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Rapid response systems

Barriers to CPR initiation and continuation during the emergency call relating to out-of-hospital cardiac arrest: A descriptive cohort study

Emogene S. Aldridge[a,*], *Nirukshi Perera*[a], *Stephen Ball*[a,b], *Tanya Birnie*[a], *Alani Morgan*[a], *Austin Whiteside*[b], *Janet Bray*[a,c], *Judith Finn*[a,b,c]

Abstract

Aim: To describe the barriers to cardiopulmonary resuscitation (CPR) initiation and continuation in emergency calls for out-of-hospital cardiac arrest (OHCA).

Methods: We analysed 295 consecutive emergency calls relating to OHCA over a four-month period (1 January – 30 April 2021). Calls included were paramedic-confirmed, non-traumatic, non-EMS-witnessed OHCA, where the caller was with the patient. Calls were listened to in full and coded in terms of barriers to CPR initiation and continuation, and patient and caller characteristics.

Results: Overall, CPR was performed in 69% of calls and, in 85% of these, callers continued performing CPR until EMS arrival. Nearly all callers (99%) experienced barriers to CPR initiation and/or continuation during the call. The barriers identified were classified into eight categories: reluctance, appropriateness, emotion, bystander physical ability, patient access, leaving the scene, communication failure, caller actions and call-taker instructions. Of these, bystander physical ability was the most prevalent barrier to both CPR initiation and continuation, occurring in 191 (65%) calls, followed by communication failure which occurred in 160 (54%) calls. Callers stopping or interrupting CPR performance due to being fatigued was lower than expected ($n = 54$, 26% of callers who performed CPR). Barriers to CPR initiation that related to bystander physical ability, caller actions, communication failure, emotion, leaving the scene, patient access, procedural barriers, and reluctance were mostly overcome by the caller (i.e., CPR was performed).

Conclusion: Barriers to CPR initiation and continuation were commonly experienced by callers, however they were frequently overcome. Future research should investigate the strategies that were successful.

Keywords: Cardiopulmonary resuscitation, Out-of-hospital cardiac arrest, Emergency medical service communication systems

Introduction

Early initiation of cardiopulmonary resuscitation (CPR) and ongoing CPR performance until the Emergency Medical Services (EMS) arrive on scene is integral to the Chain of Survival for an out-of-hospital cardiac arrest (OHCA).[1] Due to the out of hospital setting and sudden nature of OHCA, layperson bystanders are often relied on to initiate the Chain of Survival, by calling for an ambulance and performing CPR.

Emergency call-takers are the initial contact in a prehospital medical emergency and are tasked with recognising the event as an OHCA and directing the caller to commence CPR. To assist call-takers, call scripts include instructions for dispatcher-assisted CPR (DA-CPR), where call-takers can coach callers on how to perform CPR and provide motivation to sustain CPR performance until the EMS arrives.[2] Most EMS have incorporated a DA-CPR protocol in their call centres,[3] because it improves uptake of bystander CPR (B-CPR),[4] although B-CPR rates do vary internationally.[5] Previous research shows bystanders encounter a range of barriers to the initiation of CPR during the emergency call,[6–9] however issues of CPR continuation to EMS arrival, and barriers encountered after CPR commencement, are largely undocumented.[10] In this study, we analysed emergency calls for EMS-confirmed cases of OHCA with the aim of describing the barriers to CPR initiation and continuation to

* Corresponding author at: Curtin University, Western Australia, Australia.
E-mail address: emogene.aldridge@postgrad.curtin.edu.au (E.S. Aldridge).

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EMS arrival, and whether the barriers were overcome. It was anticipated that the results from our study could be used to identify important barriers to CPR initiation and continuation, as a basis for targeting future research into the success of different call-taker strategies in dealing with key barriers to CPR.

Methods

Study design, setting and EMS system

We conducted a retrospective analysis of emergency call recordings relating to EMS-confirmed OHCA attended by St John Western Australia (SJ-WA). Western Australia (WA) has an area of 2.5 million km^2,a population of 2.7 million people.[11,12] and is serviced by a single EMS, namely SJ-WA. SJ-WA reported that the overall OHCA incidence for 2021 was 129.6 per 100 000 adults, and B-CPR was performed in 81.5% of cases with EMS resuscitation.[13] 30-day survival for cases with EMS resuscitation in 2021 was 10.5%.[13] All medical emergency calls are managed by the SJ-WA State Operations Centre, which utilises the Medical Priority Dispatch System (MPDS) v13[14] that prompts DA-CPR instructions for OHCA cases. DA-CPR instructions ask callers to perform 600 chest compressions and then two breaths, followed by cycles of 100 compressions and two breaths until EMS arrives. An abridged version of the call handling protocol utilised at the study site can be found in the supplementary information (Appendix A).[15–17] Approval for this study was obtained from the Curtin University Human Research Ethics Committee (HR128/2013) and SJ-WA Research Governance Committee. This study reports according to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines for reporting observational studies.[18]

Study data

OHCA cases meeting the study inclusion criteria were identified from the SJ-WA OHCA Database,[13] maintained by the Prehospital, Resuscitation and Emergency Care Research Unit (PRECRU) at Curtin University. This database collates patient and arrest characteristics, clinical care provided and dispatch data for all OHCAs attended by SJ-WA.

