Clinical paper

Survey of resuscitation practices at emergency medical service agencies in the U.S

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Abstract

Background: Survival for out-of-hospital cardiac arrest (OHCA) varies across emergency medical service (EMS) agencies. Yet, little is known about resuscitation response and quality improvement activities at EMS agencies. We describe herein a novel survey to EMS agencies in a U.S. registry for OHCA.

Methods: Using data from the Cardiac Arrest Registry to Enhance Survival (CARES), we identified 577 EMS agencies with ≥10 OHCA cases annually between 2015 and 2019 that remained active in CARES. We administered a survey to EMS directors regarding agency characteristics, cardiac arrest response, relationships with first responders and dispatchers, quality improvement activities and perceived barriers in the community.

Results: Of eligible EMS agencies, 470 (81.5%) completed the survey. The high completion rate was likely due to frequent personalized emails and phone calls, liaising with CARES state coordinators to encourage survey response, and multiple periodic drawings of an automated external defibrillator during the survey period for participating EMS agencies. The survey examined rates of resuscitation training modalities; use of resuscitation equipment and devices in the field; frequency of simulation; non-EMS stakeholder response to OHCA (dispatchers, fire, police); quality improvement; and community factors affecting bystander response to OHCA.

Conclusions: In this study design paper on the RED-CASO survey, we provide summary data on EMS agency characteristics in the U.S. Upon linkage to CARES patient-level data, this survey will provide critical insights into 'best practices' at EMS agencies with the highest OHCA survival rates as well as provide insights into current disparities in outcomes.

Keywords: Cardiac arrest, EMS, Survival, Outcomes

Introduction

Over 350,000 out-of-hospital cardiac arrests (OHCA) occur annually in the U.S,[1] and survival rates remain low.[2,3] Although many studies have reported large variation in OHCA survival by geographic units (e.g., census tract, county,[4] and region[5]), such studies are limited as they do not provide actionable insights for improving resuscitation care quality. In contrast, emergency medical service (EMS) agencies play a critical role in pre-hospital care for OHCA in the community – they provide 911 emergency response, dispatch of medical personnel, triage, treatment, and rapid transport of OHCA victims to appropriate hospitals. Given that nearly all OHCA are assessed by EMS agencies, differences in care practices likely contribute to variability in OHCA survival across sites.

Recently, within the Cardiac Arrest Registry to Enhance Survival (CARES), we reported large variation in risk-standardized rates of survival to hospital admission for OHCA among 764 EMS agencies, with a median rate of 27.3% (interquartile range, 24.5–30.1%; range: 16.0–45.6%).[6] The wide variation in OHCA survival highlights potential opportunities to learn from EMS agencies with the highest rates of OHCA survival. However, little is known about resuscitation training, practices, policies, strategies, and quality improvement initiatives at EMS agencies. Moreover, if site-level data were collected on EMS agencies and linked to cardiac arrest outcomes, it would provide invaluable insights as to resuscitation practices and characteristics employed by agencies with the highest rates of OHCA survival and potentially define 'best practices' by top-performing EMS agencies.

We recently received funding for the Reducing Ethnic-racial Disparities in Cardiac Arrest Survival Outcomes (RED-CASO) study – a mixed methods study that is designed to identify best practices for EMS agencies, especially those in predominantly Black and Hispanic communities. In this Methods paper, we outline the survey administration process which allowed us to achieve an 81.5% survey completion rate and provide a summary of survey responses for the quantitative part of the RED-CASO study. We also discuss how this survey can be leveraged in future studies to obtain critical insights into best practices for EMS agencies with the highest survival rates for OHCA.

Methods

Identifying EMS agencies eligible for survey

CARES is a prospective, multicenter registry of patients with OHCA in the U.S, with a catchment area of over 179 million residents, representing approximately 53% of the U.S. population. Established by the Centers for Disease Control and Prevention and Emory University, the design of the registry has been previously described.[7,8] Briefly, all patients with a confirmed OHCA and for whom resuscitation is attempted are identified and followed by EMS agencies. Data are collected from three sources: 9-1-1 dispatch (public safety answering point) centers, EMS agencies, and receiving hospitals. Standardized international Utstein definitions are used for uniformity in clinical variables and outcomes across EMS agencies.[9]

Based on our prior work,[6] our initial cohort for the survey included 764 EMS agencies participating in CARES during 2015–2019 with an annual volume of at least 10 OHCA cases. From this sample, we excluded 145 agencies for whom site-specific contact information was not available or as the agency had been acquired by another EMS agency. We also excluded 42 agencies that were no longer participating in CARES. Therefore, our final study cohort comprised 577 eligible EMS agencies to complete the survey.

