

Chain of Survival at Mass Gatherings: A Case Series of Resuscitation Events

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Keywords: chain of survival; first responder; mass gathering; resuscitation

Abbreviations:

AED = automated external defibrillator
CPR = cardiopulmonary resuscitation

Received: 27 November 2009

Accepted: 26 January 2010

Web publication: 20 January 2010

Abstract

Background: At a large public event, or mass gathering, various factors influence patient presentations that brings challenges to patient care. The chain of survival has been investigated in the prehospital setting. However, this has not explicitly included the mass-gathering environment.

Objective: This study sought to determine the facilitators and barriers to the chain of survival at mass gatherings.

Methods: This case-series research was exploratory and descriptive, using the analysis of personal experiences of resuscitation. Participants were members of St John Ambulance Australia who had participated actively in a resuscitation event in 2007. Telephone interviews were used as a means of data collection. Participant narrative was recorded electronically, transcribed verbatim, and analyzed thematically using a well established human science approach.

Results: The thematic analysis revealed five main themes and a number of sub-themes. Four of the main themes were aligned easily with the four chain of survival links. The remaining main theme outlined a new link in the chain of survival of specific importance to mass gatherings, 'early planning'. Additionally, a number of sub-themes were identified, which exemplified various facilitators and barriers to the chain of survival in this environment.

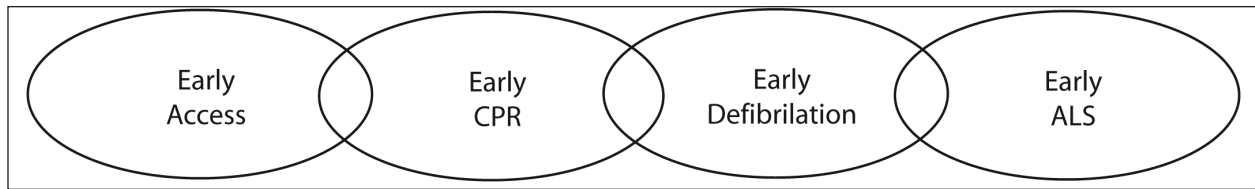
Conclusions: This research highlights various barriers and facilitators to the chain of survival in the mass-gathering environment. Additionally, the unique "early planning" link in the chain of survival as described in this research highlights the importance of a preparatory phase for responders at mass gatherings.

Ranse J, Zeitz K: Chain of survival at mass gatherings: A case series of resuscitation events. *Prehosp Disaster Med* 2010;25(5):457-463.

Introduction

The survival rate of out-of-hospital sudden cardiac arrest in Australia is reported at approximately 10%.^{1,2} The chain of survival outlines various links that enhance a person's chance of survival following a sudden cardiac arrest.¹⁻³ These links include time to early: access of emergency response systems, basic life support, defibrillation, and advanced cardiac life support (Figure 1). Current research provides support for individual elements in the chain of survival, rather than the chain on survival in totality. This research is the first to explore the inter-relationship of the links of the chain of survival, with a primary focus within the mass-gathering environment.

Due to the nature of mass gatherings, challenges impact on the resuscitation chain of survival. Mass gatherings are defined variably in the literature; commonly based on participant and spectator numbers.⁴ Throughout this article, the term *mass gathering* has been defined as: "an organised event taking place within a defined space, which is attended by a large number of people".⁵ It is known that a number of physical and environmental factors exist at mass gatherings that influence patient presentations, such as: (1) crowd density; (2) geography of the venue; (3) seated or mobile crowd; and (4) indoors versus outdoor events.⁴ These and arguably other characteristics, such as first responder education and training, communications infrastructure at events, and location of first responders, have not been addressed in the published literature. This research aims to identify facilitators and barriers to the



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Table 1—Resuscitation chain of survival

chain of survival at mass gatherings through the analysis of personal experiences of resuscitation in this environment.

Background

Various strategies in the out-of-hospital environment have been implemented to reduce the time from collapse to the time of defibrillation to increase a person's chance of survival. To achieve this, the most significant strategies have been the implementation of public access defibrillator programs, community responders and the presence of first responders at mass gatherings using automated external defibrillators (AEDs).