All calls relating to OHCA events identified in the SJ-WA OHCA Database between 1 January 2021 and 30 April 2021 were reviewed. Exclusion criteria for calls were: traumatic aetiology, EMS witnessed arrest, non-second party caller, OHCA not recognised during the emergency phone call, B-CPR in progress prior to call, and call coded as obvious death[19] by SJ-WA. We utilised SJ-WA's operational definition for second party callers as callers in close proximity to the patient.[20] Emergency call audio recordings for cases that met the aforementioned criteria were then extracted from SJ-WA, and screened to further ascertain suitability.

Data were extracted from calls by listening to the entire call and using a formal abstraction form to determine patient and caller characteristics. Two investigators (ESA and TB) initially independently listened to 10% of the calls, refining the data abstraction tool and data dictionary. A single investigator (ESA) then reviewed all calls and performed data abstraction.

Barriers to CPR initiation were defined a priori as any factor that delayed (or prevented) B-CPR initiation. Delays were defined as any factor that interrupted the flow of the call, where the call-taker had to pause, repeat, or re-instruct the caller. Barriers to CPR continuation were defined as any statement during the call that indicated interrupted or stopped CPR, or where the caller expressed an intention to do so. A list of potential barriers were initially created from the results of a recent scoping review,[10] and a policy statement from the American Heart Association.[2] Additional barrier categories were created as needed. These cases were then discussed between three authors (ESA, SB and JF) until a consensus was achieved for the proposed new category.

Data analysis and reporting

Descriptive analysis was performed using SPSS v27 (IBM, Armonk, NY, USA). Categorical data are presented as counts and percentages, and continuous variables are shown as means ± standard deviation. Comparisons were made between the groups using χ^2 tests for categorical variables, and Mann Whitney U and Kruskal Wallis test for non-parametric continuous variables. After the data abstraction process, three authors (EA, SB, JF) reviewed the list of barriers and grouped these into broader categories. These classifications were then reviewed by all authors until a consensus was reached.

Results

Study population

Over the four-month period, 894 OHCA incidents attended by SJ-WA were recorded in the SJ-WA OHCA Database. After initial screening, 486 calls were listened to in full, and 295 met the inclusion criteria (Fig. 1). Table 1 shows patient and arrest characteristics. Most patients were male (71%) and the mean age (SD) was 64.6 (19.5) years. Callers were mostly female (64%) and related to the patient (62%) (Table 2). Ninety-two percent of callers were offered DA-CPR instructions, with 79% worded as a statement ("I'm going to tell you how to do resuscitation, place the heel of your hand. . ."). Most cases had B-CPR performed (69%) and of those, 175/205 (85%) continued CPR till EMS arrival.

Barriers

Nearly every caller experienced one or more barriers to CPR initiation or continuation during the call (99%) (Table 2). Most callers (n = 286, 97%) experienced a barrier to CPR initiation. Of the 205 calls where B-CPR was performed, 154 (75%) experienced barriers to continuing CPR. In total, eight broad categories of barriers were identified across three main groups (psychological, physical and communication), namely: caller reluctance, perceived appropriateness, emotion, bystander physical ability, patient access, leaving the scene, communication failure, and caller distractions (Table 3). Cases had a median of 3 (IQR = 2–4) barriers to either CPR initiation or continuation throughout the call. There was no difference in the number of barriers between callers who did not initiate CPR (median = 3, IQR = 2–3) and callers who initiated CPR (median = 3, IQR = 2–4), p = 0.436. There was a significant association between time to first compression and number of barriers encountered in the call as follows: callers with 0–1 barriers time to first compression median = 2.48, IQR = 0.00–4.11 minutes; 2–3 barriers time to first compression median = 2.92, IQR = 0.00–4.78 minutes; and callers with 4 or more barriers time to first compression media = 3.85, IQR = 0.00–7.26 minutes, p = 0.025. There was no association between the number of barriers encountered in the call with ROSC (p = 0.075) or 30-day survival (p = 0.22).

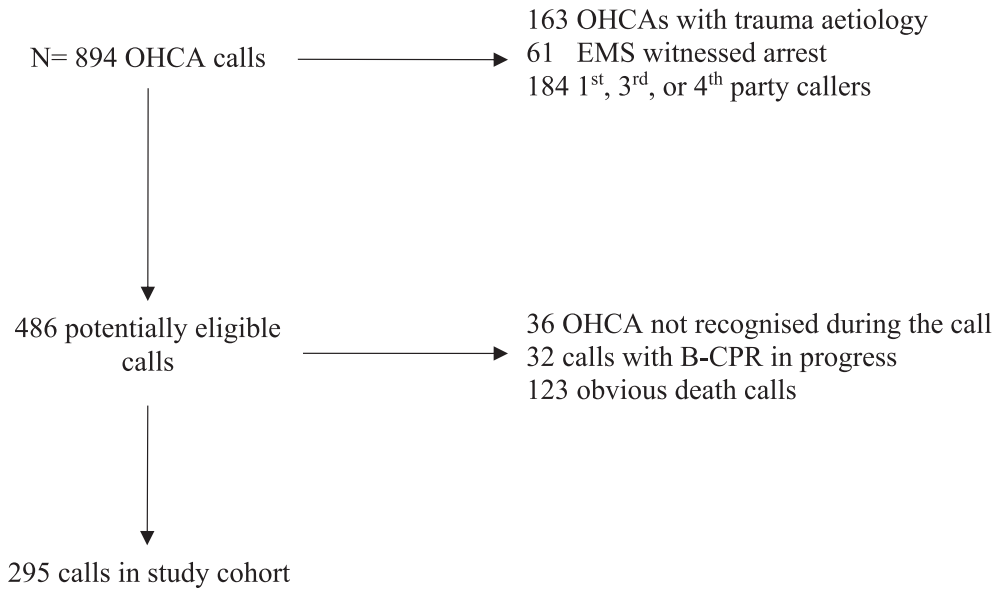


Fig. 1 – Study cohort.