Design of the EMS agency survey

Between May 6, 2022 and September 10, 2022, we developed a novel EMS agency survey using an iterative process. The investigative team was multidisciplinary (emergency medicine, internal medicine, cardiology, and qualitative research and implementation science) and multi-professional (physicians, qualitative researchers and implementation scientists, a lawyer, a former paramedic, and a vice-president at the American Heart Association). Moreover, we ensured diversity in race, ethnicity, and gender and included two investigators who are Hispanic, one who is African American, one who is Native American, and 70% were women. We pilot tested the survey by administering it to 4 EMS agencies in the states of Missouri and Ohio to ensure questions and response options were clear.

The survey had three main objectives for research: (1) provide a contemporary summary of EMS agency resuscitation training and practices, (2) identify training and practices that are more commonly performed at EMS agencies with the highest rates of OHCA survival (top-performers), and (3) examine differences in training and practices between EMS agencies working in catchment areas in which the majority of residents were Black or Hispanic vs. White.

A copy of the survey can be found in Supplementary Appendix Table 1. There were 4 major domains covering up to 67 possible questions in the survey. The main domains included demographic information and characteristics of the EMS agency, EMS agency

treatment of OHCA, non-EMS stakeholder response to OHCA (dispatchers, fire, police), and community factors affecting bystander response to OHCA. Each EMS agency identified the person most qualified to answer questions related to resuscitation training, protocols and policies, as well as first responder and dispatcher response. This was most often the EMS agency Director.

Implementation of the survey

To date, there have been few published surveys of EMS agencies, and most have been limited by low response rates (10–24%)[10–12] or small sample sizes (25 and 46 sites surveyed).[13,14] To reduce bias due to non-response, we set a goal of a survey completion rate of >60%. To achieve that goal, we used a multi-pronged approach that included 5 key components.

- Ensure adequate time from launch to closeout of survey: The survey was deployed on September 27, 2022 with a 5-month window to complete the survey.
- Provide frequent reminders to EMS agencies to complete survey: After the initial email to EMS agency directors in September, we sent 3 reminder emails monthly during the survey. Two were mass emails, while the third was individualized to the EMS agency.
- Direct phone calls to EMS agencies: We made phone calls to EMS agencies that had not yet completed their survey between November 15 to December 15, 2022, and January 15 to February 10, 2023, using staff members with extensive experience conducting phone interviews with other research studies.
- Leverage state coordinators in CARES registry to contact sites to complete survey: CARES has state coordinators in 34 U.S. states. The lead author (PSC) presented the objectives of the survey at CARES state coordinators' monthly meetings in October of 2022 and January of 2023 to disseminate information about the survey and elicit their support for encouraging sites to complete the survey. Additionally, we provided the state coordinators a list of EMS agencies who had not completed the survey as of November 15, 2022, and late January of 2023 and requested their support for encouraging EMS agencies to complete the survey.
- AED drawings to generate excitement among eligible EMS agencies to participate in the survey: Among the 577 eligible EMS agencies, we offered 6 free AEDs to EMS agencies to encourage survey completion. These AED drawings occurred during 6 separate days during the survey period. We publicized the recipients of the AED drawing winners and where each agency intended to deploy their free AED in the community.