Public access defibrillator programs have become widespread at venues where members of the public congregate, such as casinos,⁶ shopping centres, major public attractions, office complexes, airports,⁷ and on aircraft.⁸ Commonly, these AEDs are fixed within buildings or aircraft and accessible to any person. At such venues where AEDs have been used, survival rates from sudden cardiac arrest have been reported as greater than 50%.⁶⁻⁷ However, it has been demonstrated that out-of-hospital cardiac arrests are spread widely within a population and have relatively low rate of bystander cardiopulmonary resuscitation (CPR).⁹ Therefore, the potential impact of increasing bystander CPR rates versus investing in defibrillators in the community should be considered as an important strategy to enhance the chain of survival.

Commonly, community responders are laypersons who have had training in basic life support and the use of an AED. They operate within a defined jurisdiction as an adjunct to the local ambulance services. Community responders have been utilized in America¹⁰ and Ireland¹¹ to transport an AED to a patient with suspected cardiac arrest. Such programs have reported a doubling in the chance of survival from cardiac arrest¹⁰ and are of particular strength within rural communities.¹¹

Organizations, such as St John Ambulance Australia, deploy first responders at public events to clinically manage injuries and medical emergencies. First responders are layperson with additional training in advanced first aid, oxygen therapy and AED use.¹²⁻¹³ Over an eight-year period at the Melbourne Cricket Ground and Shrine of Remembrance in Melbourne, first responders participated in 28 resuscitation events using AEDs. Of these, 20 patients (71%) were discharged from hospital alive.¹⁴ The only additional literature regarding first responders participating in resuscitation at mass gatherings has been a single case study exploring the experience of first responders.¹² However, these research manuscripts^{12,14} do not outline facilitators, other than the use AEDs, and barriers to the chain of survival in this environment.

Methods

Design

This case series research was exploratory and descriptive in design, using individual accounts of participant experiences of resuscitation via telephone interviews as a means of data collection.

Setting

This research involved mass gatherings within Australia where St John Ambulance Australia was the primary provider of first responder services. St John Ambulance Australia undertakes this role in all Australian jurisdictions. Such events may have included parades, ceremonies, public parties, sporting events, concerts, and agricultural shows. Cases reported in this research were from mass gatherings where >5,000 participants and spectators combined had congregated.

Population and Sample

The population for this research was members of St John Ambulance Australia who attended a mass gathering to provide clinical care to spectators and participants. The sample was participants who had real-life experience of actively participating in at least one resuscitation event in 2007. Active participation was defined as undertaking a role such as: (1) external cardiac compressions; (2) assisted ventilations; (3) assisting with defibrillation; (4) scribing; (5) coordination; or (6) liaising with the ambulance service.

Participant Recruitment

Resuscitation events were identified by State and Territories managers in each jurisdiction of Australia, except one. The managers liaised with peer-support personnel in their jurisdiction who, in turn, contacted potential participants, outlining the aims and objectives of the research, and to gauge interest in participating in the research. No contact was made between the researchers and potential participants until participants had indicated that they were willing to participate. The researchers were not provided with any information pertaining to members who did not wish to participate.

Data Collection

This research used a single, semi-structured telephone interview as a means of data collection. The interviews gathered information pertaining to participant demographics and the sequence of events surrounding resuscitation. Each interview was recorded electronically. Interviews provided an opportunity to collect qualitative data regarding the participant's attitude, perception, and opinion.¹⁵ Interviews allowed for the identification of broad themes and to gain an understanding of key issues associated with the facilitators and barriers in the resuscitation chain of survival at mass gatherings.

| | |
|------------------------------|------------|
| Total number of participants | 15 |
| Age (in years) | 26 (16–58) |
| Gender | |
| Male | 9 |
| Female | 6 |
| Years as a member | 8.8 (1–31) |
| Clinical Accreditation | |
| First Aiders | 4 |
| First Responders | 9 |
| Registered Nurse | 2 |

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Table 1—Participant demographics

Data Analysis

Participant narrative was transcribed verbatim and analyzed thematically. The thematic analysis was performed by the individual researchers using a highlighting approach as outlined by van Manen.¹⁶ Following individual analysis, themes were compared for commonalities. Comparisons of individual themes outlined by the researchers enhanced the validity and reliability of the data analysis process.