Bystander physical ability

Bystanders commonly reported physical ability as a barrier to initiating or continuing CPR, occurring in 191/295 calls (65%) (Table 3). Moving the patient to a hard surface was the most prevalent, with 141/295 (48%) callers having issues, the majority experiencing this barrier prior to starting CPR. The emergency script allows the call-taker to judge the situation to either direct the caller to keep trying to move the patient or to seek help. Two callers started CPR and then the call-taker realised that the patient was not on a hard flat surface and the patient had to be moved. Physical limitations impeded 81 callers' ability to either start CPR (n = 73) or to perform CPR continuously (n = 8). Common reasons given by callers were that they were elderly, physically impaired due to injury or not strong enough. Interruptions or termination of CPR due to exhaustion occurred in 54/205 (26%). Only one caller had a physical disability that completely prevented them from performing CPR. The majority of callers (n = 126/171, 74%) were able to overcome physical barriers and initiate CPR (Fig. 2). Sixty-four callers experienced physical ability barriers while they were performing CPR, but the majority (n = 50/64, 78%) managed to continue CPR until EMS arrival.

Communication failure

Failure in communication between the caller and call-taker caused barriers to both initiation of CPR and continued performance, occurring in 160 calls (Table 3). Call-takers having difficulty establishing the OHCA location (n = 135/295, 46%) was the most common cause of communication failure and acted as a barrier to CPR initiation. Lack of understanding (n = 32/295, 11%) between the caller and call-taker was due to confusion regarding wording of the call-taker instructions affected initiation and continuation (e.g. "he is on his back... no, no, he's on the bed... I have to get him on the floor?" and "I've pumped the chest five times, now do I give breaths?"). Telecommunication issues, where the call dropped out or the caller was unable to get the phone on speaker, were experienced in 22/295 (7%) calls, most occurring as a barrier to CPR initiation (n = 15/295, 68%). Chaotic environments, including noisy backgrounds, many bystanders, or pets, delayed initiation, or continuation of CPR in 22/295 (7%) calls. Language barriers were only evident in three calls (1%). Of all the barriers, communication failure was the most likely to be overcome, with 73% (n = 113/154) of callers resolving the issue and initiating CPR, and 96% (n = 23/24) continuing CPR until EMS arrival (Fig. 2).

Emotion

Bystanders demonstrated emotional distress or fear in 137/295 (46%) calls (Table 3). Emotional distress resulting in delays or prevention of CPR initiation occurred in 107/295 (36%) calls and affected the ability to continue to perform CPR in 48/295 (16%) callers. Thirteen callers were scared to touch the patient, with one caller expressing, "I can't, I can't, I can't touch him, I don't want to feel him, I don't want to touch a dead person". Eight callers were aggressive towards the call-taker, five prior to CPR initiation and three after CPR had commenced. Callers in this group were usually aggressive regarding being asked to perform CPR and wanted the ambulance to arrive on scene faster (e.g. "just get the ambulance here now! The depot is just down the road, so why are they taking so long?"). Sixty-four percent (n = 78/122) of callers who were emotionally distressed or reported being afraid of the situation were able to overcome it and perform CPR (Fig. 2). Emotional barriers often co-occurred with other barriers: bystander ability, reluctance, communication failure, caller actions and appropriateness barriers whilst performing CPR (Table 4b).

Perceived appropriateness

Callers questioned the appropriateness of CPR in 133/295 (45%) calls, in four different ways: (1) the caller perceived that the patient was dead and beyond help, (2) the caller thought the patient was alive and breathing, (3) the caller stated that the patient had a terminal illness or a not for resuscitation (NFR) order in place, or (4) the caller thought that the patient would not want to be resuscitated (Table 3). Appropriateness barriers were mostly to CPR initiation (n = 121/133, 91%). Perceived death was the largest appropriateness barrier to CPR initiation, with 99/121 (82%) callers expressing that they thought the patient to be dead and CPR would not help.

Table 1 – Patient characteristics.

Patient characteristics (N = 295)	N	%
Patient sex		
Male	203	69%
Female	92	31%
Mean patient age (SD) years	65 (19.5)	
0–17 years old	6	2%
18+ years old	289	98%
Location of arrest		
Private	249	84%
Public	25	8%
Residential/Nursing Facility	21	7%
Initial arrest rhythm		
VT/VF/Shockable	43	15%
Non-shockable (unspecified)	10	3%
Asystole	214	73%
PEA	27	9%
Unknown rhythm	1	0%
Aetiology of OHCA		
Drowning	4	1%
Drug overdose	10	3%
Presumed cardiac	272	92%
Respiratory	9	3%
OHCA witness status		
Bystander witnessed	126	43%
Unwitnessed	169	57%
EMS resus attempted	183	62%
Bystander CPR was performed	205	69%
Bystander CPR continued till EMS arrival	175	85%
Ventilations performed	62	30%
AED applied	17	6%
Reason for stopping CPR		
Call ended prior to EMS arrival	7	3%
EMS arrival	175	85%
Bystander actions	22	11%
ROSC	1	0%
Patient outcomes		
Any ROSC	41	14%
Patient survival 30 days post OHCA	17	6%

Note: Any ROSC is defined as any form of return to spontaneous circulation (ROSC) prior to or on patient arrival to the emergency department.