Results

Of 577 EMS agencies eligible for the survey, 470 (81.5%) completed the survey over the 21-week survey period. Fig. 1 shows the trajectory of survey completion over time. There was an initial surge in 182 (31.5%) responses during the first 4 weeks (Fig. 1). However, response rates rose at a slower rate over the next 3 weeks. Starting in week 7, our team made calls and sent out individualized emails to each EMS agency which had not yet completed the survey. We also
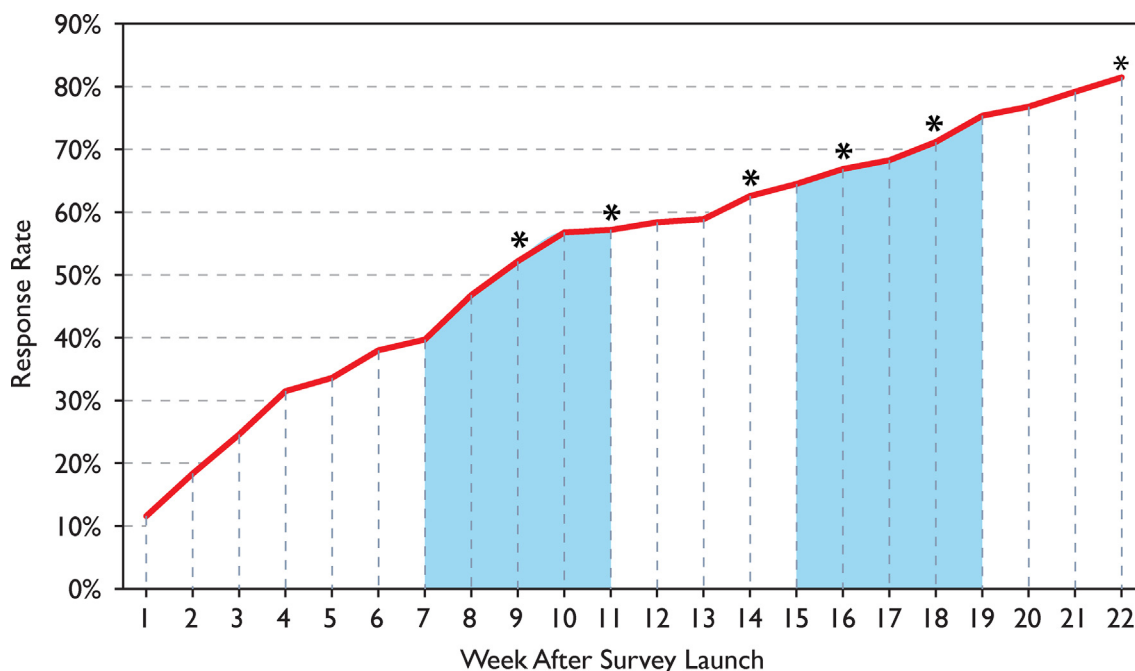
Fig. 1 – Survey Response Rates Over Time. Cumulative completion rates are shown during the 22-week survey window. Calls to EMS agency directors to encourage survey completion were made during the 4-week periods shaded in blue. The 6 asterisks denote the dates for the free AED drawings to eligible EMS agencies to incentivize survey completion.

reminded EMS agencies that our first AED drawing was to occur on December 1 (week 9). As a result, there were 109 completed surveys from weeks 7 to 10, yielding 328 (56.8%) completed surveys. Between weeks 10 to 17, survey completion slowed with 66 additional surveys. Starting in week 17, we again made calls to each site without a completed survey, sent indvidualized emails to each site, and engaged the CARES state coordinators to contact sites to encourage survey completion. These efforts resulted in an additional 76 completed surveys during the remaining 5 weeks of the survey period, yielding 470 completed surveys.

Overall, the mean risk-standardized rate for OHCA survvial among the EMS agencies was 27.8% ± standard deviation (SD) of 3.6%. Notably, this survival rate was similar to the 107 eligible agencies which did not complete the survey (27.4% ± 4.5%; P = 0.24). Table 1 summarizes demographic and other characteristics of the EMS agencies that completed the survey. About half were based in medium (25,000–74.999 residents) or large towns (75,000–149,999 residents), while 9% were in large metropolitan cities of >500,000 residents. Regarding EMS agency model, 83.4% used a paid model, while 15.3% were mixed (paid and volunteer) and the remaining 1.3% were primarily volunteer based. Forty percent were fire department-based agencies, 35% were private, and 17% were governmental-based agencies. The average number of full-time employees and volunteers at each agency was 201 ± 388, with an average of 84 ± 172 paramedics. At orientation, the median duration of cardiac arrest training was 4 hours (interquartile range: 2–8 hours), with most agencies incorporating in-person and simulation training. EMS competency was most often evaluated using simulation and written testing, and CPR competency was assessed at least once a year at 63% of agencies. A majority (77.4%) of EMS agencies employed staff for engaging in quality improvement efforts.