Protection of Human Participants

This research project was approved by the St John Ambulance Australia Human Research Ethics Committee. Exemplars used throughout this manuscript are not post-fixed with any identifying characters, such as pseudonyms or numbers, therefore removing the likelihood of linking exemplars to particular cases, enhancing the de-identification of participants and events.

Results

From the analysis of participant narrative, a number of facilitators and barriers in the chain of survival at mass gatherings were identified. The findings highlighted resuscitation at mass gatherings as a process influenced by participant preparedness.

Participant Demographics

A total of 16 first responders participated in this study. One was excluded from the analysis as his/her resuscitation did not occur at a mass gathering. The demographics of the remaining 15 participants are outlined in Table 1.

There were five participants who previously had been participants of resuscitation events in the out-of-hospital environment. Three of these were first responders and two were registered nurses. Additionally, the two registered nurses had both been involved in in-hospital resuscitation events.

Summary of Resuscitation Cases

Table 2 provides a summary of the resuscitation cases in which the participants were involved.

Thematic Analysis

Thematic analyses of the participant narrative revealed five main themes and a number of sub-themes relating to the participants experience (Table 3).

Theme 1: Being Organized—Participants outlined their educational preparedness to actively participate during a resuscitation event. This preparedness was based primarily on repetitive training. Some participants had experience in clinical competitions, where repetitive training is a form of preparation.

...the training is useful in terms of preparing you for the event...I felt very calm and was able to just go through the steps and do what was needed.

Specific pre-event activities were perceived to influence the ability of participants to respond to a resuscitation event. For example, when a new team of responders was formed, participants described the value of discussing the roles each would undertake if required to participate in a resuscitation event.

...we knew who was going to be doing what. So we got all that organised and while the other two were doing the CPR and the breathing I was getting the defibrillator ready.

Participants highlighted that familiarity with the geography of the venue assisted in a timely response. On the other hand, individuals were challenged by some locations. In particular, the locations of responder posts often were determined by the event organizer, without consultation of the first responder service provider.

I'm familiar with the [venue] as I have done a lot of duties there [this assisted in my response]...

Theme 2: Calling for Help—Responders, with resuscitation equipment, disbursed among crowds at mass gatherings assisted in being close to a patient when they collapsed.

The gentleman that shouted out for help said that he'd [the patient] had just fallen down ... five seconds before we arrived.

In comparison to first responders, security personnel are greater in number and more widely dispersed among crowds at mass gatherings. As a result security personnel commonly are the primary contact for members of the public who recognized the need for clinical assistance. When this occurs, security personnel play a three-fold role: (1) commencing resuscitation; (2) seeking advanced clinical assistance; and (3) providing crowd control. At events where radio communications between security and first responders was well-established, response was timely.

We were called through the security system ... good communication skills [assisted in a fast response].

When responding to a cardiac arrest, participants had to navigate a number of obstacles, such as crowds and venue infrastructure.

...the cardiac arrest occurred in the public car park ... they only have one gate open so it's a bit of a maze to get through...

| | Case 1 | Case 2 | Case 3 | Case 4 | Case 5 |
|--|--------|--------|---------|--------|---------|
| Casualty age (approximately) (years) | 70 | 40 | 60 | 85 | 20 |
| Time from collapse to arriving at the casualty (min) | 0.5 | 0.5 | 4 | 1.5 | 8 |
| Time from collapse to start of CPR (min) | 1 | 0.5 | 7 | 3 | 10 |
| Was bystander CPR applied | No | Yes | No | No | No |
| Time from collapse to time of defibrillation (min) | 1.5 | 2 | 7* | 4 | 11* |
| Time from collapse to time of ROSC (min) | 2 | 2 | N/A | 15 | Unknown |
| Time from collapse to time ambulance called (min) | 1 | 2 | 3 | 4 | 10 |
| Time from collapse to time ambulance arrived (min) | 5 | 10 | 15 | 9 | 25 |
| Time from collapse to time resuscitation abandoned (min) | N/A | N/A | 45 | N/A | N/A |
| Outcome | ROSC | ROSC | No ROSC | ROSC | ROSC |