Callers' perception of death varied from hesitant (e.g. "he was having difficulty breathing and I think he may have just passed"), to completely convinced (e.g. "my wife has just died, my wife is dead, she's gone, she's blue"). Appropriateness as a barrier to CPR initiation was overcome in 48% (n = 58/121) of calls. When appropriateness barriers presented after CPR was initiated, 72% (n = 13/18) of callers continued performing CPR until the EMS arrived (Fig. 2). CPR initiation delays due to appropriateness were often accompanied by the barriers of communication failure and emotion.

Caller distractions

Callers not listening to the call-taker, relaying information to others, providing inadequate information to the call-taker, performing other tasks, or hanging up prematurely were barriers to both CPR initiation and continuation, and occurred in 80/295 calls (27%) (Table 3). Callers were asked to perform other tasks such as "please go now and unlock the door for the ambulance" or "put the dog away before the ambulance arrives", usually after CPR had started. Caller distractions were mostly overcome, with 69% (n = 31/45) of those with this barrier initiating CPR and 64% (n = 28/44) continuing CPR (Fig. 2).

Caller reluctance

Callers expressed that they did not want to perform or continue CPR in 76/295 calls (26%), most (n = 53, 70%) of which contained barriers to CPR initiation (i.e. delaying or preventing B-CPR initiation) (Table 3). Unspecified reluctance was defined as where callers expressed apathy or indifference about performing CPR and was only found to be a barrier to CPR initiation (e.g. "oh I can't do that, I can't... yeah he's gone", "no I can't, just get the ambulance here, he's blue"). Reluctance was also expressed when callers were asked to perform mouth-to-mouth resuscitation, body fluids were present on or around the patient, other bystanders were unwilling to swap in to provide CPR, and when there was a lack of confidence in the ability to perform CPR. When reluctance was a barrier to CPR initiation, 54% (n = 26/48) of these barriers were overcome by the callers (i.e., CPR was performed) (Fig. 2). Nearly all callers (n = 32/33, 97%), who expressed a barrier due to reluctance after CPR initiation, continued CPR until the EMS arrived on scene. Reluctance as a barrier to CPR initiation was commonly accompanied by other barriers such as communication failure, emotion, and appropriateness (Table 4a).

Table 2 – Caller and call-taker characteristics.

Caller and call-taker characteristics (N = 295)	N	%
Call-taker sex		
Male	80	27%
Female	215	73%
Caller sex		
Male	103	35%
Female	192	65%
Relationship to patient		
Relative	195	66%
Colleague/Friend	59	20%
Stranger	36	12%
Relationship unknown	5	2%
Calling from		
Landline	53	18%
Mobile	237	80%
Unknown	5	2%
Cases with multiple bystanders on scene	169	57%
Call-taker offered DA-CPR instructions	270	92%
How CPR direction was worded		
Statement	234	79%
Question	36	12%
Not given	25	8%
Barriers prior to CPR initiation	286	97%
Barriers post CPR initiation	154	75%
Number of unique barrier categories per call		
0	2	1%
1	39	13%
2	74	25%
3	104	35%
4	54	18%
5	19	6%
6	3	1%

Patient access

Thirty-five callers out of the 295 cohort (12%) were not able to easily access the patient, due to a barrier between the caller and the patient (e.g. a door or wall, or the patient was wedged between two objects) or not having a portable telephone (n = 8), which only affected CPR initiation (Table 3). Of the 35 callers with difficulties accessing the patient, 21 (60%) overcame the barrier to perform CPR (Fig. 2).

Leaving the scene

Seventeen callers (6%) left the scene to get help, 16 left before CPR initiation (Table 3). Callers were sometimes (n = 15) prompted by the call-taker to leave, with the call-taker asking if the caller could find someone to help or retrieve an AED. Seventy-five percent (n = 12/16) of callers who left the scene came back, and CPR was initiated (Fig. 2).

Callers who did not perform DA-CPR

CPR was not performed in 90 calls, and certain barrier subcategories occurred more commonly in calls where DA-CPR was not initiated. CPR was not initiated by all callers who: perceived that the patient would not want resuscitation, did not provide sufficient information to the call-taker, hung up prematurely or were physically unable to perform CPR. Other barriers where CPR was less likely to occur were: fear of contact (n = 11, 85% did not initiate CPR), perceived inability to perform CPR (n = 3, 75%), patient was difficult to access (n = 6, 75%), general fear or apprehension (n = 2, 67%), language barrier between the caller and call-taker (2, 67%), a formal not for resuscitation order in place (n = 4, 67%), and the caller perceived the patient was dead (n = 59, 60%).

Discussion

This study described the barriers to DA-CPR initiation and continuation, through analysis of emergency calls relating to OHCA and examination of the interaction between the caller and the call-taker. We found that barriers to CPR initiation and continuation were very common, with bystander physical ability, communication failure and emotional distress being the most prevalent. Commonly the caller and call-taker overcame the barriers together, which enabled 69% of callers to initiate CPR, and of those, 75% to continue performing CPR until EMS arrived. While barriers preventing B-CPR initiation have been discussed before,[10] our study is unique because it not only considers barriers causing delays to DA-CPR initiation but also those causing interruptions to DA-CPR continuation, as well as the ability to overcome these barriers.

