-May15, 2020	Change % Diff (95% CI)
Total	87,525 (21,881 / year)	16,082	−26.5 (−27.1, −25.9)
Vital signs, n (%)			
At least one vital assessed	76,878 (87.8)	14,175 (88.1)	0.3 (−0.2, 0.9)
Tachycardia for age*	21,699 (24.8)	4377 (27.2)	2.4 (1.7, 3.2)
Hypotension for age*	3268 (3.7)	619 (3.9)	0.1 (−0.2, 0.4)
Tachypnea for age*	49,878 (57.0)	9618 (59.8)	2.8 (2.0, 3.6)
Pulse oximetry <95%*	15,029 (17.2)	3107 (19.3)	2.1 (1.5, 2.8)
Neurologic characteristics, n (%)			
Abnormal mental status	13,115 (15.0)	2660 (16.5)	1.6 (0.9, 2.2)
Loss of consciousness	3112 (3.6)	658 (4.1)	0.5 (0.2, 0.9)
Response characteristics			
ALS response, n (%)	81,202 (93.0)	14,400 (89.5)	−3.2 (−3.7, −2.7)
Response time (mean ±SD)	9.1±5.5	9.2±5.3	0.0 (−0.1, 0.1)
Scene Time (mean ±SD)	15.7±9.5	18.3±10.8	2.6 (2.4, 2.7)
Transport Time (mean ±SD)	14.1±9.1	13.2±8.3	−0.9 (−1.1, −0.8)
Interventions**			
Advanced airway, n (%)	653 (0.8)	174 (1.1)	0.3 (0.2, 0.5)
Intubation, n (%)	527 (0.6)	97 (0.6)	0.0 (−0.1, 0.1)
Supraglottic airway, n (%)	219 (0.3)	94 (0.6)	0.3 (0.2, 0.5)
Non-Invasive Ventilation, n (%)	640 (0.7)	55 (0.3)	−0.4 (−0.5, −0.3)
Given oxygen, n (%)	13,672 (15.6)	2528 (15.7)	0.1 (−0.5, 0.7)
Nebulized medication, n (%)	4548 (5.2)	291 (1.8)	−3.4 (−3.6, −3.1)
Given any medication, n (%)	15,037 (17.2)	2291 (14.3)	−2.9 (−3.5, −2.3)
Vascular access obtained, n (%)	29,765 (34.0)	4834 (30.1)	−3.9 (−4.7, −3.2)
Intravenous fluids, n (%)	4522 (5.2)	902 (5.6)	0.4 (0.1, 0.8)
Monitor use, n (%)	15,976 (18.3)	2838 (17.7)	−0.6 (−1.2, 0.0)
12-Lead EKG, n (%)	13,556 (15.5)	2463 (15.3)	−0.2 (−0.8, 0.4)
Medical consult called, n (%)	6510 (7.4)	1658 (10.3)	2.9 (2.4, 3.4)

* Proportion based on number of cases with specific vital sign assessed; other variables based on total N.
** Patients receiving the reported intervention (n) and the rate of interventions per patients encountered (%).