Table 2 summarizes EMS agencies' cardiac arrest response. Over 90% used emergency medical dispatchers (EMDs), used standardized protocols for interrogation and pre-arrival instructions and provided dispatcher-assisted CPR. Thirty-three percent of dispatcher systems were able to direct layperson callers to the nearest AED, and 28.6% of dispatcher systems could direct other rescuers to the scene of an OHCA. Although 3 in 4 agencies reviewed CPR quality, only 53% conducted reviews of CPR quality at least annually. Most agencies used waveform capnography and mechanical CPR devices, but only 35% of agencies used a device to provide automated CPR feedback. Ongoing simulation training for OHCA occurred in 87% of agencies but simulations occurred with at least a frequency of every 6 months in only 36% of agencies. Time from 9-1-1 call to dispatch was reviewed at least once annually in 55% of EMS agencies and feedback to dispatchers on dispatch times was provided at 35% of agencies. Time from dispatch to time of EMS arrival was reviewed at least once annually in 70% of agencies and feedback on EMS response time was provided to EMS personnel at 42% of agencies. Most patients were transported to the nearest available hospital, but 17% are transported to a designated cardiac arrest center and 28% to a STEMI center.

Perceived barriers to bystander response for medical emergencies are shown in Fig. 2. Three-quarter of EMS agencies did not view awareness of how to activate 9-1-1 as a barrier in their catchment areas. However, language barriers were perceived to be an important or a very large barrier at 14% of EMS agencies and somewhat a barrier at 50% of EMS agencies. Immigration status and public safety were perceived to be at least somewhat a barrier at one-third of EMS agencies' catchment areas, legal liability was at least somewhat a barrier at 44% of EMS agencies' catchment areas,

Table 1 – Demographic and Other Characteristics of EMS Agencies.

	TOTAL N = 470
Size of community	
Rural area (less than 2500 people)	6 (1.3%)
Small town (2500–24,999 people)	72 (15.3%)
Medium town (25,000–74,999 people)	141 (30.0%)
Large town (75,000–149,999 people)	85 (18.1%)
Mid-sized city (150,000–499,999 people)	79 (16.8%)
Suburb/fringe of a mid-sized city	13 (2.8%)
Large city (500,000 or more people)	43 (9.1%)
Suburb or fringe of a large city	31 (6.6%)
EMS agency medical personnel model?	
Paid	392 (83.4%)
Volunteer/Paid-on-call	5 (1.1%)
Mixed	72 (15.3%)
Other	1 (0.2%)
Type of EMS agency	
Fire department	188 (40.1%)
Private (includes for-profit and non-profit entities)	164 (35.0%)
Governmental, non-fire department	81 (17.3%)
Hospital based	21 (4.5%)
Other	15 (3.2%)
Missing	1
Annual number of EMS ambulance dispatches	29663.6 ± 52089.6
Annual number of EMS patient transports	19809.3 ± 38259.0
Full time employees and volunteers	200.8 ± 388.0
a. Emergency Medical Technicians	109.0 ± 288.4
b. Advanced Emergency Medical Technicians	6.3 ± 22.4
c. Paramedics	83.9 ± 172.4
Hours of cardiac arrest training during orientation, median	4 (IQR: 2–8)
a. Online training	144 (30.6%)
b. In person training	425 (90.4%)
c. Simulation training	295 (62.8%)
Is EMS staff competency in CPR evaluated?	417 (88.9%)
a. Written exam	255 (54.3%)
b. Oral exam	90 (19.1%)
c. Simulation	401 (85.3%)
How often is EMS personnel competency in CPR assessed	
Quarterly	42 (10.1%)
Twice a year	33 (7.9%)
Annually	188 (45.1%)
Every two years	142 (34.1%)
Other	12 (2.9%)
Missing	53
Does your EMS agency employ staff for quality improvement efforts?	364 (77.4%)
Approximately how often does your EMS agency share reports?	
Quarterly	114 (24.3%)
Twice a year	28 (6.0%)
Annually	106 (22.6%)
Other	170 (36.2%)
Not performed	52 (11.1%)

and infection risk was at least somewhat a barrier in 63% of EMS agencies' catchment areas.