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Table 2—Summary of cases. All times are presented in minutes as described by participants. ROSC = return of spontaneous circulation (CPR = cardiopulmonary resuscitation)

*Time from collapse to when a defibrillator was applied—no shock was advised for these casualties

| Main Theme | Sub-Theme |
|---------------------------------------|--|
| Being organized | Training Delineation of roles within teams Venue familiarization Location of responder positions |
| Calling for help | Being close Calling for help Navigating the infrastructure maze Sense of urgency |
| Stepping up to the plate | Bystander CPR Teamwork Having equipment in a state of readiness Recognizing need for CPR Managing crowds |
| Shock | Familiarity of AED |
| Right People, Right Place, Right Time | Coordinated approach to calling an ambulance Navigating the ambulance |

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Table 3—Thematic analysis (AED = automatic external defibrillator; CPR = cardiopulmonary resuscitations)

We were between the two main stages...people crowding around...screaming. It was on a hill...getting dark...we couldn't really see much...

...there was a security guard present, and he didn't know what to do...

A sense of urgency was described as a component of accessing the patient. Responders described “being alert” related to a sense of commotion from the crowd and a “heightened anxiety” on arrival at the scene.

Theme 3: Stepping Up to the Plate—Of the five cases described, only one had bystander CPR commenced prior to the arrival of responders. In this case, the bystanders were healthcare professionals. From the remaining four cases, security personnel were with the patient prior to the arrival of the responders but had not commenced CPR.

Effective teamwork between first responders was an important facilitator of a resuscitation event. A number of participants described the role of leadership within a team and the need for someone to take lead, be in charge and to coordinate the team. One participant described it as “stepping up to the plate”.

Participants outlined how having resuscitation equipment, such as oxygen and an AED, easily accessible and in a state of readiness assisted their response. However, in one case, the patient did not present as a typical cardiac arrest. This resulted in a delay to the commencement of CPR and unsureness of the need to continue CPR.

...when I did compressions she put her hands on her chest and tried to move my hand away...but the defibrillator

told us to keep going...keep doing CPR... so we were a bit confused...so we just still did it [CPR].

During a resuscitation event, participants described the presence of the onlooking crowd. These onlookers resulted in the first responders feeling publicly tested.

...the stress of people around watching you and you want to make sure you get it right...you want to save this person...not only for them, their sake, your sake, but for everyone else watching.

...the crowd was an issue, but it's always going to be an issue until you have somebody [security or police] there to help...

Theme 4: The Shock—In all resuscitation cases, response teams consisted of a first responders and first aiders. Not all first aiders were taught how to use an AED.

...everyone should be taught how to use it [an AED] because at that time I was only a first aider and I didn't have to know how to use it.

Theme 5: Right People, Right Patient, Right Time—Responders facilitated access to advanced life support through the activation of the government ambulance services. Commonly, a central communications centre at the mass gathering relayed details to the ambulance services, allowing responders to focus on resuscitation efforts.

... the protocol on the day was to radio through [to a central communications centre], and then they would call for the ambulance.

Participants described the need for ongoing communication with the ambulance service to assist in getting the right people to the right patient at the right time.

[The ambulance service] never got rung back to let them know that the person was in cardiac arrest...

It just took a bit of time with the ambulance trying to explain where you are...it was in a particular area of [the town], and people [from the town] would know that area but if you're not from the town they wouldn't understand...

Discussion

The thematic analysis that emerged from the participants' narrative demonstrates strong synergy with the chain of survival links. Four of the themes align themselves with the existing chain of survival: (1) early access; (2) early CPR; (3) early defibrillation; and (4) early advanced life support. In addition, "early planning" should be considered a link in the chain of survival at mass gatherings (Figure 2). This link was identified from the theme 'being organized'.

