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REVIEW

Emergency Medical Services (EMS) Calls During COVID-19: Early Lessons Learned for Systems Planning (A Narrative Review)

Alaa Al Amiry [1]
Brian J Maguire [2,3]

[1]Department of Clinical Studies, College of Pharmacy and Health Sciences, Ajman University, Ajman, United Arab Emirates; [2]Leidos (Research Laboratory), Groton, CT, USA; [3]Central Queensland University in Australia, Rockhampton, Queensland, Australia

Background: Over the course of the COVID-19 progress, reports from many locations around the world indicated major increases in EMS call volume, which imposed great pressure on EMS dispatch centers (EMSDC) globally. No studies yet have been done to examine this phenomenon.

Objective: This paper examines the interrelated effects of the unprecedented global increase of EMS call, the effect of the COVID-19 crisis on responding to non-COVID-19 emergencies, and the concurrent effects of having overwhelmed dispatch centers. It tries to explain the current evidence of the bottleneck of EMS calls during the early phase of the worldwide pandemic.

Eligibility Criteria: We examine the numbers of EMS calls internationally between March and June 2020, derived from published literature and news media. Only articles in English were selected, with certain keywords related to EMS calls, ambulance delay, stroke and cardiac arrest.

Source of Evidence: Google Scholar was the main searching source.

Results: After applying the selection criteria, a total of 29 citations were chosen, and a pattern of knowledge resulted in the emergence of five themes: EMS calls during COVID-19, Reduced EMS operator response time, Ambulance response delays, Collateral mortality and morbidity among non-COVID-19 cases, and Total ambulance call time.

Conclusion: Over the course of COVID-19 progress, there was a global phenomenon of exponential increases in EMS calls, which is expected to impose a great pressure on EMS dispatch centers. Several factors contributing to the bottleneck of EMS calls are identified and explained.

Keywords: EMS calls, COVID-19, ambulance response time, RT, pandemic response, EMS access, ambulance delay

Plain Language Summary

During COVID-19 peak in 2020, EMS calls have surged unprecedently internationally, causing global disruption in EMS dispatch centers' services and significant delays in emergency response worldwide. We examined the bottleneck phenomenon that resulted in the disruption of EMS calls in different countries, and found three main factors:

- EMS-related factors
- Social-related factors
- Patient-related factors

For better understanding, we also explained each factor based on the available literature. Interestingly, we discovered a pattern of knowledge resulted in the emergence of five themes:

Correspondence: Alaa Al Amiry
Email a.alamiry@ajman.ac.ae

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EMS calls during COVID-19, Reduced EMS operator response time, Ambulance response delays, Collateral mortality and morbidity among non-COVID-19 cases, and Total ambulance call time.

We believe that by understanding these factors and their collateral impact on EMS calls, we can implement better crises and disaster response plans. This is an informative paper to EMS decision makers worldwide.

Introduction

Emergency medical services (EMS) play a major role in disaster operations, including responding to pandemics.[1–3] EMS personnel role as first responders to biological disasters is well documented.[4]

Over the course of the COVID-19 progress, reports from many locations indicated major increases in EMS call volume. For example, in New York City (NYC) alone, EMS call volume rose from an usual daily high of 4000 calls to over 7000 calls.[5,6] These dramatic increases in call volume can be expected to impose great pressure on EMS dispatch centers (EMSDC).

The optimal time-to-response (TTR) of 10-seconds established by European members,[7] is at the core of EMS service to remain timely accessible. Becoming overloaded with calls is considered a major risk to EMS services, because any disruption to its primary goal of being timely will dramatically affect its contribution to the chain of survival.[8]

In order to determine COVID-19 global impact on EMS call volume and chain of survival, this study examines the number of EMS calls internationally, and describes collateral effects of increasing call volume on dispatch centers and community health, between March and June 2020. Up to author's knowledge, no studies have been done yet to examine this phenomenon and try to explain it.