Table 3
Logistic Regression of Patient Factors Associated with Non-Transport

	Univariate		Multivariable Analysis	
	OR (95% CI)	*p*-value	OR (95% CI)	p-value
Study Period	1.57 (1.51, 1.64)	<0.001	1.68 (1.59, 1.78)	<0.001
Age				
Adult (18–64 years)	Ref	–	Ref	–
Pediatric (0–17 years)	1.43 (1.33, 1.54)	<0.001	0.95 (0.87, 1.04)	0.237
Geriatric (≥65 years)	1.00 (0.96, 1.04)	0.988	1.05 (1.00, 1.10)	0.055
Male	1.07 (1.03, 1.11)	<0.001	1.00 (0.95, 1.04)	0.905
Medical Category				
Medical	Ref	–	Ref	–
Cardiac Arrest	18.66 (17.12, 20.34)	<0.001	43.89 (36.97, 52.11)	<0.001
Cardiac	0.55 (0.49, 0.66)	<0.001	0.90 (0.77–1.05)	0.184
Psychiatric/Behavioral	1.08 (0.95, 1.24)	0.240	0.79 (0.68, 0.92)	0.002
Respiratory	0.92 (0.85, 0.99)	0.031	2.47 (2.23, 2.75)	<0.001
Stroke	0.30 (0.22, 0.42)	<0.001	0.74 (0.51, 1.07)	0.110
Toxicological	2.51 (2.15, 2.93)	<0.001	1.96 (1.61, 2.40)	<0.001
Trauma	3.51 (3.35, 3.66)	<0.001	3.56 (3.38, 3.75)	<0.001
Other/Unknown	8.30 (7.80, 8.83)	<0.001	8.45 (7.85, 9.10)	<0.001
Day period				
00:00–05:59	Ref	–	Ref	–
06:00–11:59	0.85 (0.81, 0.90)	<0.001	0.85 (0.79, 0.91)	<0.001
12:00–17:59	0.91 (0.86, 0.96)	<0.001	0.89 (0.83, 0.95)	0.001
18:00–23:59	0.98 (0.93, 1.04)	0.484	1.02 (0.95, 1.09)	0.627
Day of week				
Weekday	Ref	–	Ref	–
Weekend	1.10 (1.06, 1.15)	<0.001	1.08 (1.03, 1.14)	0.001
Median Income by ZIP code				
Fourth quartile (lowest income)	Ref	–	Ref	–
Third quartile	1.00 (0.95, 1.05)	0.915	0.93 (0.88, 0.99)	0.024
Second quartile	1.01 (0.96, 1.06)	0.650	1.21 (1.14, 1.28)	<0.001
First quartile (highest income)	1.13 (1.07, 1.19)	<0.001	1.24 (1.16, 1.32)	<0.001
Vital signs				
At least one vital assessed	0.16 (0.15, 0.16)	<0.001	0.25 (0.23, 0.26)	<0.001
Tachycardia for age	0.33 (0.32, 0.35)	<0.001	0.59 (0.56, 0.64)	<0.001
Hypotension for age	0.80 (0.72, 0.88)	<0.001	1.22 (1.04, 1.43)	0.013
Tachypnea for age	0.35 (0.34, 0.37)	<0.001	0.90 (0.85, 0.95)	<0.001
Pulse oximetry <95%	0.25 (0.24, 0.27)	<0.001	0.67 (0.61, 0.73)	<0.001
Neurologic characteristics				
Abnormal mental status	1.13 (1.08, 1.19)	<0.001	0.73 (0.67, 0.80)	<0.001
Loss of consciousness	1.78 (1.64, 1.92)	<0.001	2.01 (1.74, 2.32)	<0.001
Response characteristics				
ALS response	1.06 (0.99, 1.13)	0.081	–	–
Response time (mean)	0.98 (0.98–0.98)	<0.001	0.97 (0.97, 0.98)	<0.001
Interventions				
Advanced airway	2.07 (1.77, 2.42)	<0.001	0.47 (0.35, 0.62)	<0.001
Non-Invasive Ventilation	0.01 (0.00, 0.06)	<0.001	0.03 (0.00, 0.24)	0.001
Given oxygen	0.12 (0.10, 0.13)	<0.001	0.19 (0.16, 0.22)	<0.001
Nebulized medication	0.18 (0.15, 0.21)	<0.001	0.18 (0.14, 0.23)	<0.001
Given any medication	0.39 (0.36, 0.41)	<0.001	3.10 (2.74, 3.50)	<0.001
Vascular Access obtained	0.10 (0.09, 0.11)	<0.001	0.07 (0.06, 0.08)	<0.001
Intravenous fluids	0.11 (0.09, 0.14)	<0.001	0.27 (0.21, 0.35)	<0.001
Monitor use	0.21 (0.19, 0.23)	<0.001	0.38 (0.21, 0.35)	<0.001
12-Lead EKG	0.20 (0.19, 0.22)	<0.001	0.47 (0.41, 0.53)	<0.001
Medical consult called	4.29 (4.08, 4.50)	<0.001	28.32 (26.01, 30.83)	<0.001

resulting in less driving, sports, and outdoor activities likely had an impact on the number of traumatic injuries seen. The decrease in elective procedures and other routine care may have also decreased the need for EMS, as there were likely fewer complications or follow up required.

