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ORIGINAL RESEARCH

Lay Bystanders' Perspectives on What Facilitates Cardiopulmonary Resuscitation and Use of Automated External Defibrillators in Real Cardiac Arrests

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***Background*—**Many patients who suffer an out-of-hospital cardiac arrest will fail to receive bystander intervention (cardiopulmonary resuscitation [CPR] or defibrillation) despite widespread CPR training and the dissemination of automated external defibrillators (AEDs). We sought to investigate what factors encourage lay bystanders to initiate CPR and AED use in a cohort of bystanders previously trained in CPR techniques who were present at an out-of-hospital cardiac arrest.

***Methods and Results*—**One-hundred and twenty-eight semistructured qualitative interviews with CPR-trained lay bystanders to consecutive out-of-hospital cardiac arrest, where an AED was present were conducted (from January 2012 to April 2015, in Denmark). Purposive maximum variation sampling was used to establish the breadth of the bystander perspective. Twenty-six of the 128 interviews were chosen for further in-depth analyses, until data saturation. We used cross-sectional indexing (using software), and inductive in-depth thematic analyses, to identify those factors that facilitated CPR and AED use. In addition to prior hands-on CPR training, the following were described as facilitators: prior knowledge that intervention is crucial in improving survival, cannot cause substantial harm, and that the AED will provide guidance through CPR; prior hands-on training in AED use; during CPR performance, teamwork (ie, support), using the AED voice prompt and a ventilation mask, as well as demonstrating leadership and feeling a moral obligation to act.

***Conclusions*—**Several factors other than previous hands-on CPR training facilitate lay bystander instigation of CPR and AED use. The recognition and modification of these factors may increase lay bystander CPR rates and patient survival following an out-of-hospital cardiac arrest. **(*J Am Heart Assoc*. 2017;6:e004572. DOI: 10.1161/JAHA.116.004572.)**

Key Words: automated external defibrillator • bystander • cardiac arrest • cardiopulmonary resuscitation • defibrillation • qualitative research

Every year, ≈700 000 individuals in North America and Europe will suffer an out-of-hospital cardiac arrest (OHCA); typically, less than 10% will survive.[1,2] This statistic contrasts markedly with the 50% survival rate that can be achieved when bystanders intervene to provide cardiopulmonary resuscitation (CPR), including the use of automated external defibrillators (AEDs).[3–6] To increase bystander intervention, millions of laypeople (ie, nonspecialists within the general public) undergo CPR training, and AEDs have been widely disseminated.[7–9] Despite these efforts, many OHCA patients still fail to receive bystander intervention,[10–12] and it is estimated that 65% of CPR-trained bystanders will fail to provide CPR.[13] As emphasized by the Institute of Medicine, resuscitation guidelines, and The American Heart Association,

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Accompanying Tables S1 and S2 are available at http://jaha.ahajournals.org/content/6/3/e004572/DC1/embed/inline-supplementary-material-1.pdf

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a deeper understanding of those factors that enable bystanders to attempt CPR and AED use can be used to modify those approaches designed to encourage bystander intervention.[13–16]

The success of methods used to train the general public in CPR and AED use have been assessed through simulation, and with surveys used to examine the likelihood with which an individual would attempt CPR, or use an AED.[17–27] However, little is known as to how laypeople perceive OHCAs (including CPR and using an AED), given that these data are extremely scarce.[15,28–30] Impediments to initiating CPR include panic, and a fear of causing harm or not performing CPR adequately, even for those who have received CPR training or have performed CPR.[13,26,29,30] There have been no comprehensive studies of what lay bystanders perceive facilitates CPR and AED use, and importantly, the factors that can help to overcome any reluctance to intervene.[13] Moreover, although AEDs are widely available, and are easy to use, we lack data as to how bystanders perceive this apparatus during an actual OHCA, including how previous hands-on AED training might influence bystander performance.[31–35] Our knowledge gap as to bystander perception may reflect a bias in medical research towards treatment outcomes, clinical providers, and decision making, rather than bystander perspectives of a cardiac arrest, CPR, or using an AED.[13,31,36,37] Furthermore, the methods traditionally employed (quantitative methods) are inadequate in capturing the nuanced bystander experience in relation to the context of a cardiac arrest.[36,37] Instead, qualitative research methods provide the opportunity to study the complexity that underpins the reluctance of lay bystanders to perform CPR or use an AED.[36,38–40] As such, these methods are more appropriate for exploring the factors that encourage bystanders to intervene (including how bystanders overcome their initial hesitation to act). Such knowledge may provide valuable information for optimizing CPR training, dispatcher instructions, and CPR awareness campaigns to increase bystander involvement in OHCA.

In addition to prior hands-on training in technical CPR skills, other factors may facilitate bystander CPR and AED use. We sought to gain insight into lay bystanders' perceptions of what facilitated their use of CPR and an AED during authentic OHCAs.

Methods

Study Design

This is a qualitative study of lay bystanders' perspectives on factors that facilitate CPR and AED use in an authentic OHCA setting, using data collated from semistructured interviews. These interviews provide the opportunity to explore the complexity or range of reasons as to why lay bystanders choose to provide CPR and AED assistance, inclusive of dimensions such as thought, motivation, and context.[37,38] Rather than providing absolute measurements, the qualitative approach is oriented towards understanding phenomena. Using semistructured interviews, bystanders are free to express themselves using their own words, with data collection open ended. Furthermore, semistructured interviews allow the respondent to identify and describe concerns or concepts that may not have been anticipated or considered by the researchers (the semistructured interview guide is shown in Table S1).[36]

Study Setting and the Recruitment of Bystanders

The study was conducted from January 2012 until April 2015 in Denmark, which has a population of 5.6 million individuals. In cases of suspected OHCA, the emergency dispatcher follows a standard protocol to guide bystanders to perform CPR and use an AED.[41] This includes identifying and guiding bystanders to nearby and accessible AEDs. If the AED is not immediately available (ie, on-site), the emergency dispatch center can request the person responsible for the device to deliver it to the emergency site. AEDs in this study were either on-site or were delivered to the site of an OHCA guided by the emergency dispatch center.