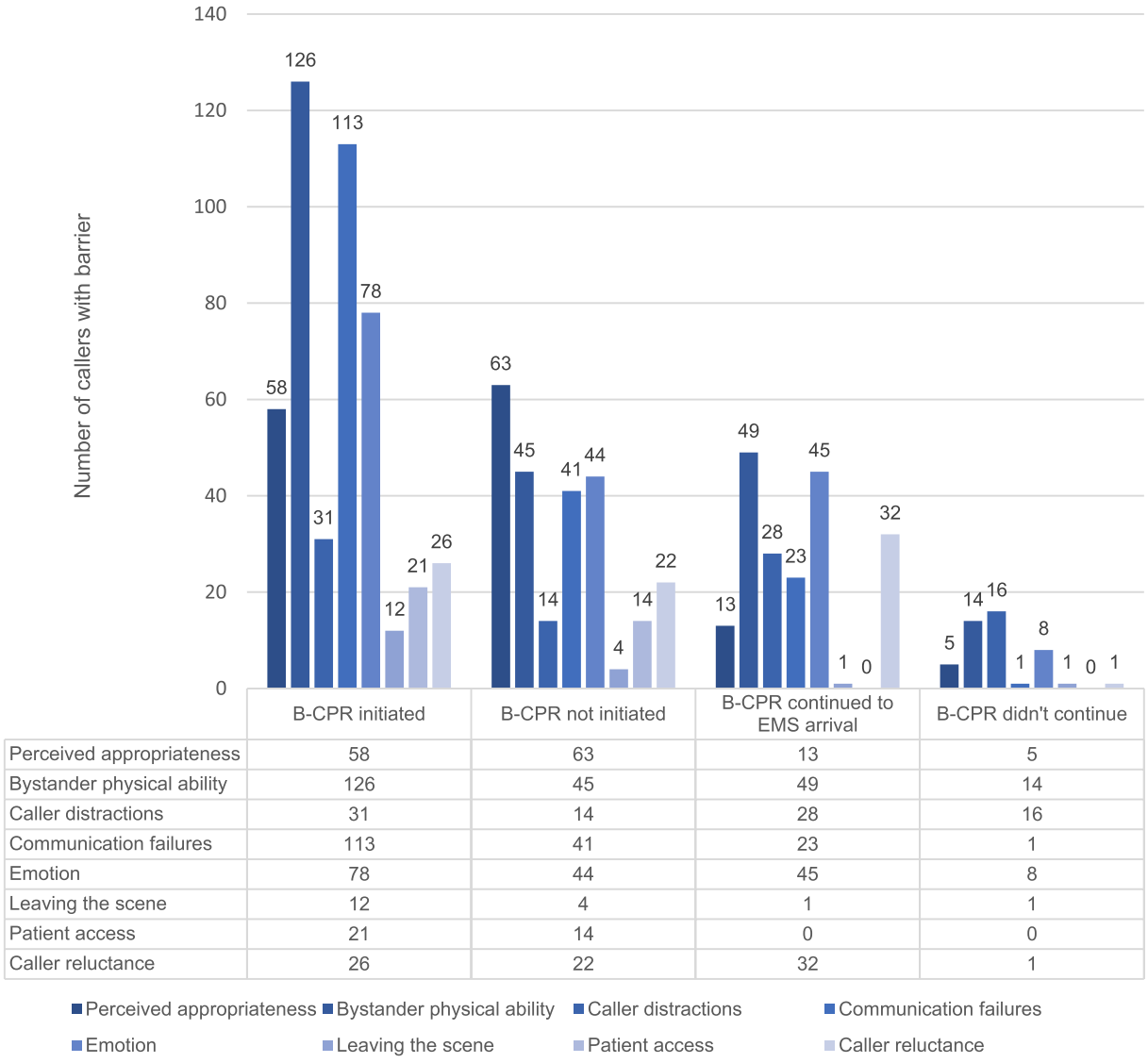
Our study accounted for barriers that both prevented or delayed CPR initiation and impacted callers' continued performance of compressions. This could explain the higher prevalence of barriers in this study compared to other studies which typically account for either prohibiting barriers or delaying barriers. The COVID-19 pandemic

Table 3 – Psychological, physical and communication barrier categories identified within the calls. Some calls had multiple barriers within each category (e.g. emotional distress and fear of hurting the patient).

A. Psychological barriers	N CPR initiation barriers	N CPR continuation barriers
Caller reluctance (N = 76*)	53±	35§
Performing ventilations	1	10
Body fluids present	24	20
Other bystanders unwilling to swap over	1	5
Reluctance (not specified)	22	0
Perceived ability	5	0
Perceived appropriateness (N = 133*)	137±	18§
Perceived dead	99	11
Perception of patient wishes	6	0
Agonal breaths/breathing	26	6
Not for resuscitation order in place	6	1
Emotion (N = 137*)	138±	56§
Emotional distress	107	48
Fear/apprehension (not specified)	3	0
Fear of contact	13	0
Fear of hurting patient	10	5
Aggressive caller	5	3
B. Physical barriers		
Bystander physical ability (N = 191*)	216±	64§
Bystanders' physical limitations	73	8
Physical disability prevents CPR	1	0
Moving patient to hard surface	142	2
Tired/exhaustion	0	54
Patient access (N = 35*)	44±	0§
Patient difficult to access	8	0
Caller not next to patient	28	0
No portable phone	8	0
Leaving the scene (N = 17*)	16±	2§
Gone to get help from others	15	2
Retrieving AED	1	0
C. Communication barriers		
Communication failure (N = 160*)	190±	24§
Lack of understanding	22	10
Language barriers	3	0
Telecommunication issues	15	7
Chaotic environment	15	7
Establishing location	135	0
Caller distractions (N = 80*)	49±	44§
Caller providing inadequate information	3	0
Caller relaying instructions to other bystanders	6	6
Caller hung up	1	0
Caller asked to perform another task	10	31
Not listening to call-taker	29	7