During the pandemic period, patients tended to be slightly sicker in the study period with increases in the proportions of patients with tachycardia, tachypnea, or pulse oximetry under 95% at some point during their care. We also noted increases in abnormal mental status, loss of consciousness, and advanced airway utilization. While the individual differences in vital signs were rather modest, this either suggests a higher level of patient acuity during EMS encounters or could represent a similar decrease in low-acuity encounters as has been seen in emergency department utilization [13,14,20,21]. Despite an increase in abnormal vital signs, we saw less use of medications, cardiac monitoring, and intravenous catheter placement. This may suggest that crews were less likely to perform some routine interventions such as IV placement and nebulized medication administration in certain patients due to infectious concerns or due to guidance from medical directors. However, the small increase in advanced airway management suggests EMS personnel were confident in their PPE use and remained committed to high-quality patient care.

In our multivariable analysis, we found several factors that were associated with non-transport, including the study period. Cardiac arrests were highly associated with non-transports because in our system most arrests are terminated in the field if ROSC is not obtained. Similarly, consults were highly associated with patient non-transport most likely because most consults in our system are for patient refusals. We did find that respiratory, toxicologic, and trauma patients were associated with non-transport, possibly due to the minor nature of some of these presentations or due to other unknown factors. Not surprisingly, abnormal

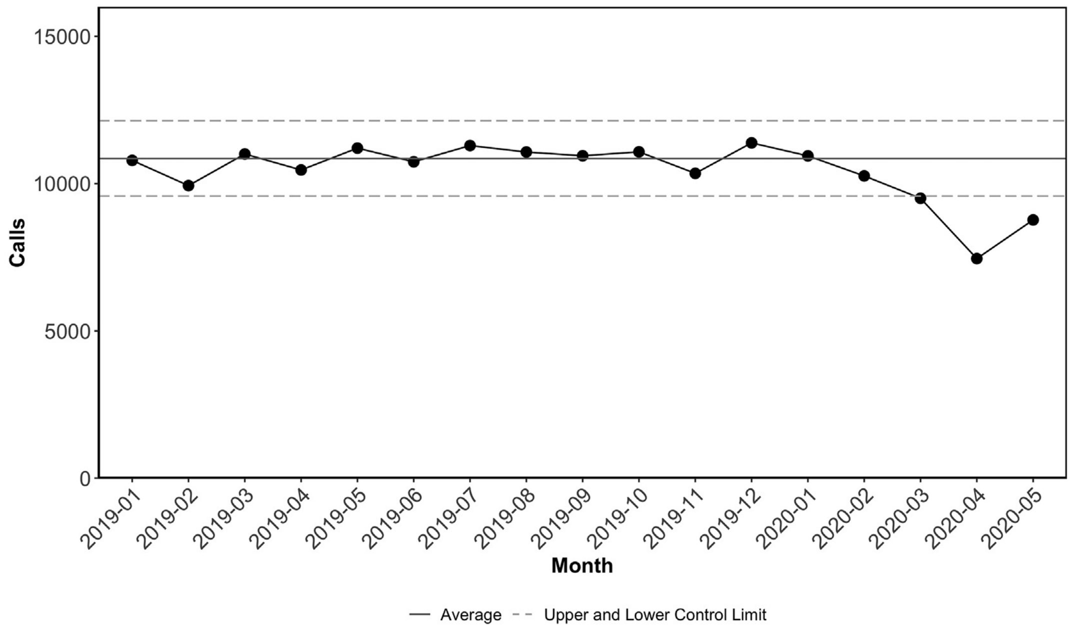

Fig. 2. Control Chart of Total Responses by Month. * Average and upper / lower control limits are based on 2019 responses.

vital signs, abnormal mental status, or any treatment were associated with transportation.