Approximately 10 000 AEDs were registered with the AED network as of April 2015.[8] Of these, 1100 had been donated by a foundation (TrygFonden) that, since 2005, has donated AEDs to public locations across Denmark (ie, sports venues, train stations, airports, etc). All of the donated AEDs were registered with the nationwide Danish AED network, which links AEDs to emergency dispatch centers. Upon installation of the donated AED, the individual responsible for the device is instructed to do the following whenever the AED is used: (1) collect names and contact information for those present during resuscitation and (2) contact the foundation for AED maintenance, data retrieval, and bystander debriefing. During the study period, the donated AEDs were used for 103 OHCAs with information regarding all cases collected as described above.

Whenever one of the donated AEDs was used, a physician experienced in resuscitation (C.M.H.) received the contact information for at least 1 bystander. Bystanders were then phoned as soon as possible after the OHCA and offered a debriefing. At this point, bystanders were informed that the primary aim of the telephone call was to offer them this debriefing. Secondarily, they were informed of the current study and asked for their consent to participate. Bystanders were assured that they would receive debriefing irrespective of their participation; interviews were conducted by telephone.

It was impossible to establish bystander contact for 8 of the 103 OHCAs that occurred during the study period. For 6 OHCAs, the contacted bystander declined the offer to be debriefed (5 of these were police officers or security guards who had already been debriefed via their workplace). In total, 128 bystanders were interviewed.

Data Collection and Processing

Data collation consisted of (1) notes from interviews (n=59) and (2) recorded interviews (n=69). In order to capture a wide range of bystander perspectives, we used a purposive maximum variation sampling strategy, initially selecting 26 recorded interviews for analysis.[40] The basic principle behind this technique is to gain greater insights into a particular phenomenon by its multifaceted examination.[40] For this study, we only included interviews with lay bystanders defined as those who were present during the OHCA, and were neither physicians, nor emergency medical service personnel, police officers, or fire fighters, as these individuals can be expected to approach resuscitation in a more professional manner. Prior to analysis, the following 4 criteria were used to select interviews with the aim of maximizing the heterogeneity of our sample: (1) bystanders with diverse demographic characteristics (age, sex, background); (2) location of the OHCA (ie, public versus residential); (3) whether the bystander was initially present at the location of the OHCA or was contacted by the emergency dispatch center; and (4) whether the bystander was initially alone. A transcription service was used to transcribe each of the 26 interviews verbatim. Transcripts were stripped of personal identifiers.

Data Analysis

The analytical process began during the interview, with initial insights from the interviewer (C.M.H.) serving to refine the guide used to structure subsequent interviews. The analysis was guided by the specific research objectives (ie, to identify what facilitates lay bystander practice of CPR and AED use) and followed Mason's recommendations for inductive, cross-sectional indexing.[38] This allows research findings to emerge from the frequent, dominant, or significant themes inherent in raw data.[42]

The analysis was performed as a 5-stage iterative process for each transcript (Figure 1). This process entailed (1) multiple reads of each transcript by 2 researchers (C.M.H. and S.M.R.) in order to get an overall impression of the narrative and become familiar with the breadth of the data. This allowed the researchers to identify central themes and to develop a coding schedule; (2) coding the data (S.M.R.); (3) description of the main codes (ie, identifying and sorting meaningful units and developing more specific codes based on overall themes [S.M.R., C.M.H., M.H.R.]); (4) linking codes into major themes (ie, a condensation approach, formulating overriding meanings and positions in relation to each code [S.M.R., C.M.H., and M.H.R.]); and (5) synthesizing or deriving explanations for the relationships between factors that facilitate bystander CPR and AED use, and identifying illustrative citations (S.M.R., C.M.H., M.H.R., T.T.-T., L.Z.). The analytical process was supervised by 2 experts in qualitative methods (T.T.-T. and M.H.R.). The involvement of multiple researchers in the analytical process ensured rigor and consistency in data interpretation. The lead author's