Note: *The total number of calls with a barrier to CPR initiation and/or continuation. ±Total number of calls with one or more types of barrier to CPR initiation. §Total number of calls with one or more types of barrier to CPR continuation

was reported to increase the number of barriers experienced by callers, without affecting their willingness to perform CPR,[21] which could explain the increase in barriers within this cohort. Despite the increase in prevalence, there are similarities to individual barrier categories in the literature. In our study, callers displayed emotional barriers in 46% of calls. Cheng et al.[22] found 55% of callers to an EMS dispatch centre in northern Taiwan were anxious, upset or hysterical, and in the United Kingdom, Deakin et al[23] reported that 50% of callers panicked and didn't initiate CPR. Bystander ability to reposition patients has been reported to affect between 26%[9] and 41%[24] of callers, delaying CPR initiation. In our study cohort, difficulties moving the patient affected 48% of callers. Callers perceived the patient to be dead more frequently than Riou et al.[25] found in the analysis of emergency calls from the same EMS as our study (34% v 19%), however this could be due to Riou et al[25] limiting their cohort of OHCA cases to where EMS resuscitation was attempted. A surpris-



	B-CPR initiated	B-CPR not initiated	B-CPR continued to EMS arrival	B-CPR didn't continue
Perceived appropriateness	58	63	13	5
Bystander physical ability	126	45	49	14
Caller distractions	31	14	28	16
Communication failures	113	41	23	1
Emotion	78	44	45	8
Leaving the scene	12	4	1	1
Patient access	21	14	0	0
Caller reluctance	26	22	32	1

Fig. 2 – Number of calls that overcame each barrier category, to initiate B-CPR and continue B-CPR to EMS arrival.

Table 4a – Co-occurrence of barriers within the calls to CPR initiation, N (%).

Barriers to CPR initiation (N = 295)	Bystander physical ability	Communication failure	Emotional	Perceived appropriateness	Caller reluctance	Caller distractions	Patient access	Leaving the scene
Bystander physical ability		79 (51%)	68 (56%)	57 (47%)	20 (42%)	21 (47%)	16 (46%)	10 (63%)
Communication failure	79 (46%)		56 (46%)	64 (53%)	30 (63%)	23 (51%)	22 (63%)	6 (38%)
Emotional	68 (40%)	56 (36%)		59 (49%)	23 (48%)	23 (51%)	9 (26%)	8 (50%)
Perceived appropriateness	57 (33%)	64 (42%)	59 (48%)		25 (52%)	14 (31%)	10 (29%)	8 (50%)
Caller reluctance	20 (12%)	30 (19%)	23 (19%)	25 (21%)		11 (24%)	6 (17%)	5 (61%)
Caller distractions	21 (12%)	23 (15%)	23 (19%)	14 (12%)	11 (23%)		6 (17%)	3 (19%)
Patient access	16 (9%)	22 (14%)	9 (7%)	10 (8%)	6 (13%)	6 (13%)		1 (6%)
Leaving the scene	10 (6%)	6 (4%)	8 (7%)	8 (7%)	5 (10%)	3 (7%)	1 (3%)	
Total	**171**	**154**	**122**	**121**	**48**	**45**	**35**	**16**

Table 4b – Co-occurrence of barriers within the calls to CPR continuation, N (%).

Barriers to CPR continuation (N = 205)	Bystander physical ability	Communication failure	Emotional	Perceived appropriateness	Caller reluctance	Caller distractions	Leaving the scene
Bystander physical ability		9 (38%)	17 (32%)	6 (33%)	11 (33%)	15 (34%)	2 (100%)
Communication failure	9 (14%)		9 (17%)	1 (6%)	1 (3%)	4 (9%)	0 (0%)
Emotional	17 (27%)	9 (38%)		7 (39%)	8 (24%)	11 (25%)	1 (50%)
Perceived appropriateness	6 (10%)	1 (4%)	7 (13%)		2 (6%)	5 (11%)	1 (50%)
Caller reluctance	11 (17%)	1 (4%)	8 (15%)	2 (11%)		3 (7%)	0 (0%)
Caller distractions	15 (24%)	4 (17%)	11 (21%)	5 (28%)	3 (9%)		0 (0%)
Leaving the scene	2 (3%)	0 (0%)	1 (2%)	1 (6%)	0 (0%)	0 (0%)	
Total	**63**	**24**	**53**	**18**	**33**	**44**	**2**

ing finding was the small proportion of callers expressing tiredness or exhaustion impacting their ability to perform chest compressions. Anecdotally and based on simulation studies[26], this was expected to be much higher than 26% of callers performing CPR. The 30-day survival rate in this study cohort was 6%.[27–29] Published survival rates are often subgroups of the total cohort, e.g. where EMS resuscitation was performed, or only bystander witnessed cases – both of which have a higher survival rate. In this study, the survival rate did not have these restrictions on resuscitation attempt and is similar to the national average for all presumed medical OHCAs attended.