EMS medical directors in our system encouraged field providers to contact online medical command to discuss cases they felt would be amenable to home care. We did find an increase in our system's consultation rate, and in some of these consults physician advice may have resulted in patients staying home when otherwise they would have been transported. However, there may have also been cases where patients wanted an evaluation by EMS personnel but did not intend to be transported to the hospital.

Overall, 9–1-1 responses declined to a greater proportion compared to the increase in the number of non-transports during EMS patient encounters. While there may have been some component of EMS personnel or consultant-recommended non-transports, the marked decline in requests for 9–1-1 evaluation suggests that patients were less likely to seek care in general and suggest more patient-generated refusals of transport. Our findings are consistent with multiple reports of decreased ED encounters and hospitalizations for patients during the early period of the pandemic in areas with a low incidence of COVID-19 [6-9]. Investigations of specific disease processes have found similar and concerning results regarding decreased utilization of healthcare services during the pandemic. Data from 9 hospitals in the United States demonstrated a 38% decline in cardiac catheterization laboratory activations for ST-elevation myocardial infarctions from January 1, 2019, to March 31, 2020 [16]. Similar declines in admissions for acute coronary syndrome were found across several hospitals in Italy [17].

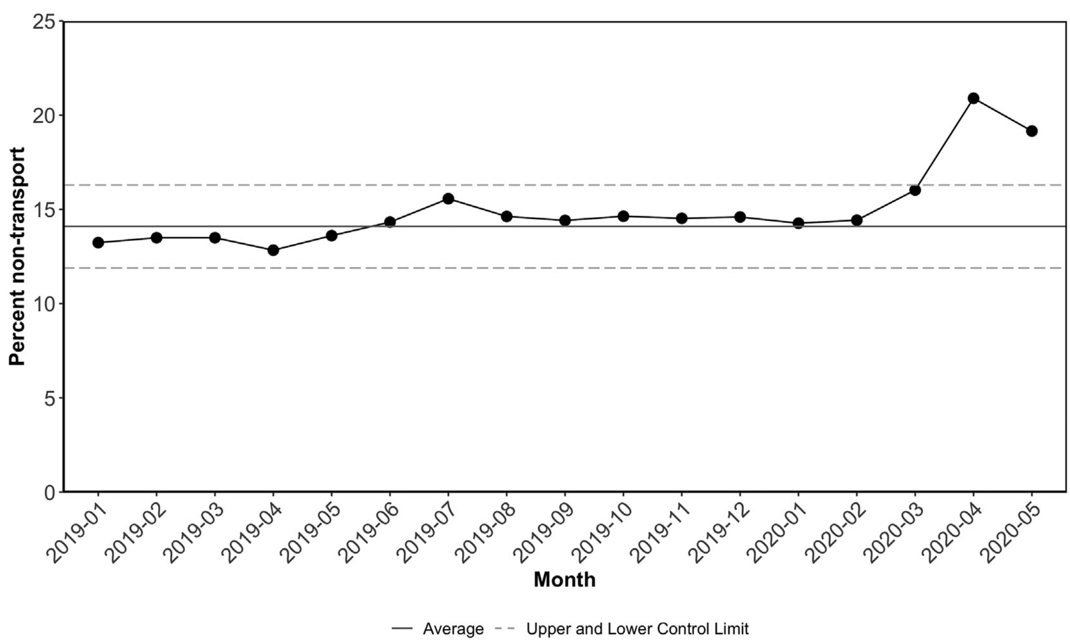

Fig. 3. Control Chart of the Non-Transport Rate by Month. * Average and upper / lower control limits are based on 2019 responses.

Other studies, including our own previously reported findings, have demonstrated a decreased use of stroke emergency services, admissions, and thrombectomy procedures during the early period of the pandemic [18,19]. Our data of EMS response volume reveals a proportional decrease in EMS responses for cardiovascular complaints, similarly identifying that patients with these complaints were not seeking care through the 9–1-1 system during the pandemic, despite a presumed similar prevalence of cardiovascular disease during this period. Taken together, these data identify a likely patient-driven decrease in emergency care engagement across the spectrum of care delivery.