Early Planning

This research has outlined unique aspects to the traditional links in the chain of survival that have not been highlighted previously. In particular, these relate to the importance of

preparedness. This preparedness phase or, "early planning" link, differs from the "early access" link in the chain of survival, which has traditionally focused on access to emergency medical systems.³ The "early planning" link in the mass-gathering environment illustrates a higher level of planning required to bring the chain of survival links together; this has been a similar experience with managing multiple casualty incidents where the preparatory role has been undervalued.¹⁷ In particular, the "early planning" link draws attention to the need for education, role delineation, familiarity with the environment and strategic placement of responders. To enhance preparedness, training that is of a regular repetitive nature is required.¹³ This training is not exclusively for responders associated with the first aid service provider, but should include other agencies such as security personnel and bystanders. The early and pre-arrest delineation of roles within teams prior to deployment is imperative to timely resuscitation, this understanding of roles directly relates to the planning of teamwork. Being familiar with the geography of the venue will ensure a rapid response. Similarly, the strategic positioning of static responder posts should be mutually agreed between the event organizer and the responder service provider, as it is the responder service provider that has the contextual knowledge and experience of providing clinical services at mass gatherings.

Chain of Survival at Mass Gatherings

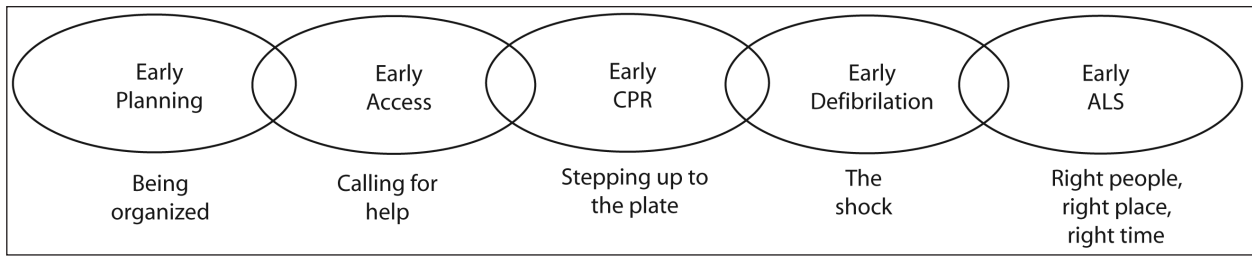
Through the analysis of personal experiences of resuscitation, this research identified a series of facilitators and barriers that hold together the links in the chain of survival in the mass-gathering environment (Figure 3). These facilitators and barriers were illustrated previously as participant sub-themes in the research findings.

This research supports the notion of "calling for help" early.³ Within the mass-gathering environment, early access can be enabled by luck and a sense of urgency, which are likely to be the byproduct of "early planning". On the other hand, not knowing the venue infrastructure may impair timely access to the patient.

While security personnel were among the first layperson present, in only one case had bystander CPR been initiated. It is suggested that communities do not have the capacity to initiate bystander CPR;⁹ this was exemplified in this research. The ability of operators to use equipment, and recognize signs of life are important in strengthening the chain of survival. Perhaps these are not well recognized in traditional training. Additionally, knowing infrastructural, physical, and human barriers, and knowing the behavior of crowds is advantageous to responders.⁵ This research has highlighted that responders are aware of the presence of crowds, resulting in a feeling of being publically tested; this is a similar finding to that of junior healthcare professionals performing resuscitation.¹⁸