This paper provides a global perspective on the pattern of EMS access by the public during COVID-19. This work aims to inform EMS managers and policymakers and to create a resource to aid in prospective management of this and future crises. Due to the nature of the matter in hand, authors believe that a narrative review would be best to synthesise conclusions and draw valuable, timeless lessons from the bottleneck affecting the EMS dispatch centers worldwide during such crises.

Methods

Protocol

Our methodology follows the PRISMA scoping reviews extension protocol.[9] Appendix A shows which items were applied and which were not.

Eligibility Criteria, Information Source and Study Selection

Both Google and Google Scholar websites were searched for the following keywords among published scientific articles, pre-prints and news in the general media:

- EMS calls COVID-19
- Emergency calls COVID-19
- Ambulance calls COVID-19
- 911 calls COVID-19
- Stroke COVID-19
- Cardiac arrest COVID-19
- Heart attack COVID-19
- Ambulance delay COVID-19

Full-text citations in English were chosen, covering incidents between March and June 2020. Articles beyond this time period were excluded. This period of time was chosen as the first peak of COVID-19 pandemic.

Charting the Data and Synthesizing Results

Each article was read thoroughly to look for keywords and incidents supporting the study's aims. As patterns of knowledge were found, five themes have emerged:

- EMS calls during COVID-19,[7,8,10–19]
- Reduced EMS operator response time,[7]
- Ambulance response delays,[14,20,21]
- Collateral mortality and morbidity among non-COVID-19 cases,[14,17,19,22–29,31] and
- Total ambulance call time.[17,29,33–35]

Results

Literature Search

The selection process resulted in a total of 29 articles,[7,8,10–35] in which 25 included either "COVID-19" or "coronavirus" in their titles, (n= 20 and 5 respectively), and four citations, in which COVID-19 was within the body. Most of the citations (n=18) included keywords "ambulance", "emergency", "EMS", and/or "paramedics" either in their titles or bodies, two citations involved "EMS calls" or "calls" within their bodies, two citations included "delay" in their titles, four articles included "cardiac arrest", "MI", or "heart attack" either in their titles or in their bodies, and six citations included "Stroke" in their titles.

EMS Calls During COVID-19

EMS calls can play a major role in predicting the epicenter, clusters and progression of epidemics.[10] In fact, the number and type of EMS calls are valid key indicators to predict many health-related conditions in a society. One study finds that daily COVID-19 EMS calls have the strongest correlation with the anticipated use of ICU beds, which can be utilized as an effective prediction tool for a possible second pandemic wave.[11] Table 1 illustrates the changes in EMS calls in different geographical regions.

Even in the early days of the pandemic, the number of EMS calls began increasing in an unprecedented manner in many locations around the globe. For example, the number of EMS calls to the national EMSDCs in Israel increased 1900% during the first three months of 2020.[12] EMS calls increased by 24% in Copenhagen, Denmark,[7] and in NYC, the daily number of EMS calls increased more than 50% compared to pre-COVID-19 highs.[13] While in Tijuana, Mexico, despite a drop in non-urgent calls, the proportion of urgent cases soared to 11.2% of total calls compared to a normal level of only 6.7% of all EMS calls.[14] This influx of urgent calls may be influenced by a combination of panic and misinformation associated with COVID-19.[15]

Table 1 EMS Call Volume Increases, Operator Time and Ambulance Response Times, During the Peak of Pandemic by City and Country, March to June 2020

City/Country	EMS Call Volume Increase	Operator TTR	Ambulance Response Times
Israel	1900%		
Copenhagen, Denmark	24%	500% increase in TTR	
Manhattan, New York City, USA	50%		46% increase
Tijuana, Mexico	67% (Urgent cases)		25% increase
Northern regions of Italy	440%		Up to one-hour
Emilia Est, Italy	Three-fold		
Lombardia, Italy	Five-fold		Up to one-hour
Lausanne, France	212.5%		
Greater Paris, France	225%		
Catalonia, Spain	330%		
Bronx, NYC, USA			70% increase
India			Up to 12 hours
Southern Europe			30 minutes increase