Our findings could serve as a starting point for further research on pandemic planning and response. In regions that are not significantly impacted by infected patients during a national pandemic, careful thought needs to be given to the effects of both medical director guidance as well as the general impression the public has about the infectious dangers of the healthcare system. Future pandemic planning should anticipate patient hesitancy to engage with the EMS system and the likely increase in patient non-transports.

4.1. Limitations

The findings from this study are subject to the limitations of any retrospective review of patient care records. Some values such as race and ethnicity were missing in over a third of cases, which precluded use of these variables in the multivariable analysis. Fortunately, all other variables had a missingness of <2% and other missing values were addressed through multiple imputation. Our research did not include any longitudinal tracking and was unable to evaluate for changes in outcomes, either after ED presentation or non-transport. Determining the proportion of patients meeting low versus high-risk criteria for non-transport and the reasons for non-transport were outside the scope of this work. We discuss our interpretation of decreases in overall requests for EMS responses and a likely contribution of patient preferences leading to increases in non-transports. The true proportional impact of patient preferences versus the influence of EMS personnel or medical consultation on non-transports is unknown. We also did not have specific data on the proportion of non-transport patients that were either suspected of or ultimately diagnosed with COVID-19. This study was conducted over a short time period, and as the pandemic continues there may be further changes to patient and EMS behavior or outcomes. Despite these limitations, this study provides important data with respect to EMS utilization during the early period of a global pandemic and provides findings that carry implications towards the future implementation of EMS response in the present and future health crises.

5. Conclusion

In an EMS region with low to moderate burden of infection during the initial period of the COVID-19 pandemic, we found a decline in overall EMS response volumes and an increase in the rate of non-transports that was independent of patient demographics and other response characteristics. We observed an increased proportion of responses for respiratory distress and fewer calls for trauma. Fewer patients received non-invasive ventilation or nebulized medications. These data serve to inform future EMS response preparations for areas that are not anticipated to receive a high burden of infectious disease during a pandemic.

Credit authorship statement

Timothy Satty: Conceptualization, Methodology, Investigation, Writing - original draft, Writing - review & editing, Visualization. **Sriram Ramgopal:** Methodology, Software, Formal analysis, Resources, Writing - review & editing, Visualization. **Jonathan Elmer:** Methodology, Software, Formal analysis, Resources, Writing - review & editing. **Vincent N. Mosesso:** Methodology, Writing - review & editing, Supervision. **Christian Martin-Gill:** Conceptualization, Software, Validation, Formal analysis, Investigation, Data curation, Writing - review & editing, Visualization, Supervision, Project administration.