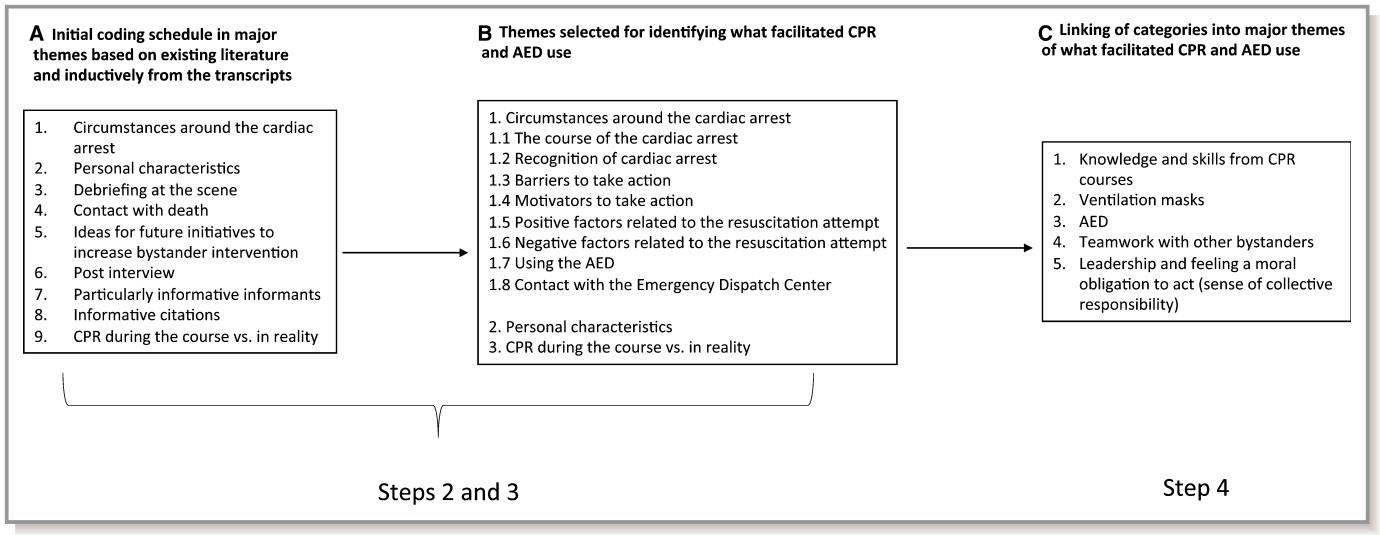

Figure 1. Development of themes. The figure shows steps 2, 3, and 4 of the 5-stage iterative process used for in-depth thematic analyses: step 2—coding of the data; step 3—description of the main codes (ie, identifying and sorting meaning units and developing more specific codes based on overall themes); and step 4—linking codes into major themes (ie, condensation, formulating central meanings, and their relationships to each code). AED indicates automated external defibrillator; CPR, cardiopulmonary resuscitation.

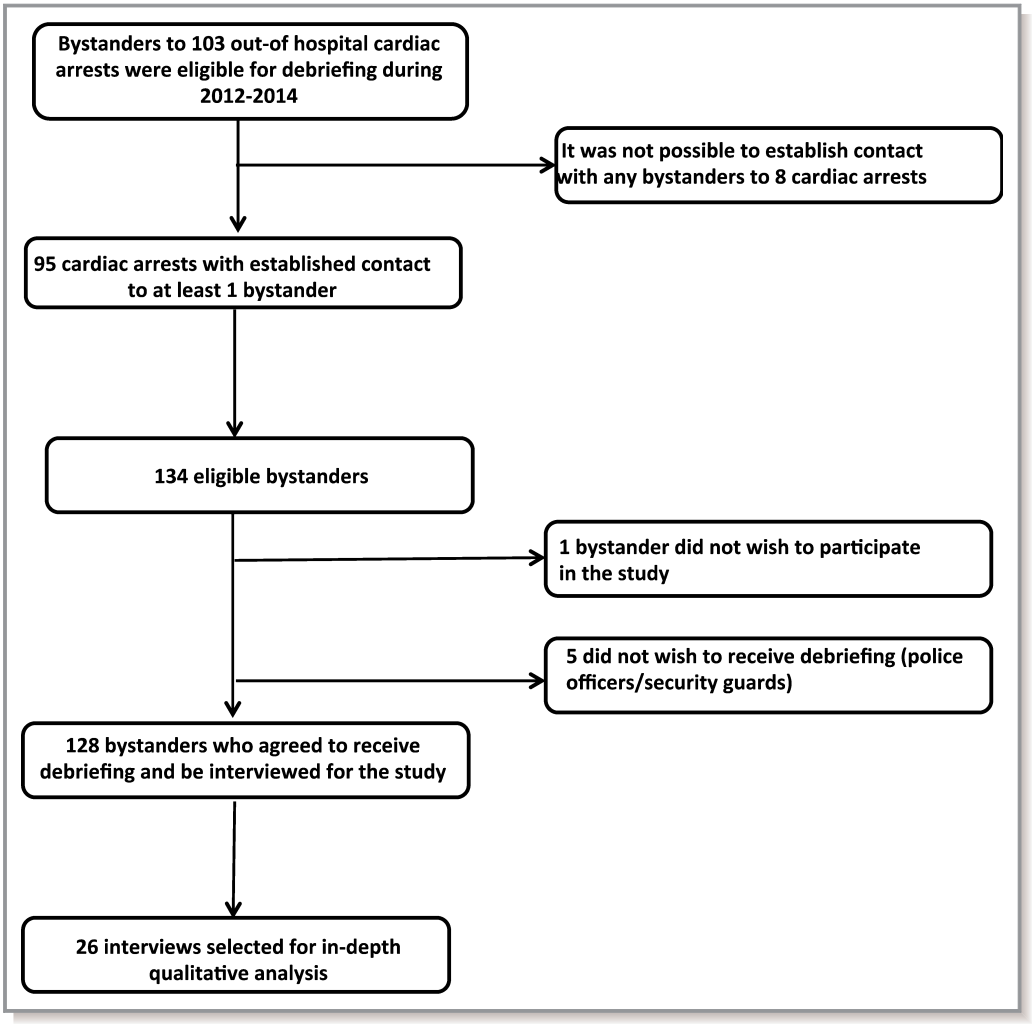

Figure 2. Selection of bystander interviews. The figure shows the selection of bystander interviews following out-of-hospital cardiac arrest.

position as a medical doctor with expertise in debriefing bystanders to an OHCA provided a unique opportunity to gain insight into this issue, while the involvement of independent researchers and specialists in qualitative research served to balance this perspective. The analysis was performed using NVivo software (QSR International Inc, Melbourne, Australia). Initial codes were created inductively from the transcripts based on existing literature (Table S2).[43] Cross-sectional indexing was then used to identify (1) general elements that shaped the resuscitation attempt, (2) which resources bystanders used to initiate and perform CPR, (3) how bystanders overcame their hesitation to initiate and perform CPR, (4) whether previous CPR training empowered bystanders to take action, and (5) other factors that would have been helpful during the resuscitation attempt. During the analytical process, the sample of 26 interviews was deemed sufficient as no new themes or subcategories emerged during the final interviews (ie, data saturation was reached).[38] The selection of quotes was based on how well they illustrated and elucidated the themes and important points identified in the material as a whole.