Discussion

To date, there are scant data on resuscitation practices, training, and policies for treating OHCA at EMS agencies in the U.S., and almost none are linked to cardiac arrest survival data. As nearly all OHCAs for which CPR is initiated are attended by EMS agencies, the RED-CASO study survey provides important insights regarding EMS practices for pre-hospital OHCA care. Moreover, linkage of survey data with the CARES registry will help advance our understanding on strategies for improving OHCA survival overall and narrowing disparities.

To date, few surveys on EMS agency resuscitation practices for OHCA exist in the literature. Nearly all have either been small in sample size[13,14] or had low completion rates[10–12] and these have not been linked to OHCA survival at the EMS agency level. Because of difficulties in achieving a high survey completion rate in a large cohort of EMS agencies, we described in detail the multiple strategies we used to maximize survey response rates. These included a lengthy survey window period, weekly emails to EMS agency contacts that included individualized messages, involvement of state coordinators at CARES to contact sites on two different occasions, and highly publicized AED drawings spaced over a 3-month period, all of which helped to achieve the high response rate of 81.5%. The resultant 470 completed surveys from EMS agency directors thus provide a robust study sample across different types of communities to ensure generalizability. To the best of our knowledge, this represents the largest description of EMS agency-level responses on resuscitation practices and training in the literature.

Given the substantial mortality, morbidity, and costs associated with OHCA in the U.S., the National Academy of Medicine, in its highly influential 2015 report, *Strategies to Improve Cardiac Arrest Survival: A Time to Act,* highlighted cardiac arrest as a national research priority and called for renewed efforts to identify best practices among EMS agencies for resuscitation response and treatment to further improve survival rates.[15] Indeed, we found significant variability among EMS agencies in risk-standardized survival for OHCA, and there were differences in resuscitation practices, such as duration of resuscitation training at orientation, reviews of dispatch times and CPR competency, and dispatcher system capabilities. The RED-CASO survey will seek to identify whether these or other practices are best practices at EMS agencies with high survival rates for OHCA by linking survey responses to CARES data. With the linked data, we will evaluate which EMS agency factors (including those related to dispatchers, first responders, and the community) are associated with agencies with the highest survival rates.

Although survival for OHCA has improved in recent years, there is over-representation of Black and Hispanic communities among counties with the lowest rates of OHCA survival.[16] Communities in which the majority of OHCA victims are Black or Hispanic likely contend with unique challenges for prehospital OHCA care, including delays in activating 911, loss of trust of first responders (e.g., police), immigration status, language barriers, and lack of availability of

Table 2 – Cardiac Arrest Response at EMS Agencies.

	TOTAL N = 470
Does the 9-1-1 emergency telephone number use emergency medical dispatchers (EMD's)?	433 (92.1%)
Do EMDs use standardized interrogation questions and provide pre-arrival instructions?	427 (90.9%)
Do EMD's in your coverage area provide dispatcher assisted CPR instructions?	432 (91.9%)
How often is dispatcher assisted CPR administered for patients with cardiac arrest?	
Not performed	37 (7.9%)
<25% of the time	18 (3.8%)
26–50% of the time	36 (7.7%)
51–75% of the time	53 (11.3%)
76–100% of the time	181 (38.6%)
Unknown	144 (30.7%)
Missing	1
Can dispatchers in your coverage area direct a caller to the closest AED?	155 (33.0%)
Missing	1
Can dispatchers direct citizen rescuers to the scene to assist with bystander CPR?	134 (28.6%)
Missing	1
Does your EMS agency have a standard clinical protocol in responding to cardiac arrests?	463 (98.5%)
Does your agency have an ongoing quality improvement program to measure CPR quality (e.g., data collection and feedback)?	370 (78.7%)
How often is overall CPR quality of the agency reviewed?	
Not performed	100 (21.3%)
Quarterly	137 (29.1%)
Semi-annually	22 (4.7%)
Yearly	89 (18.9%)
Other	122 (26.0%)
Does your agency use quantitative waveform capnography?	464 (98.7%)
How often is quantitative waveform capnography used in cardiac arrests at your agency?	
Not used	6 (1.3%)
<25% of the time	2 (0.4%)
26–50% of the time	10 (2.1%)
51–75% of the time	26 (5.5%)
76–100% of the time	414 (88.1%)
Unknown	12 (2.6%)
How often is use of waveform capnography reviewed?	
Not performed	6 (1.3%)
Quarterly	136 (28.9%)
Semi-annually	26 (5.5%)
Yearly	49 (10.4%)
Other	188 (40.0%)
None performed	65 (13.8%)
Does your EMS agency use a device to provide automated CPR feedback?	
No Device	304 (64.7%)
Pocket CPR	1 (0.2%)
MRX AED	1 (0.2%)
TRUE CPR	11 (2.3%)
QCPR	34 (7.2%)
Other device	119 (25.3%)