Declaration of Competing Interest

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References

[1] WHO. World Health Organization. Coronavirus disease 2019 (COVID-19) situation report–51, https://www.who.int/emergencies/diseases/novel-coronavirus-2019/situation-reports; 2020 Mar [accessed 2020 Aug 22].
[2] Pennsylvania Department of Health. Commonwealth of Pennsylvania. Daily COVID-19 Situation Report, https://www.health.pa.gov/topics/Documents/Diseases%20and%20Conditions/COVID-19%20Situation%20Reports/20200312nCoVSituationReportExt.pdf; 2020 Mar 12 [accessed 2020 Aug 22].
[3] Pennsylvania Department of Health. Commonwealth of Pennsylvania. Daily COVID-19 Situation Report, https://www.health.pa.gov/topics/Documents/Diseases%20and%20Conditions/COVID-19%20Situation%20Reports/20200413nCoVSituationReportExt.pdf; 2020 Apr 13 [accessed 2020 Aug 22].
[4] Pennsylvania Department of Health. Commonwealth of Pennsylvania. PA Coronavirus (COVID-19) Update Archive, https://www.health.pa.gov/topics/disease/coronavirus/Pages/May-Archive.aspx; 2020 May 1 [accessed 2020 Aug 25].
[5] United States Census Bureau. U.S. Department of Commerce. QuickFacts: Allegheny County, Pennsylvania, https://www.census.gov/quickfacts/alleghenycountypennsylvania; 2020 Jun 25 [accessed 2020 Aug 25].
[6] Maass B. CBS Denver. Colorado Emergency Room Visits Drop During Coronavirus Pandemic: Some Health Care Workers See Pay Cuts, https://denver.cbslocal.com/2020/04/10/coronavirus-emergency-room-visits-hospital-layoffs; 2020 Apr 10 [accessed 2020 Aug 22].
[7] Deruy E. The Mercury News. Coronavirus: Bay Area ERs are eerily empty and worried you're too afraid to visit, https://www.mercurynews.com/2020/04/22/coronavirus-bay-area-ers-are-eerily-empty-and-worried-youre-too-afraid-to-visit/; 2020 Apr 22 [accessed 2020 Aug 25].
[8] Bernton H. The Seattle Times. Hospitalizations for novel coronavirus-like illness declined last week in Washington, offering a glimmer of hope, https://www.seattletimes.com/seattle-news/hospitalizations-for-covid-19-like-illness-declined-last-week-in-washington-offering-a-glimmer-of-hope; 2020 Mar 30 [accessed 2020 Aug 25].
[9] Shekhar AC, Effiong A, Ruskin KJ, Blumen I, Mann NC, Narula J. COVID-19 and the Prehospital Incidence of Acute Cardiovascular Events (from the Nationwide US EMS). Am J Cardiol. 2020;134:152–3.
[10] Hartnett KP, Kite-Powell A, DeVies J, Coletta MA, Boehmer TK, Adjemian J, et al. Impact of the COVID-19 Pandemic on Emergency Department Visits - United States, January 1, 2019-May 30, 2020. MMWR Morb Mortal Wkly Rep. 2020;69(23):699–704.
[11] Thornton J. Covid-19: A&E visits in England fall by 25% in week after lockdown. BMJ. 2020;369:m1401.
[12] Lazzerini M, Barbi E, Apicella A, Marchetti F, Cardinale F, Trobia G. Delayed access or provision of care in Italy resulting from fear of COVID-19. Lancet Child Adolesc Health. 2020;4(5):e10–1.
[13] Lee L, Mannix R, Guedj R, Chong SL, Sunwoo S, Woodward T, et al. Paediatric ED utilisation in the early phase of the COVID-19 pandemic. Emerg Med J. 2020. https://doi.org/10.1136/emermed-2020-210124.
[14] Goldman RD, Grafstein E, Barclay N, Irvine MA, Portales-Casamar E. Paediatric patients seen in 18 emergency departments during the COVID-19 pandemic. Emerg Med J. 2020;37(12):773–7.
[15] Rosenbaum L. The Untold Toll - The Pandemic's Effects on Patients without Covid-19. N Engl J Med. 2020;382(24):2368–71.
[16] Garcia S, Albaghdadi MS, Meraj PM, Schmidt C, Garberich R, Jaffer FA, et al. Reduction in ST-Segment Elevation Cardiac Catheterization Laboratory Activations in the United States During COVID-19 Pandemic. J Am Coll Cardiol. 2020;75(22):2871–2.
[17] De Filippo O, D'Ascenzo F, Angelini F, Bocchino PP, Conrotto F, Saglietto A, et al. Reduced Rate of Hospital Admissions for ACS during Covid-19 Outbreak in Northern Italy. N Engl J Med. 2020;383(1):88–9.
[18] Desai SM, Guyette FX, Martin-Gill C, Jadhav AP. Collateral damage - Impact of a pandemic on stroke emergency services. J Stroke Cerebrovasc Dis. 2020;29(8):104988.