Every minute where CPR is delayed is associated with a significant decrease in the OHCA patient's chance of survival.[30] OHCA requires bystanders to act, and to do so as soon as possible.[31] Call-takers are required to problem solve and work with the callers to facilitate this action. Understanding the barriers callers face and assessing the proportion of callers who can overcome some barriers, highlights the opportunity for EMS call centres to utilise alternative methods to further assist callers. Determining the location of the arrest, for example, could be simplified using an app such as what3-words,[32] which can be more precise than the caller. Further research could focus on how call-takers are able to work with callers to overcome the barriers encountered. Our next study will examine emergency call recordings, for strategies utilised by call-takers to assist callers in initiating and performing CPR.

Limitations

There are several potential limitations of this study. First, there is risk of coding inaccuracy in the barriers, with similar situations being coded differently due to nuances within the calls. We aimed to reduce this inaccuracy through initial testing of 10% of calls with two authors and establishing a comprehensive data dictionary through discussion with all authors. Secondly, there are assumptions that are made when listening to audio recordings of emergency calls as it is not always clear when the caller commences compressions, pauses, or stops. These assumptions mean that there may be some misclassification of B-CPR initiation and continuation, and some overestimation of CPR continuation. Finally, the calls examined are from one EMS, which uses MPDS for triaging emergency calls. Thus, our findings may vary from other EMS's.

Conclusion

Barriers to CPR initiation and CPR continuation are common in emergency calls for OHCA. Most callers were able to overcome these barriers, to perform CPR and keep going until the EMS arrived. Further insight into strategies and coaching utilised by call-takers could prove useful to EMS in improving rates of CPR initiation and continuation, and ultimately improve survival rates.

CRediT authorship contribution statement

Emogene S. Aldridge: Writing – original draft, Visualization, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Nirukshi Perera:** Writing – review & editing, Methodology, Conceptualization. **Stephen Ball:** Writing – review & editing, Methodology, Data curation, Conceptualization. **Tanya Birnie:** Writing – review & editing, Validation, Data curation. **Alani Morgan:** Writing – review & editing, Data curation. **Austin Whiteside:** Writing – review & editing, Data curation. **Janet Bray:** Writing – review & editing, Supervision. **Judith Finn:** Writing – review & editing, Supervision, Methodology, Conceptualization.

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 data to this article can be found online at https://doi.org/10.1016/j.resuscitation.2023.110104.

Author details

[a]*Prehospital, Resuscitation and Emergency Care Research Unit, School of Nursing, Curtin University, Western Australia, Australia*[b]*St John Western Australia, Western Australia, Australia* [c]*Monash School of Public Health and Preventive Medicine, Monash University, Victoria, Australia*