Ethics

All participants were informed as to the aim of the study, that participation was voluntary, and that the results would be anonymous. All agreed to participate with no financial incentives offered to participants. The study was approved by the Danish Data Protection Agency (J.nr. 2012-41-0213). The Danish Ethics Committee was informed of the study and judged that written consent was not required, and that informed consent from the participants was sufficient to conduct the study.

Results

Of 128 bystander interviews, 26 were selected for an in-depth analysis (Figure 2). The characteristics of the bystanders are

shown in Table. All of these bystanders had been trained in CPR, with 92% (n=24) trained in both CPR and AED use.

Most bystanders described that they acted instantly and instinctively to the OHCA, irrespective of how they became involved in the emergency, or their relationship to the patient. Two bystanders described that they wanted to initiate CPR but could not because they did not manage to overcome their barriers to initiating CPR. They experienced the CPR attempt as uncomfortable and shocking, and found themselves panicking. They felt a sense of powerlessness and repugnance over the patient's appearance that prevented them from initiating CPR. Instead they took care of practical tasks (eg, calling the emergency dispatch center and clearing the emergency exits).

Overall, bystanders described the following as factors that facilitated their CPR and AED use: (1) prior hands-on CPR training and knowing that their intervention could not cause harm but is vital in improving survival, (2) use of a ventilation mask, (3) prior knowledge that the AED would provide guidance through CPR, (4) prior hands-on AED training (ie, familiarity with the device), (5) use of the AED voice prompt during CPR, (6) teamwork, and (7) showing leadership and feeling a moral imperative to help others in need (ie, collective responsibility).

Knowledge and Skills From CPR Courses

The majority of bystanders found that previous CPR training was critical when faced with an authentic OHCA emergency, as described in their comments below.

> Well, it was completely as during a training session, right, and actually, I think, in my brain, right, I knew what I had to do and so on, but I reacted in the exact same way as if it was a training session. [. . .] I was not aware, it didn't sink in, that he's dead now. I knew he was, right, but hmm [. . .], I hadn't really thought it through.
>
> (Male, 70 years, retired baker)

> [. . .] hmm, actually I think what we did during the [CPR training] course was very realistic compared to it, I mean of course it was a living person lying there, hmm, but it – it is advantageous to have tried it before – of course it's different performing compressions on a living person and touching a living person and it makes you feel uncomfortable to take the clothes off a person who is dead, right. It is a little uncomfortable, but you do it and you know what you have to do because you've tried it before. So I think it makes a whole difference.
>
> (Female, 50 years, chief chef in a Community Health Center)

Bystanders described how CPR courses provided them not only with the technical CPR skills, but also with the knowledge that their "intervention is crucial for improving survival" and that "doing anything is better than nothing."

> No, I wasn't [afraid], because hmm again I would say it was a fantastic course we'd received where they told us that it was better to do something than nothing.
>
> (Male, 65 years, retired schoolteacher)

Among other things, bystanders generally felt that the CPR course empowered them to take action, ie, they "dared to take action" and subsequently "felt adequately equipped to provide CPR." The knowledge that intervention is critical in improving survival, and cannot cause substantial harm, was crucial in encouraging those bystanders to intervene who felt insecure about their ability to perform CPR adequately, or hesitated because of some other reason. For instance, it was

Table. Characteristics of the 26 Bystanders

Characteristics	
Median age, IQR, y	53.5 (39.0–70.0)
Male, % (n)	61.5 (16)
Relationship to the patient, % (n)	
Family member	3.9 (1)
Friend	26.9 (7)
Had previously seen the person	7.7 (2)
Stranger	61.5 (16)
Has previously performed CPR, % (n)	19.2 (5)
OHCA in public location, % (n)	80.8 (21)
Bystander involvement, % (n)	
Received phone call from the Emergency Medical Dispatch Center	19 (5)
On-site	27 (7)
Summoned by other bystanders	35 (9)
Randomly passed by	19 (5)
Bystander role in resuscitation attempt, % (n)	
Caller and practical tasks	23 (6)
CPR only	23 (6)
CPR+AED	35 (9)
AED only	19 (5)
CPR-trained bystanders, % (n)	
CPR (+AED)	92 (24)
CPR (−AED)	8 (2)
Median time from CPR training to OHCA, months	22
Median days from OHCA to interview, IQR	11 (5–30)
Performed resuscitation as a team effort with other bystanders, % (n)	80.8 (21)

AED indicates automated external defibrillator; CPR, cardiopulmonary resuscitation; IQR, interquartile range; OHCA, out-of-hospital cardiac arrest.

critical to understand the lifesaving potential of providing CPR, even if they broke the patient's ribs, versus not providing CPR.

> Put the person on their back, push the neck back, lift the head, right, and then 25–30 times on the heart, right there, and you should not be afraid to push hard, because it's better to crack a couple of ribs [laughed] than for the person to die.
>
> (Male, 63 years, retired machine engineer, aircraft mechanic, and chief of safety)

Even though some bystanders had trouble remembering the exact number of chest compressions or ventilations, they articulated that familiarity with the CPR procedure strengthened their self-confidence. Some bystanders were surprised as to how much they remembered from their CPR course, as if they felt they instinctively knew what to do. Some found it encouraging that they were able to remember their CPR skills, and would be able to use them in case of a future emergency.

Ventilation Masks

The patient's appearance was one of the greatest barriers to performing CPR, with several bystanders mentioning how they found it crucial to use a mask when ventilating the patient due to oral fluids (froth, vomit, blood, etc).

> . . . no, the only thing I thought about then, and afterwards, was that I was happy we had one of those masks for when we had to ventilate him. He wasn't so appealing, and there was no doubt that I was going to do it until hmm Jonas said they had a mask, then I thought, ah that would probably be really nice [laughed].
>
> (Male, 36 years, canoe and kayak coach, previously worked in the military)

Some of those who did not have a mask, felt a strong need for one while ventilating the patient.