[19] Pandey AS, Daou BJ, Tsai JP, Zaidi SF, Salahuddin H, Gemmete JJ, et al. Letter: COVID-19 Pandemic-The Bystander Effect on Stroke Care in Michigan. Neurosurgery. 2020; 87(3):E397–9.
[20] Lucero AD, Lee A, Hyun J, Lee C, Kahwaji C, Miller G, et al. Underutilization of the Emergency Department During the COVID-19 Pandemic. West J Emerg Med. 2020; 21(6):15–23.
[21] Butt AA, Azad AM, Kartha AB, Masoodi NA, Bertollini R, Abou-Samra AB. Volume and Acuity of Emergency Department Visits Prior To and After COVID-19. J Emerg Med. 2020;59(5):730–4.
[22] Lerner EB, Newgard CD, Mann NC. Effect of the Coronavirus Disease 2019 (COVID-19) Pandemic on the U.S. Emergency Medical Services System: A Preliminary Report. Acad Emerg Med. 2020;27(8):693–9 https://doi.org/10.1111/acem.14051.
[23] Mann DM, Chen J, Chunara R, Testa PA, Nov O. COVID-19 transforms health care through telemedicine: Evidence from the field. J Am Med Inform Assoc. 2020;27 (7):1132–5.
[24] Hollander JE, Carr BG. Virtually Perfect? Telemedicine for Covid-19. N Engl J Med. 2020;382(18):1679–81.
[25] United States Census Bureau. County Population Totals: 2010-2019, https://www.census.gov/data/tables/time-series/demo/popest/2010s-counties-total.html; 2020 [accessed 2020 Dec 12].
[26] Department of Health, Bureau of EMS. Commonwealth of Pennsylvania. EMS Regulations and Protocol, https://www.health.pa.gov/topics/EMS/Pages/Regulations.aspx; 2020 [accessed 2020 Aug 25].
[27] Tran K, Cimon K, Severn M, Pessoa-Silva CL, Conly J. Aerosol generating procedures and risk of transmission of acute respiratory infections to healthcare workers: a systematic review. PLoS One. 2012;7(4):e35797.
[28] Edelson DP, Sasson C, Chan PS, Atkins DL, Aziz K, Becker LB, 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. Circulation. 2020;141(25):e933–43. https://doi.org/10.1161/CIRCULATIONAHA.120.047463.
[29] Department of Health, Bureau of EMS. Commonwealth of Pennsylvania. EMS Informational Bulletins, https://www.health.pa.gov/topics/EMS/Pages/Bulletins.aspx; 2020 [accessed 2020 Aug 25].
[30] National Center for Immunization and Respiratory Diseases (NCIRD), Division of Viral Diseases. Centers for Disease Control and Prevention. Interim Infection Prevention and Control Recommendations for Patients with Suspected or Confirmed Coronavirus Disease 2019 (COVID-19) in Healthcare Settings, https://www.cdc.gov/coronavirus/2019-ncov/infection-control/control-recommendations.html; 2020 Jul 15 [accessed 2020 Aug 22].
[31] Massachusetts Office of Emergency Medical Services. Commonwealth of Massachusetts. Emergency Medical Services Statewide Treatment Protocols, https://www.mass.gov/lists/emergency-medical-services-statewide-treatment-protocols; 2020 Apr 1 [accessed 2020 Aug 25].
[32] The Regional Emergency Medical Services Council of New York City. NYC REMAC. 2020-09 REMAC Advisory: Implementation of EMS Viral Triage Protocol for Disaster Response, https://www.nycremsco.org/2020-remac-advisories/; 2020 [accessed 2020 Aug 25].
[33] Manson S, Schroeder J, Van Riper D, Ruggles S.. IPUMS. IPUMS. National Historical Geographic Information System: Version 14.0 [Database], http://doi.org/10.18128/D050.V14.0; 2019 [accessed 2020 Jun 3].
[34] United States Census Bureau. U.S. Department of Commerce. American Community Survey, https://www.census.gov/programs-surveys/acs; 2020 Apr 21 [accessed 2020 Jun 3].
[35] American Heart Association. Pediatric Advanced Life Support: Provider Manual. Dallas, TX: American Heart Association; 2016.