Table 2 (continued)

	TOTAL N = 470
Are there instances when your agency uses a mechanical CPR device during a cardiac arrest? (choose all that apply)	388 (82.6%)
a. For all cardiac arrests	268 (57.0%)
b. When short of staff in the field	45 (9.6%)
c. To prevent infection risk	12 (2.6%)
d. For prolonged resuscitations	66 (14.0%)
e. While transporting patients without ROSC	83 (17.7%)
f. Other	74 (15.7%)
How often does your agency provide regular training for mechanical CPR devices?	
Quarterly	44 (9.4%)
Semi-annually	48 (10.2%)
Yearly	201 (42.8%)
Other	46 (9.8%)
None performed	131 (27.9%)
Does your agency perform simulation training for Cardiac Arrest care?	407 (86.8%)
Missing	1
What type of simulation is used? (choose all that apply)	
a. BLS simulation with a mannikin	181 (38.5%)
b. Full scenario simulation	359 (76.4%)
c. Other	7 (1.5%)
How often is simulation training performed by EMS agency members?	
Not performed	62 (13.2%)
Quarterly	66 (14.1%)
Every 6 months	45 (9.6%)
Yearly	225 (48.0%)
Other	67 (14.3%)
Unknown	4 (0.9%)
Missing	1
Which airway devices are used by your agency? (choose all that apply)	
a. Endotracheal tube	453 (96.4%)
b. Impedance threshold device	78 (16.6%)
c. Supraglottic airway device	411 (87.4%)
d. Blind insertion airway device	137 (29.1%)
Does your agency perform 12 lead electrocardiogram (ECG) in the pre-hospital setting?	469 (99.8%)
Are ECGs for suspected STEMI transmitted from the field to a receiving hospital in real time?	381 (81.2%)
Missing	1
Does your agency monitor time from 911 call to time of dispatch for cardiac arrest?	350 (74.5%)
How often are data on dispatch time for cardiac arrest reviewed?	
Monthly	146 (31.1%)
Quarterly	76 (16.2%)
Every 6 months	7 (1.5%)
Yearly	32 (6.8%)
Unknown	71 (15.1%)
Not reviewed	138 (29.4%)
Is feedback provided to dispatchers regarding time from 911 call to dispatch?	166 (35.3%)
Does your agency monitor time from dispatch to time of EMS arrival at a cardiac arrest scene?	368 (78.3%)
How often is arrival time reviewed?	