Several studies conducted in different regions in Italy documented the increased surge of EMS calls. For instance, three days after the discovery of Italy's first COVID-19 case, the call volume to Emilia Est Dispatch Center increased three-fold.[15] Meanwhile, in the northern regions of Italy, a sudden and sustained influx of EMS calls of 440% of normal levels was documented in the first five weeks of COVID-19 outbreak.[16] The worst was in Lombardia, which was dubbed COVID-19 Ground Zero in Europe, where EMS calls swelled five times more than its EMSDC baseline.[17]

In Greater Paris, the number of daily EMS calls increased from 2000 to 6500.[18] In Catalonia, Spain, EMS calls increased by 330% during the month of March, 2020, with unprecedented numbers reaching 40,000 EMS calls during three pandemic peak days.[19] Tangentially, in Lausanne, France, non-emergency calls to a COVID-19-dedicated "help line" received 2500 calls per day compared to 800 calls to their regular dispatch center line.[8]

Reduced EMS Operator Response Times

This rapid increase of EMS calls can strain the EMS system's capacity and comes with potentially dramatic community health effects. Due to increased demand on EMSDCs, the time required to answer EMS calls by EMSDC significantly increased.

The overwhelmed EMSDCs of Copenhagen prompted an unprecedented prolonged queue to answer EMS calls. Call times increased to 12 minutes (mean time), compared to around two minutes in the pre-COVID-19 era, with some calls having a two-hour wait time.[7] This can be considered as an indirect indicator of delayed dispatch of ambulances, keeping in mind the optimal TTR of 10 seconds.

Ambulance Response Delays

In Tijuana, Mexico, the response time (RT) of ambulances to arrive at the scene extended from 16.4 minutes in 2019 to 20.5 minutes during COVID-19 peak.[14] This RT delay

was also evident in NYC, where, in Manhattan and the Bronx, the average RT to life-threatening medical cases rose from 6.5 minutes pre-COVID to 9.5 minutes and 11 minutes, respectively.[14] This was also observed in India. According to local news reports, extensive delays of 12 hours and more were frequent in several Indian states, rising morbidity and mortality.[20,21]

Call Volume and Collateral Mortality for Non-COVID-19 Cases

Recent literature identifies that the non-COVID-19 emergency cases most affected by the pandemic are stroke and cardiac arrest (Table 2). Since the pandemic onset, a global drop in the number of patients seeking medical care for these emergency conditions has been documented,[22] suggesting a disruptive effect of COVID-19 to the chain of survival. For example, a survey conducted in the USA during April 2020 found an "alarming trend" for calling EMS. Evidence from a National Association of Emergency Medical Technicians survey shows an overall reduction in EMS responses by 34%. EMS calls in Texas, dispatched to stroke and cardiac arrest have declined by 36% and 42%, respectively.[23] Similarly, dispatched ambulances to stroke-related calls has dropped by 20% and 29% in Chicago and New Jersey, respectively.[24,25]

Stroke admissions in Southern Europe have dropped as well by 25%, and the number of EMS calls dispatched to stroke cases decreased, with a 30-minute delay in RT.[26] In Catalonia, activation of stroke codes in a major stroke center dropped by 18% during the lockdown of the region.[19]

Remarkably, despite the published data elsewhere, an examination of EMS calls in the UK shows no delay in seeking help when citizens experience critical symptoms.[27] However, one cardiac center in England witnessed a significant symptom-to-hospital arrival delay from 3.4 to 13.2 hours during the pandemic.[28]

This recognized disruption to the chain of survival by the pandemic has resulted in a global surge of prehospital mortality. When applied in Italy, mathematical models demonstrate an increase of mortality rates by 300% one month after the onset of COVID-19.[17] In India, out-of-hospital mortality surged 45% in the 15 top hospitals, and to 80% in seven others between March and April, 2020.[30] Although not yet confirmed, the excess out-of-hospital mortalities by 145% in Tijuana, Mexico, documented during the peak of COVID-19 were likely a combination of undetected COVID-19 cases, fatalities secondary to delay of care, and a saturated healthcare system.[14]

In Texas, USA, out-of-hospital-cardiac-arrest (OHCA) cases spiked by 113% in April 2020, when compared to the previous year, and on-scene pronounced death rate by 164% during the same period.[23] In NYC, the death rate climbed to six times above baseline from the onset of COVID-19 through April 2020.[31] Table 2 summarizes these findings.