> Yes, I found it challenging to perform mouth-to-mouth ventilation. I also thought that it was disgusting [laughing] [. . .] At first I had to overcome this, but it was also because he had so much froth around his mouth
>
> (Male, 52 years, nurse)

When bystanders were asked how they managed to overcome this barrier, they often referred to practicalities such as: "using the sleeve to wipe off froth around the mouth" or "asking for a napkin to do so" or "to switch CPR position with another bystander who found it less challenging." Some bystanders explained they were able to "shut it out" [the presence of oral fluids] as "another person's life was at stake."

The AED Apparatus

Bystanders who were familiar with the AED found the instrument easy and even exciting to use. The AED was anthropomorphized as being a "professional," which actively contributed to making the bystanders feel more comfortable and confident during the CPR attempt. Bystanders articulated this (in the main) by saying that the AED "guided me throughout the CPR procedure" and "told me exactly what to do."

> Then I unpacked it [the AED] and it just speaks for itself, the defibrillator. I ripped off her clothes and placed some of those electrodes where they should be placed and then she guided me. That's what's so great about the defibrillator; you just have to do what's being said.
>
> (Male, 61 years, manager in a sports club)

This ameliorated the responsibility of bystanders and made them feel calmer and more confident in an otherwise stressful situation.

> Well, I know there aren't AEDs everywhere but I really feel it provides reassurance. When I had delivered the first shock, no, that's not right, when I was going to provide chest compressions for the third time, I thought it was very irritating they [emergency medical services] hadn't arrived yet, but then I thought: I think we can keep him because he'd starting breathing slowly and otherwise I would just deliver another shock, I thought, and then I calmed down again. I really thought it was nice to have it there.
>
> (Female, 71 years, retired nurse)

Prior knowledge that the AED would provide CPR instructions was also mentioned as an important calming influence. In addition to the guiding feature, some bystanders described that the AED also helped them to improve their performance of CPR (and overcome barriers), such as providing a sufficiently solid and profound pressure when providing chest compressions.

> Well, actually I think that this machine is of great importance. You know, also when it concerns chest compressions. Well, I think if the machine hadn't told me, it told me something about my compressions should have a depth of two inches (5 cm). Well, that's a pretty hefty pressure [. . .] It's important that the machine tells you this, or else I think one could probably hesitate to provide such solid pressure [. . .] This machine brings reassurance.
>
> (Male, 52 years, nurse)

Most bystanders found their CPR course essential for feeling comfortable with using the AED, inclusive of its unpacking, starting, electrode placement, and the whole procedure in general.

> Well, hmm, especially because, I mean, we learned how to unpack it and place those electrodes, and it's clearly written where they should be placed, so there is no problem.
>
> (Male, 65 years, retired school teacher)

Furthermore, some bystanders reported that the AED could have created more panic than reassurance in the absence of prior, hands-on, AED training. One of the 2 bystanders without this training found it stressful to concentrate on how to operate the AED during the CPR attempt, and subsequently blamed herself for incorrectly placing the electrodes.

Bystander Teamwork

In most cases, bystanders described the resuscitation attempt as a team effort. This involved participants performing different tasks, such as providing chest compressions, while others ventilated, called the emergency dispatch center, or fetched the AED.

> They all knew what to do. When John started to operate the machine [the AED], I began providing 30/2 [meaning 30 chest-compressions and 2 ventilations]. While the machine analyzed his heart rhythm, John took the [ventilation] mask out of the box and then she [third bystander] started ventilating the patient [. . .]. In order to get the most out of the situation, John passed Anne the phone [fourth bystander] so she could be responsible for keeping contact with the ambulance service team. Well, it just worked out great.
>
> (Male, 23 years, receptionist in a fitness center, previously worked in the military)

Several bystanders were surprised as to the success of their teamwork and felt it made an important contribution to the resuscitation attempt. Prerequisites for good teamwork entailed bystanders taking action, delegating tasks, not getting in each other's way, and staying calm. In particular, "good teamwork" was most commonly cited by bystanders who were already familiar with each other (eg, members of a sports club, colleagues, or family members). Additionally, some felt that their teamwork was a significant factor in the patient's survival. In a few cases, bystanders experienced difficulty in dealing with individuals who became panic-stricken. In this scenario it was convenient to "delegate tasks" or to announce that the situation was "under control" in order to establish calm.

Leadership and the Moral Imperative to Act

Bystanders described how "showing leadership" or "feeling a moral obligation to act" were drivers in their participation in the resuscitation attempt. Some bystanders explicitly described their leadership skills or how they perceived themselves as "the kind of person who takes action." For instance, bystanders who felt that their previous work experience involved taking action and assuming leadership roles described their action as part of their ability to "maintain an overview" and "take charge of the situation" during the resuscitation attempt.

> Well, I don't know, of course one feels a responsibility, I am the unit chief here and of course I have a responsibility for what goes on here, but I also have experience, more than most people, so in relation to the resuscitation attempt, I just thought it was natural for me to jump in and take over.
>
> (Male, 34 years, manager in a fitness center, military background)

Others did not explicitly describe showing leadership but this was implicit in their narrative (ie, in how they showed initiative, delegated tasks, and otherwise assumed responsibility).

> No, I got Mark to help, hmm I felt like that we could, yeah, people sometimes get, not paralyzed, but maybe don't get on with things. And in that sense I have experience that it often helps if you just lead people to do something.
>
> (Male, 36 years, canoe and kayak coach, previously worked in the military)

Bystanders who demonstrated leadership expressed the importance of taking action and helping others in need, as well as assuming responsibility in emergency situations (and preventing emergencies). Attempting resuscitation or showing leadership was described as a duty.