REFERENCES

1. Nolan J, Soar J, Eikeland H. The chain of survival. Resuscitation 2006;71:270–1. https://doi.org/10.1016/j.resuscitation.2006.09.001.
2. Kurz MC, Bobrow BJ, Buckingham J, et al. Telecommunicator cardiopulmonary resuscitation: a policy statement from the American Heart Association. Circulation 2020;141:e686–700. https://doi.org/10.1161/CIR.0000000000000744.
3. Beck B, Bray JE, Smith K, et al. Description of the ambulance services participating in the Aus-ROC Australian and New Zealand out-of-hospital cardiac arrest Epistry. Emergency Med Australasia 2016;28:673–83. https://doi.org/10.1111/1742-6723.12690.
4. Song KJ, Shin SD, Park CB, et al. Dispatcher-assisted bystander cardiopulmonary resuscitation in a metropolitan city: a before–after population-based study. Resuscitation 2014;85:34–41. https://doi.org/10.1016/j.resuscitation.2013.06.004.
5. Nishiyama C, Kiguchi T, Okubo M, et al. Three-year trends in out-of-hospital cardiac arrest across the world: second report from the International Liaison Committee on Resuscitation (ILCOR). Resuscitation 2023;186. https://doi.org/10.1016/j.resuscitation.2023.109757.
6. Ho AFW, Sim ZJ, Shahidah N, et al. Barriers to dispatcher-assisted cardiopulmonary resuscitation in Singapore. Resuscitation 2016;105:149–55. https://doi.org/10.1016/j.resuscitation.2016.05.006.
7. Michiels C, Clinckaert C, Wauters L, Dewolf P. Phone CPR and barriers affecting life-saving seconds. Acta Clinica Belgica 2020:1–6. https://doi.org/10.1080/17843286.2020.1752454.
8. Case R, Cartledge S, Siedenburg J, et al. Identifying barriers to the provision of bystander cardiopulmonary resuscitation (CPR) in high-risk regions: a qualitative review of emergency calls. Resuscitation 2018;129:43–7. https://doi.org/10.1016/j.resuscitation.2018.06.001.
9. Langlais BT, Panczyk M, Sutter J, et al. Barriers to patient positioning for telephone cardiopulmonary resuscitation in out-of-hospital cardiac arrest. Resuscitation. 2017:163–8. https://doi.org/10.1016/j.resuscitation.2017.03.034.
10. Aldridge ES, Perera N, Ball S, Finn J, Bray J. A scoping review to determine the barriers and facilitators to initiation and performance of bystander cardiopulmonary resuscitation during emergency calls. Resusc Plus. 2022;11. https://doi.org/10.1016/j.resplu.2022.100290 100290.
11. Australian Bureau of Statistics. Snapshot of Australia, 2021. Canberra: Australian Bureau of Statistics; 2022. Available from: https://www.abs.gov.au/statistics/people/people-and-communities/snapshot-australia/2021.
12. Australian Government. Area of Australia - States and Territories Canberra: Australian Government; 2023 [Accessed 6 July 2023]. Available from: https://www.ga.gov.au/scientific-topics/national-location-information/dimensions/area-of-australia-states-and-territories.
13. St John Western Australia. Out-of-hospital cardiac arrest report 2021. Belmont: St John Western Australia; 2023. Available from: https://impact.stjohnwa.com.au/docs/default-source/default-document-library/ohca-report-2021-final.pdf?sfvrsn=d5ee25d4_0.
14. Priority Dispatch. Discover ProQA 2023 [Accessed 6 July 2023]. Available from: https://prioritydispatch.net/discover_proqa/.
15. Barrus B. Prone CPR instructions 2023 [Accessed 27 November 2023]. Available from: https://www.iaedjournal.org/prone-cpr-instructions.
16. Whitaker I, Olola C, Toxopeus C, et al. Emergency medical dispatchers' ability to determine obvious or expected death outcomes using a medical priority dispatch protocol. Ann Emergency Dispatch Response 2015;3.
17. Barrus B. To use or not to use 2017 [Accessed 27 November 2023]. Available from: https://www.iaedjournal.org/use-not-use.
18. von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. Ann Intern Med. 2007;147:573–7. https://doi.org/10.7326/0003-4819-147-8-200710160-00010.
19. St John Western Australia. Clinical Practice Guideline: The Deceased Belmont: St John Western Australia; 2020 [Accessed 6 July 2023]. Available from: https://clinical.stjohnwa.com.au/clinical-practice-guidelines/general/the-deceased.
20. Clawson JJ, Boyd-Dernocoeur K, Rose BH. Principles of Emergency Medical Dispatch. 6th ed. Priority Press; 2015.
21. Lim SL, Shahidah N, Saffari SE, et al. Impact of COVID-19 on out-of-hospital cardiac arrest in Singapore. Int J Environ Res Public Health 2021;18. https://doi.org/10.3390/ijerph18073646.
22. Cheng-Yu C, Wei-Che C, Li-Heng T, et al. Impact of the caller's emotional state and cooperation on out-of-hospital cardiac arrest recognition and dispatcher-assisted cardiopulmonary resuscitation. Emergency Med J 2019;36:595–600. https://doi.org/10.1136/emermed-2018-208353.
23. Deakin CD, Evans S, King P, Deakin CD, Evans S, King P. Evaluation of telephone-cardiopulmonary resuscitation advice for paediatric cardiac arrest. Resuscitation 2010;81:853–6. https://doi.org/10.1016/j.resuscitation.2010.02.007.
24. Missel AL, Drucker CJ, Kume K, et al. Association between bystander physical limitations, delays in chest compression during telecommunicator-assisted cardiopulmonary resuscitation, and outcome after out-of-hospital cardiac arrest. Resuscitation 2023;188:109816. https://doi.org/10.1016/j.resuscitation.2023.109816.
25. Riou M, Ball S, Morgan A, et al. 'I think he's dead': a cohort study of the impact of caller declarations of death during the emergency call on bystander CPR. Resuscitation 2021;160:1–6. https://doi.org/10.1016/j.resuscitation.2021.01.001.
26. McDonald CH, Heggie J, Jones CM, Thorne CJ, Hulme J. Rescuer fatigue under the 2010 ERC guidelines, and its effect on cardiopulmonary resuscitation (CPR) performance. Emergency Med J : EMJ. 2013;30:623–7. https://doi.org/10.1136/emermed-2012-201610.
27. Beck B, Bray J, Cameron P, et al. Regional variation in the characteristics, incidence and outcomes of out-of-hospital cardiac arrest in Australia and New Zealand: results from the Aus-ROC Epistry. Resuscitation 2018:49–57.
28. Yan S, Gan Y, Jiang N, et al. The global survival rate among adult out-of-hospital cardiac arrest patients who received cardiopulmonary resuscitation: a systematic review and meta-analysis. Crit Care 2020;24. https://doi.org/10.1186/s13054-020-2773-2.
29. Nishiyama C, Kiguchi T, Okubo M, et al. Three-year trends in out-of-hospital cardiac arrest across the world: Second report from the International Liaison Committee on Resuscitation (ILCOR). Resuscitation 2023;186:109757. https://doi.org/10.1016/j.resuscitation.2023.109757.
30. Valenzuela TD, Roe DJ, Cretin S, Spaite DW, Larsen MP. Estimating effectiveness of cardiac arrest interventions: a logistic regression survival model. Circulation (New York, NY). 1997;96:3308–13. https://doi.org/10.1161/01.CIR.96.10.3308.
31. Panchal AR, Bartos JA, Cabañas JG, et al. Part 3: Adult Basic and Advanced Life Support: 2020 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. Circulation. 2020;142:S366–468. https://doi.org/10.1161/CIR.0000000000000916.
32. Amitash MS, Rahul KP, Sumedh H, Tejaal M, Baskar V, Shahina Parveen M, editors. Accurate Location-based Routing for Emergency Response: A Case Study of an App for First Responders using What3Words. In: 2023 8th International Conference on Communication and Electronics Systems (ICCES); 2023 1-3 June 2023.