Table 2 Call Dispatched to Stroke, Calls Dispatched to Acute Cardiac Illness, Out of Hospital Cardiac Arrests (OHCA), and Out-of-Hospital Mortality, During the Peak of Pandemic by City and Country, March to June 2020

City/ Country	Call Dispatched to Stroke	Calls Dispatched to Acute Cardiac Illness	OHCA	Out-of-Hospital Mortality
Texas, USA	36% reduction	42% reduction	113% increase	164% increase
Chicago, USA	20% reduction			
New Jersey, USA	29% reduction			
NYC, USA				Six times higher
Southern Europe	25% reduction			
Catalonia, Spain	18% reduction			
India				45–80% increase
Tijuana, Mexico				145% increase

Total Ambulance Call Time

Evidence shows a prolonged total ambulance call time during the pandemic. In Italy, an 8-minute ambulance ride took an hour during COVID-19.[17] Moreover, anecdotal observations indicate reluctance in some trauma centers to receive trauma patients due to the lack of sufficient inpatient capacities[28] leading to additional travel time.

The new regulations force the donning of appropriate PPE by EMS personnel in preparing for EMS calls, which is considered a time-consuming procedure that impacts the RT of ambulances.[33–35] Therefore, responding to high-acuity trauma patients can be delayed by suiting up with PPE. Paradoxically, a scarcity of PPE and appropriate face masks is found to be a reason in some areas of the world to cause ambulance delays.[35]

Discussion

EMS Bottleneck Explained

By exploring the literature, the bottleneck effect resulting from delayed EMS RT during COVID-19 can be attributed to three major factors:

- EMS-related factors
- Social-related factors
- Patient-related factors

The following section will further explain each factor.

EMS-Related Factors

Four elements were identified under this factor. The first relates to the risk of exposure. One certain fact is the high risk of exposure among EMS personnel to COVID-19,[32] with a risk of potential staff loss due to contracting the infection.[28] Indeed, OHCA incidents have increased among COVID-19 patients, prompting the need for the aerosol generating CPR, therefore exposing EMS personnel to an increased risk of exposure.[23,33]

The second element is the shortage of the number of available ambulances, which are not only due to responding to the overwhelming EMS calls, but also to getting ready for the next call. Ambulances have been found to be potential disease vectors.[36] Therefore, once a vehicle has been exposed to a potentially infectious patient, there is a requirement to decontaminate the ambulance, which will cause further delays and stress on limited EMS resources.[37,38]

The third element of EMS-factors is due to the fact that EMS personnel can be victims of COVID-19 and are subject to death, illness, sick leave and prolonged quarantine, which contribute to staff shortages and further increases the burden on the already strained EMS systems.[8,39] Although this is not well documented in EMS, it has been witnessed among other health care providers as they are forced to be under quarantine post exposure.[40]

In NYC, a study on fire department personnel documented that, by the end of March 2020, 573 of 4408 EMS clinicians had confirmed cases of COVID-19, and there were 1198 COVID-19 cases among the 11,230 firefighters;[41] for EMS clinicians the risk was 130 cases per 1000 persons compared to 107 for firefighters; therefore, the relative risk was 20% higher for EMS personnel than for firefighters. The COVID-related fatality rate has also been higher for EMS personnel compared to other professions.[42,43]

Although EMS personnel regularly face high risks of work-related illness, injury and death,[44,45] the pandemic also resulted in a risk of EMS personnel cross-contaminating their families. Reports indicate EMS personnel were sleeping in their cars between shifts to prevent that.[6,13]

Finally, although overlooked, is the mental burden on EMS personnel, as there are real concerns about burnout, suicide,[46] and long-term loss and dropout of EMS personnel due to COVID-19-induced distress.[28] In NYC, three EMS personnel committed suicide in the first few months of the pandemic.[47,48]