> It can't be proven or said clearly enough how important it is that people perform CPR, but also that we have an AED that, at the very least, is registered with the [AED] network, so that it really is emphasized how important it is that people do something within the first few minutes, right.
>
> (Male 34 years, manager in a fitness center, military background)

Generally, these bystanders did not seem to be affected by the patients' appearance (eg, oral fluids or unusual skin coloration due to lack of circulation) and appeared to be more comfortable with performing CPR than other interviewees.

Discussion

This study investigated what facilitated bystanders to attempt CPR and the use of an AED at the scene of an authentic OHCA. Our main findings were that, other than prior hands-on

CPR training, several factors promoted bystander CPR and AED use. These included the following: prior knowledge that bystander intervention is critical for improving survival, cannot cause harm, and that the AED provides guidance through CPR; prior hands-on training in AED use; during CPR performance, teamwork, using the AED voice prompt and a ventilation mask, as well as showing leadership and feeling morally obliged to act. These findings indicate that focusing on technical CPR skills alone may fail to fully engage bystanders in CPR and AED use. A substantial focus has been placed on optimizing the training of future bystanders in CPR and AED use (ie, knowledge acquisition and retention), as illustrated in the description of core curriculum elements for basic life support training in current guidelines.[35] Despite this, low rates of bystander CPR and defibrillation persist, even in countries with widespread CPR training and AED dissemination. These data suggest that a better understanding of how to improve bystander intervention is warranted.[12,14] Our findings suggest that addressing aspects other than hands-on CPR skills and incorporating these new elements into CPR training courses, CPR awareness campaigns, and emergency dispatcher protocols (dispatch-assisted CPR) may improve bystander intervention rates.[44] Addressing nontechnical skills is currently recommended for advanced life support courses, and should be considered for basic life support courses as well.[35]

Our results agree with previous studies reporting factors that inhibit bystanders from initiating CPR (even for those with prior CPR training), and add novel insights as to how bystanders may overcome such barriers.[19,26,28,30] Fear of not performing CPR correctly has been identified as a common impediment to performing CPR.[13,19,45] We found that the knowledge that intervention improves survival and, of itself, could not cause substantial harm, not only helped bystanders "dare to take action" but also helped them to overcome their fears of underperforming. CPR training instructors, CPR awareness campaigns, and emergency dispatchers should therefore emphasize how bystander intervention is paramount in improving survival, and has a minimal chance of causing harm, even when bystanders are uncertain as to their CPR skills. Furthermore, guidelines should include this finding as one of the core elements in basic life support courses.[35]

A previous study found that panic was the most common cause for not performing CPR among CPR-trained bystanders.[13] In our study, prior knowledge that AEDs guide bystanders through CPR promoted confidence and prevented panic prior to initiating CPR. Using the AED voice prompt also provided reassurance during resuscitation, and when bystanders felt insecure about their performance or CPR skills. A previous study of lay responders in the Public Access Defibrillation Trial found that those who turned the AED on were more likely to initiate CPR for reasons that remain obscure.[31] Our results indicate that bystander AED use, particularly the voice prompt, may be beneficial for all patients who receive bystander CPR (ie, is not only beneficial to patients with ventricular arrhythmias) through its role in encouraging bystanders to act. Importantly, although those without previous training can properly operate AEDs,[33,46] bystanders generally felt it was important to have had prior hands-on AED training. One bystander felt it was very stressful to use the AED without the benefit of being familiar with the device. This finding underscores the importance of mandatory AED instruction in basic life support courses as familiarity with the AED may encourage bystanders to take action, and decreases their stress during CPR.

Current guidelines recommend that advanced life support courses include teamwork and leadership training.[34,35] Our study indicates that both teamwork and leadership may be important for facilitating lay bystander CPR as well. This is supported by studies of healthcare professionals' performance as well as social psychology studies of bystanders to emergencies.[44,47] A recent study of video recordings of OHCA identified a lack of teamwork, even when many bystanders were present.[48] CPR instructors and emergency dispatchers may appreciate that people respond differently to an OHCA, and that panic-stricken bystanders could be delegated practical tasks, such as guiding emergency medical service personnel to the patient, rather than performing CPR itself. Addressing this issue and how to solve it during a CPR course might better prepare bystanders for dealing with panic-stricken participants. Future studies should evaluate teamwork scenarios in basic life support courses and the effect of teamwork during bystander CPR on outcomes.

We employed a qualitative methodology because we sought to understand the beliefs and motivations that underlie bystander action.[36,37] Qualitative analyses focus on describing the complexity, breadth, or range of phenomena, with the sampling of participants aiming to achieve information richness rather than a representative sample. For this reason, the number of participants is usually small compared to quantitative research. Future studies could further evaluate the relevance of generalizability of the identified facilitators in larger bystander cohorts through questionnaire surveys.

Interviews were conducted by telephone. Although face-to-face interviews have long been the dominant interview technique, telephone interviewing has become more common and is well accepted.[49–51] Telephone interviews were more feasible for reaching participants throughout Denmark, as well as those who are typically more difficult to reach (eg, shift workers or people with disabilities). A further consideration is that bystanders are typically (somewhat) sensitized following

their experience, and a telephone conversation (soon after the emergency) seemed to provide sufficient proximity, while preserving the interviewees' privacy. Finally, since bystanders were offered debriefing, it was important to establish contact as soon as possible after the resuscitation attempt. Telephone contact allowed the lead author to reach bystanders in a more timely fashion than could be achieved by face-to-face interviews (that would require scheduling). Limitations to this approach include the reduction of social cues such as body language.