Table 2 (continued)	
	TOTAL
	N = 470
Monthly	193 (41.1%)
Quarterly	80 (17.0%)
Every 6 months	18 (3.8%)
Yearly	36 (7.7%)
Unknown	33 (7.0%)
Not reviewed	110 (23.4%)
What is the average response time from dispatch to EMS arrival at the scene for cardiac arrest calls?	
<4 minutes	16 (4.4%)
4–6 minutes	124 (33.8%)
7–9 minutes	169 (46.0%)
10–12 minutes	44 (12.0%)
13–15 minutes	12 (3.3%)
>15 minutes	2 (0.5%)
Missing	103
Is feedback provided to EMS personnel regarding time from dispatch to arrival at the scene?	198 (42.1%)
What is your EMS agency's average transport time from the scene of cardiac arrest to receiving hospital?	
<4 minutes	5 (1.1%)
4–6 minutes	40 (8.5%)
7–9 minutes	106 (22.6%)
10–12 minutes	148 (31.5%)
13–15 minutes	64 (13.6%)
>15 minutes	107 (22.8%)
Does your EMS agency use a Termination of Resuscitation protocol in the field?	458 (97.4%)
How often is Termination of Resuscitation implemented for patients meeting futility criteria?	
None used	12 (2.6%)
<25% of the time	54 (11.5%)
26–50% of the time	85 (18.1%)
51–75% of the time	110 (23.4%)
76–100% of the time	150 (31.9%)
Unknown	59 (12.6%)
To which type of hospital does your EMS agency typically bring a patient with OHCA? Choose the best option describing your agency	
Nearest available hospital	247 (52.6%)
Designated cardiac arrest center	82 (17.4%)
STEMI center	133 (28.3%)
Other tertiary hospital	8 (1.7%)

dispatcher-assisted CPR.[17,18] Therefore, it is critical to identify whether there are substantial differences in barriers to bystander response, as well as resuscitation training and practices, at EMS agencies with predominantly Black/Hispanic catchment areas, as compared to agencies with predominantly White catchment areas. We intentionally designed the RED-CASO survey to include questions that relate to potential disparities in bystander and first responder response. We provide some initial reporting on perceived barriers from the EMS agency side to bystander response in Fig. 2. While using perceived barriers from the EMS agency perspective may not fully represent community residents' experiences of barriers to care, survey responses linked to CARES data will nonetheless provide important insights regarding the extent to which potential differences in EMS agency factors underlie existing racial/ethnic disparities in bystander CPR and survival rates for OHCA.

Furthermore, as part of our ongoing work on the RED-CASO study, we will supplement the survey data with comparative case studies through in-depth qualitative interviews at 12 EMS agencies during 2023–2025 to gain a deeper understanding of EMS practices and identify barriers to resuscitation response. We will visit up to 9 EMS agencies in the top quartile of OHCA survival, of which at least half are working in communities where Black and Hispanic residents comprise >50% of their catchment area. Additionally, we will visit 3–4 EMS agencies in the bottom quartile of OHCA survival, where at least half have a Black/Hispanic catchment area. During these visits, we will conduct semi-structured interviews and multidisciplinary focus group sessions to define key factors in prehospital resuscitation care, such as EMS activation and response, emergency medical dispatch, CPR training and quality improvement initiatives, engagement with community, AED deployment and training, and intra- and inter-organizational characteristics and strategies. We will identify themes which distinguish top-performing EMS agencies in OHCA survival, as well as barriers to prehospital care at bottom-performing sites, with particular attention to EMS agencies that work in majority Black/Hispanic vs. majority White communities.

Prehospital resuscitation care is complex and multi-faceted requiring coordination of multiple governmental and non-governmental agencies. We believe that data from the RED-CASO study will generate critical and comprehensive insights for best practices for resuscitation care in these communities. Through these multi-layered efforts, our goal is to identify actionable insights for 'best practices' to improve OHCA survival overall, with a focus on those in majority Black or Hispanic communities. Our efforts mirror our prior work on in-hospital cardiac arrest, where we also used a mixed methods approach to identify best practices for in-hospital resuscitation care.[19–21] In that study, we found several hospital strategies that distinguished top-performing hospitals in survival for in-hospital cardiac arrest: the composition of resuscitation teams and roles of team members, effective modes of communication and leadership, adequate resuscitation training and education of hospital staff, and a dynamic resuscitation champion.

Our survey should be interpreted in the context of the following limitations. First, the survey is limited to EMS agencies in CARES, which represents a catchment area of ~50% of all U.S. residents. Moreover, we restricted our survey to EMS agencies with an annual case volume of at least 10 OHCA cases. Therefore, our findings may not pertain to non-participating EMS agencies or agencies with low volume of OHCA (i.e., rural areas). Specifically, the prevalence of some resuscitation strategies may be lower in non-participating EMS agencies and the prevalence of perceived resuscitation barriers may be higher. Second, surveys were generally completed by the EMS agency medical director who was felt to be the individual most able to provide insights on the range of questions asked. However, the survey responses were not independently verified for accuracy. Third, 107 (18.5%) eligible EMS agencies did not complete the survey. However, we found no major difference in survival rates between these agencies and those which completed the survey.