Social-Related Factors

The main element under this factor is the enforcement of an unprecedented, global lockdown, which has significantly disrupted both EMS' receipt and response to calls. Despite the necessity to reduce COVID-19-related mortalities,[17] the lockdown has had major unforeseen impacts on attending non-COVID-19 emergencies. Indeed, strict social distancing might be a contributing factor to the frequently undiscovered stroke cases among elderly living alone.[24] In fact, the negative correlation between lockdown and stroke admissions in Catalonia, Spain, was striking, with zero stroke admissions to a major stroke center during COVID-19 peak days.[19]

Further, the worldwide lockdown has disrupted the global supply chain, including its medical division, resulting in shortage of resources and medical supplies, which significantly affected countries with poor healthcare infrastructures and limited resources.[49]

Patient-Related Factors

The public's behavior towards seeking medical attention also contributes to adverse outcomes. Recent studies conducted in several countries have documented risk-averse behavior among patients during COVID-19. Amid the pandemic, many emergency and non-emergency patients were reluctant to call EMS or seek medical attention, driven by the fear of acquiring the virus.[8,14,23,28,49–55]

The increasing demand on EMSDC by EMS calls seeking inquiries on COVID-19 during the lockdown intensified the bottleneck. This misinterpretation of the role of EMSDC resulted in an unexpected pressure from the public on the only emergency number available.

EMS Strategies to Handle COVID-19

Several EMSDC strategies have been described to handle COVID-19 pandemic. The most common strategy is dedicating special COVID-19 numbers;[7] reports show that this has significantly mitigated the enormous demand on the main EMS number.[8,12] Other effective strategies included screening of potential infections by the EMSDC, a web-based self-triage, increasing EMSDCs capacity for call answering, community paramedics,[7,15,39] and the development of surge capacity among the response system.[56] Denmark's EMS Copenhagen has taken several initiatives to tame the immense growth of call volumes, among which is an innovative "Chatbot" to identify COVID-19 related terms.[7] In France, "the use of seated transport for low acuity cases" proved sufficient in drastically reducing the demand on ambulances.[8]

German paramedicine clinicians helped keep the hospital caseload low during COVID-19 first wave by conducting at-home examinations of low-acuity COVID-19 victims. Regular monitoring allowed clinicians to catch patients before they decompensated and only admitted victims when they required hospitalization.[57]

Conclusion

At times during the pandemic, EMS calls were mainly for COVID-19 cases, especially in areas hardest hit by the pandemic. Further, it has been observed in many occasions that EMS calls for non-COVID-19 emergencies dropped.

Reportedly, EMS calls will surge dramatically when epidemics is spreading rapidly. Attempting to maintain business as usual at times of crises is not a wise practice, especially with EMS services at its peak. Many EMS models were brisk to adjust their strategies to accommodate the increasing influx of call volumes. The massive influx of call volumes requires EMS systems to revisit their IT and personnel infrastructure, in order to increase their call capacities.

Data from different countries show contradicting evidence in seeking emergency help by victims of critical conditions. This contradiction suggests country-specific behavior that requires further exploration. The findings highlight the need for further research on how EMS call volume may predict hospitalizations, ICU bed demand and deaths in communities.

We need to depart our comfort zones when developing disaster response plans. This research shows EMS agencies' urgent need to share their experiences as case studies in order to support global EMS improvement, inform decision makers and to shape EMS future. If nothing else, this disaster has demonstrated that we live in an interdependent world in which we are more successful when we work together.

Abbreviations

EMS, emergency medical services; EMT, emergency medical technicians; EMSDC, emergency medical services dispatch center(s); RT, response time; TTR, time-to-response; COVID-19, 2019 novel coronavirus; PPE, personal protective equipment; NYC, New York City; OHCA, out-of-hospital-cardiac-arrest; CPR, cardiopulmonary resuscitation; AI, artificial intelligence.

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Disclosure

Authors confirm no conflict of interest to disclose.

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