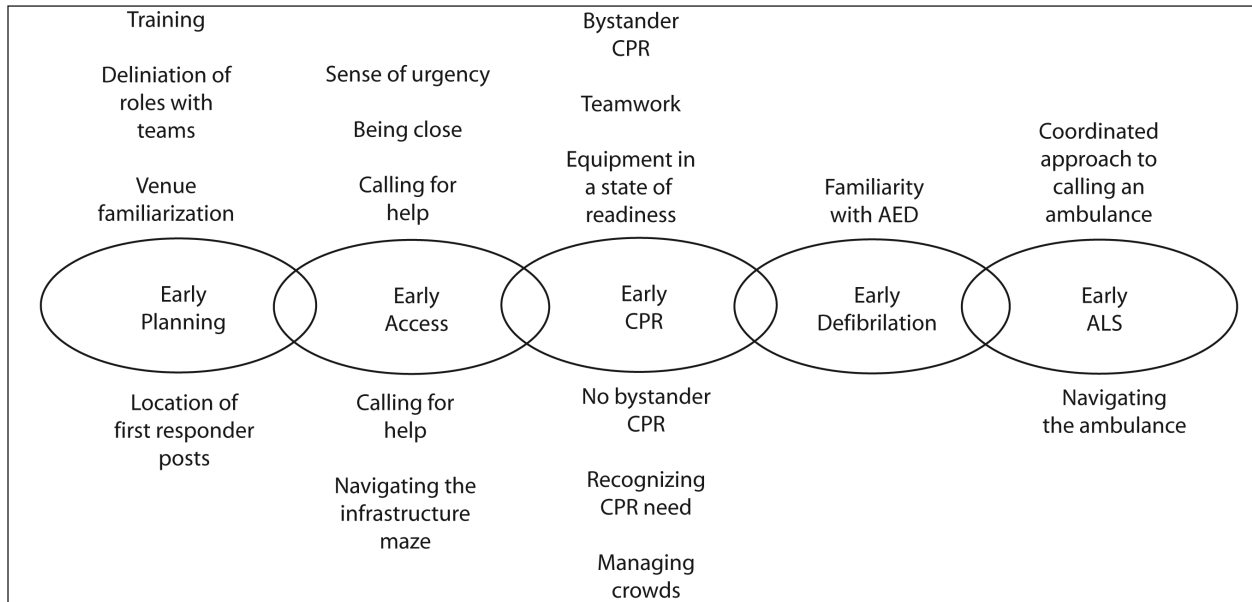
Despite the work conducted regarding public access defibrillators,^{6-8,10} and in all reported cases having an AED present, there still were inhibitors that delayed early defibrillation. This was due to confidence, familiarity, and conflict between the patients' clinical presentation and the device voice prompts.

Ambulance services provide access to higher-level clinical care, such as advanced life support. There is a level of



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Figure 2—Narrative themes aligned with the chain of survival in the mass-gathering environment



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Figure 3—Facilitators and barriers to resuscitation at mass gatherings

complexity to achieving seamless communication between security firms, responder organizations, and ambulance services. These stakeholders must meet in the “early planning” stage to outline communication strategies for when incidents such as cardiac arrest occur.

Limitations

One state or territory did not provide the researchers with any details of resuscitation events in their jurisdiction, and therefore, not all resuscitation events from 2007 may be included in this case series. This case series has provided insight into the experience of providing resuscitation at a mass gathering, these findings may not have applicability at all mass gatherings.

Recommendations

While recommendations for practice and education have been outlined in the discussion, further research is required to better understand the interrelated links of the chain of survival and the influencing factors. There is a need to explore the “early planning” link and underpinning elements. This research highlighted the need to research operational aspects of mass gatherings, such as the positioning of responder posts. Research with security firms should be undertaken to explore security personnel knowledge, skills

and confidence to perform CPR. Additionally, the chain of survival should be explored in other contexts, such as residential care homes and public places.

Conclusions

This is the first research that has explored the interrelationship of links in the chain of survival at mass gatherings, in which the participant narrative and resulting themes demonstrated a close alignment with the existing chain of survival. However, building on the existing knowledge of the chain of survival, this research has uncovered a new element that applies in the unique context of cardiac arrest occurring in the mass-gathering environment. The “early planning” link places an emphasis on preparedness for a cardiac arrest. While this link was explored in the context of mass gatherings, it may have applicability in the broader community in environments such as shopping complexes, public parks, and even residential homes. Additionally, facilitators and barriers, along with recommendations have been presented that may enhance the chain of survival in the mass-gathering environment.

Acknowledgements

The authors acknowledge the research grant provided by St John Ambulance Australia. They also thank the participants of this research for their time and sharing their experiences.

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