In summary, we describe the methodology of the RED-CASO EMS agency survey within the national CARES registry. We described how we achieved a high response rate of >80%. Our initial summary report of the responses provide an important overview of resuscitation training and practices across EMS agencies in the
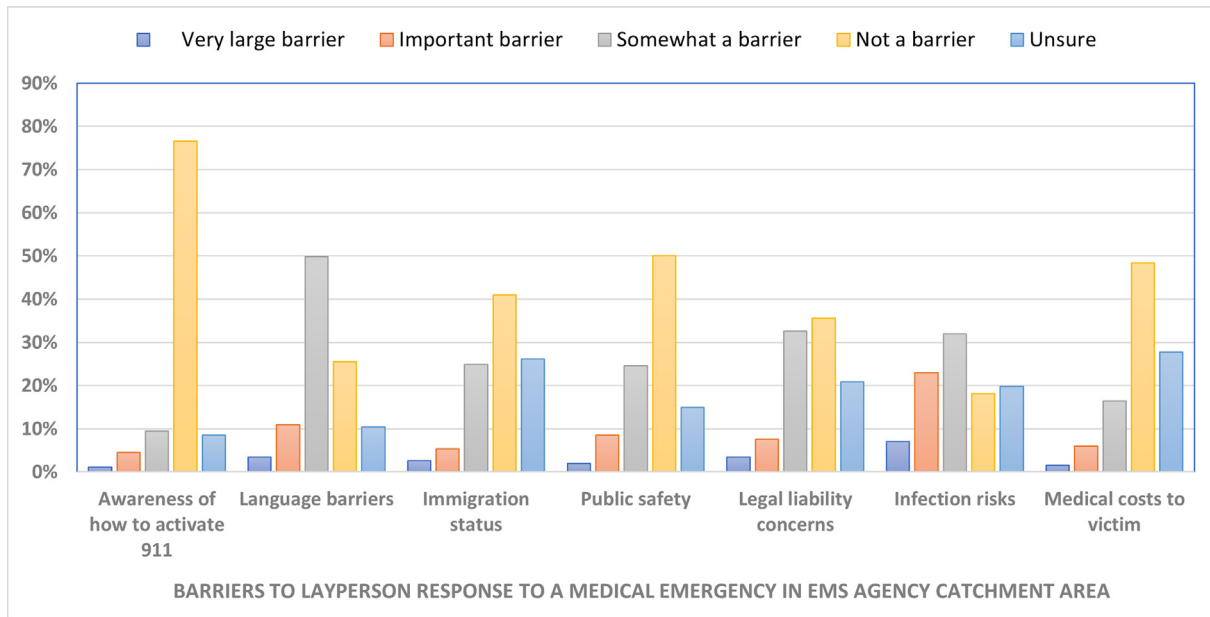
Fig. 2 – Perceived Barriers to Layperson Bystander Response at EMS Agencies. Responses from the EMS agency director regarding 7 potential barriers hindering bystander response in EMS agency communities are shown.

U.S., as well as community factors which may influence bystander response. Once survey data are linked to CARES data, we believe subsequent analyses will provide insights into best practices at EMS agencies with the highest survival rates for OHCA, as well as differences between EMS agencies working in Black/Hispanic vs. White communities to better understand existing racial/ethnic disparities in OHCA outcomes.

CRediT authorship contribution statement

Paul S. Chan: Conceptualization, Methodology, Writing – original draft, Writing – review & editing, Supervision. **Bryan McNally:** Writing – review & editing. **Rabab Al-Araji:** Writing – review & editing. **Kevin Kennedy:** Formal analysis. **Marina Del Rios:** Writing – review & editing. **Jessica Sperling:** Writing – review & editing. **Comilla Sasson:** Writing – review & editing. **Khadijah Breathett:** Writing – review & editing. **Kimberly C. Dukes:** Writing – review & editing. **Saket Girotra:** Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary material

Supplementary material to this article can be found online at https://doi.org/10.1016/j.resplu.2023.100483.

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