Several limitations merit attention when interpreting our results. Although we achieved data saturation within the interviewed sample, it is possible that we could have identified other conditions that facilitate bystander CPR and AED use if more interviews were included with a wider variety of bystanders. Since our contact with bystanders was established through the "cohort" of donated AEDs, which were deployed in public locations, 80% of the cases in this study occurred in public and only 1 bystander was a family member of the patient. Generally, 80% of OHCAs occur at home and it is possible that bystanders at home, especially relatives, might have a different perspective of what facilitates CPR and AED use. Cultural differences, for instance the fear of liability (including the presence or absence of "Good Samaritan Laws"), might play different roles in different cultures, as fear of liability has previously been identified as a barrier to performing CPR, but was not recognized in our study.[20,26,45] Also, AEDs were present in all OHCA in this study; other conditions may be of importance in the absence of an AED, which is the case for most OHCAs. Nonetheless, our sample was based on a large number of interviews (n=128), and encapsulated a relevant range of characteristics and experiences of possible significance for the bystander perception of their provision of CPR with an AED (eg, different CPR training courses, time intervals from CPR training to OHCA, previous experience with OHCA, attempting resuscitation alone or with others, etc). Moreover, the barriers and themes identified in our study are in accordance with previous studies, indicating at least some degree of wider applicability and generalizability.[13,29]

Conclusion

This study of what facilitates bystander CPR and AED use according to 26 CPR-trained lay bystanders who were at the scene of real OHCAs found that several factors other than prior hands-on CPR training were relevant. These included prior knowledge of the importance of bystander intervention in improving survival, that intervention cannot cause harm, and that the AED will provide guidance through CPR; prior hands-on training in AED use; during CPR performance; teamwork; using the AED voice prompt and a ventilation mask; as well as showing leadership and feeling a moral imperative to act. These findings indicate that focusing on technical aspects of CPR may not be sufficient to engage bystanders in CPR and AED use, and would suggest the incorporation of new elements into CPR training courses, CPR awareness campaigns, and emergency dispatcher protocols, which may improve bystander intervention.

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SUPPLEMENTAL MATERIAL

Table S1. Semi-structured debriefing/interview guide

Introduction	• "My name is Carolina Malta Hansen, I am a physician and researcher calling on behalf of the AED network…" • "I am calling to offer the opportunity to talk about your recent experience with participating in an attempt to resuscitate a person with cardiac arrest."
Frame	• "Is this a good time for you to talk?" • "Would you mind if I take notes/record our conversation?" • "Would you mind if I include some of what you tell me in my research?"
Description of experience with out-of-hospital cardiac arrest	Main questions: • "Would you like to tell me in your own words what you experienced from the very beginning?" [break – let the bystander speak freely]. Note what should be explored further, later during the interview. • "How was it for you to perform CPR/use the AED?" • "Did you experience barriers in relation to initiating or performing CPR?" • "How did you overcome … [the barriers mentioned by the bystander]?" • "Was there anything during the resuscitation attempt that made you feel uncomfortable (for example performing mouth-to-mouth, touching the person, etc.?)" • "Was there anything you felt you were unable to do?" • "How did you feel afterwards?" • "Now that you have taken a CPR training course and have attempted resuscitation in real life, is there anything you did not learn during a CPR training course that you think should be included in future courses?"
Debriefing and feedback	• Catch up on the themes that need to be explored further that were noted in the bystander's description of the experience… e.g. "you mentioned you thought it was
Closure	• "Before ending the call, I would like to know: Is there anything else you would like to discuss or ask about? Is there anything you think is important that we haven't touched upon?" • Carolina Malta Hansen's contact information is given to the bystander along with assurance that they are always welcome to call or send an email.

Table S2. Initial Codes for the Selected Bystander Interviews.

Codes	Description	Existing literature
1. Circumstances surrounding the cardiac arrest	A resume of the course of the cardiac arrest. How did the bystander become involved in the resuscitation attempt and what was the setting for resuscitation? (E.g. number of participants, presence of health care providers, doctors, EMS personnel).	It has been reported that the presence of others reduces the feeling of personal responsibility.If the witness is alone, the responsibility is obvious, but with a group of participants, the responsibility becomes collective. The size and composition of the group influences engagement; friends respond faster than strangers and the presence of a medically competent person delays intervention by other witnesses, but only among females (Axelsson A, Herlitz J, Fridlund B. How bystanders perceive their cardiopulmonary resuscitation intervention: a qualitative study. Resuscitation 2000;47:71–81.8).
1.1 The course of the cardiac arrest	How did the bystander become involved in the resuscitation attempt? What was the bystander's perception of their necessity to be involved? (e.g. was intervention automatic or pressured?). Where was the incident and how did it occur (e.g. which form of CPR was provided?). What was the bystander's role (e.g. leadership and delegation vs. calling the emergency dispatch center, opening doors, etc.?). How many bystanders were present, and were health professionals involved etc.?	
***1.2. Recognition of cardiac* arrest**	How and when did the bystander/s recognize the emergency as a cardiac arrest? What indicators of cardiac arrest were apparent (e.g. witnessed arrest, cyanosis, cold skin, ventricular fibrillation, absence of sinus rhythm)? How did other people react?	One factor is ambiguity, i.e. in order to respond to the needs of the victim the witness has to observe that something is amiss and must interpret the event correctly (Axelsson A, Herlitz J, Fridlund B. How bystanders perceive their cardiopulmonary resuscitation intervention: a qualitative study. Resuscitation 2000;47:71–81.8.). An initial issue that can delay the initiation of CPR and activating EMS is that the bystander may not recognize when a cardiac arrest has occurred. Despite the fact that members of the general public demonstrated a good understanding of this literal definition of what a cardiac arrest is, they were unable to

		connect this to the overt signs of cardiac arrest: victims are unconscious, unresponsive, and without a pulse. Instead, in both studies, participants perceived cardiac arrest to be associated with symptoms typical of a myocardial infarction or heart attack: chest pain, radiating arm pain, neck pain, nausea and dizziness. (Cheskes LS. Assessing Public Perceptions of Cardiopulmonary Resuscitation and Bystander Willingness to Act in Out-of Hospital Cardiac Arrest. Available at: https://tspace.library.utoronto.ca/bitstream/1807/44007/3/Cheskes_Lindsay_S_201403_MSc_thesis.pdf. 2014;Last accessed March, 2016.)
1.3. ***Barriers to taking action***	Feeling a lack of confidence, ambivalence, powerlessness, fear of death and disgust (e.g. when confronted with vomit, blood, or disease, etc.), intimidated by having to help a child, a younger or older person, a friend, or family member? What was the role of the emergency dispatch center, using the AED?	A host of barriers to performing CPR were identified in both studies. In the qualitative analysis several obstacles and challenges to the performance of bystander CPR were identified. These included fear of litigation, fear of contracting disease as a consequence of performing mouth-to-mouth ventilation, lack of knowledge, fear of causing harm, and fear of missing a step or "performing it wrong". Further analyses of survey responses demonstrated that the distribution and prevalence of these impediments were dependent on the identity of the patient. The fear of infectious disease, especially the Hepatitis B virus (HBV), and the human immunodeficiency (HIV) virus, dampens the willingness of both lay and professional rescuers to perform mouth-to-mouth resuscitation. (Axelsson A, Herlitz J, Fridlund B. How bystanders perceive their cardiopulmonary resuscitation intervention: a qualitative study. Resuscitation 2000;47:71–81.8)

1.4. Motivation to take action	Which resources were mobilized? Underlying feelings (competence, agency, duty, instinct, obligation). Practical arrangements / frame, the role of the emergency dispatch center, etc.	A feeling of competence promotes willingness to intervene (Axelsson A, Herlitz J, Fridlund B. How bystanders perceive their cardiopulmonary resuscitation intervention: a qualitative study. Resuscitation 2000;47:71–81.8)
1.5. ***Positive factors related to the resuscitation attempt***	Surprising elements, e.g. good teamwork, personal skills, the patient regaining consciousness, etc.	
1.6. Negative factors related to the resuscitation attempt	Surprising elements, e.g. too many passive bystanders, a feeling of inadequacy, a lack of skill?	
1.7. Using the AED	Bystanders' perceptions of using the AED /how the AED works?	
1.8. Contact with the EMD	How did bystanders perceive contact with the emergency dispatch center? (Was this surprising? How did it feel to become involved?)	
2. Personal characteristics	Personal characteristics related to participating in the resuscitation attempt (demographics: sex, age, type of personality (outgoing /reserved), perspective on life, relationship to patient, education/professional background, experience with resuscitation, previous CPR courses, incidence of cardiac arrest among family members/friends, etc.)	Humanitarian values (cultural and social perceptions) were found to be embedded within the decision to provide bystander CPR. Thematic analysis of the interview data revealed two competing concepts: the notion of "life vs. death" and a perceived diffusion of responsibility within our larger culture (Cheskes LS. Assessing Public Perceptions of Cardiopulmonary Resuscitation and Bystander Willingness to Act in Out-of Hospital Cardiac Arrest. Available at: https://tspace.library.utoronto.ca/bitstream/1807/44007/3/Cheskes_Lindsay_S_201403_MSc_thesis.pdf. 2014;Last accessed March, 2016.)

3. Debriefing at the scene	How did bystanders perceive transferring patient care over to emergency medical personnel? How did this meeting/exchange with emergency medical personnel affect the bystander's overall perspective of the resuscitation attempt? Unmet needs/bystander expectations of professionals?	An important factor as to how the rescuers experience their intervention is related to whether they have had the opportunity to be debriefed following an event. (Axelsson A, Herlitz J, Fridlund B. How bystanders perceive their cardiopulmonary resuscitation intervention: a qualitative study. Resuscitation2000;47:71–81.8.)
3.1. Patient transfer to emergency medical services	How did patient transfer occur, e.g. hectic, unpleasant, enlightening, reassuring, with praise, with bystander recognition for providing CPR, etc.?	
3.2. Recognition	How did emergency service personnel express reassurance and praise? How important was it to receive recognition for providing CPR?	
3.3. Bystanders reaction afterwards – the importance of patient outcome?	When does the reaction to the experience begin? How does this manifest (e.g. guilt, insomnia, feeling satisfied with own performance, racing thoughts, etc.)? What significance did patient status at transfer to emergency medical services have for the overall perception of the situation, personal performance, guilt, etc. Unmet needs and wishes (e.g. need for professional help, feedback from emergency medical services regarding performance, etc.?)	
3.4. To talk with someone	What did it mean to talk to somebody afterwards (health care professionals, colleagues, or other persons with whom the bystander has a close relationship? Which unmet needs persisted?	
3.5. The role of other 'bystanders'	How other bystanders acted and how the situation affected them (others). E.g. some bystanders are passive, while others actively help. Some react negatively since the experience was psychologically challenging.	
4. Contact with death	How did bystanders perceive being in contact with death? Did bystanders think the patient was dead before, during, or after the resuscitation attempt, and how did this affect the bystanders?	
5. Ideas for future initiatives to increase	Ideas for how to motivate people to perform CPR, optimize CPR courses, the role of the emergency dispatch center and	

bystander intervention	AEDs (role and placement), and what can help bystanders to cope with the cardiac arrest, etc.	
6. Debriefing with physician (days after resuscitation attempt)	How was it to talk to a professional (physician) about the resuscitation attempt? What did it mean for the bystander to receive information recorded in the AED, such as, good CPR, shock, etc.?	
7. Particularly informative participants	E.g. positive view of the resuscitation attempt, negative view of the resuscitation attempt.	
8. Informative citations	E.g. helpful suggestions for initiatives.	
9. CPR during the course vs. the reality	How did the two scenarios compare? Was there anything surprising in a pleasant or unpleasant way?	

Lay Bystanders' Perspectives on What Facilitates Cardiopulmonary Resuscitation and Use of Automated External Defibrillators in Real Cardiac Arrests

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