

Available online at [www.sciencedirect.com](http://www.sciencedirect.com)

# Resuscitation

journal homepage: [www.elsevier.com/locate/resuscitation](http://www.elsevier.com/locate/resuscitation)

## Editorial

# More evidence that out-of-hospital cardiac arrest is preventable



For decades, system-based interventions for out-of-hospital cardiac arrest (OHCA) have concentrated on the emergency response to the event after it has already occurred.<sup>1</sup> Although essential, the approach is not without its limitations. Survival from OHCA is time sensitive, and therapeutic interventions are often ineffective if the time from collapse to their initiation exceeds 10 min.<sup>2</sup> This short window of opportunity limits what can be achieved by even the most capable emergency systems, particularly as much of this time can be misused by bystanders who delay taking appropriate action.<sup>3,4</sup> In addition, as many as half of all OHCA patients experience irreversible death before the arrival of emergency medical service (EMS) personnel,<sup>5</sup> and this problem highlights a major pitfall (and opportunity) in the existing emergency response to OHCA.

Until recently, there was little evaluation of the months, days, and hours before an OHCA occurred. Early reports characterised OHCA as a sudden lethal event that produced little or no warning symptoms.<sup>6</sup> It is now known that the majority of OHCA patients experience typical prodromal symptoms in the hours before collapse,<sup>7–11</sup> many of which are recurring symptoms from the previous day.<sup>10</sup> In 2005, the European Resuscitation Council revised the first link in chain of survival shifting the attention from 'early access' to 'early recognition' — a change that highlights the need for patients and bystanders to recognise the prodromal symptoms and act imminently to prevent cardiac arrest.<sup>12</sup> Although interventions targeting the first link in the chain of survival have the largest impact on patient outcomes,<sup>13</sup> there has been relatively little progress in the development of short-term preventive strategies which could help to circumvent OHCA. This is in part due to a belief that although OHCA patients experience warning signs, they are not amenable to seeking emergency care.<sup>10</sup>

In this issue of *Resuscitation*, Shuvy et al.<sup>14</sup> present a retrospective cohort study using linked data from multiple population-based databases in Ontario, Canada. The population involves 38,906 OHCA patients who were transported by the EMS to an emergency department (ED) between 2007 and 2018. Linked data were used to describe trends in ED assessments, hospitalisations, and visits to primary care physicians in the 12 months prior to cardiac arrest. The study is the largest of its kind and significantly enhances our understanding of the patterns of healthcare utilisation in the lead up to OHCA events. The study shows that in the 90 days preceding OHCA, 29.5% of patients sought assessment in the ED, 16.5% were hospitalised, and 70.1% visited a primary care physician. Diseases of the circulatory system represented 14.4% of ED assessments and 33.7% of hospitalisations. Compared to patients aged  $\geq 65$  years,

patients aged  $<65$  years had lower rates of ED assessment for circulatory conditions (9.1% vs. 18.1%), but higher rates of mental and behavioural disorders (12.2% vs. 1.9%). Importantly, the study demonstrates that the OHCA patients are amenable to making contact with the health care system in response to warning symptoms.

The findings of the study are also likely to underestimate the total proportion of OHCA patients who sought, or could have sought, medical assessment in response to symptoms. In Canada, approximately 40% of OHCA patients are not treated by EMS,<sup>15</sup> and it is unclear if patterns of health care utilisation are also generalisable to this population. It is also very likely that a proportion of patients experience prodromal symptoms in the lead up to an OHCA but do not seek medical attention. In addition, the findings are drawn from an unselected population of OHCA patients of which many could be non-cardiac in aetiology. Although this could underestimate rates of hospitalisation in patients with OHCA from cardiac aetiologies, it also highlights patterns of health care utilisation in populations with non-cardiac aetiologies (e.g. intentional injury), which are also preventable with early intervention.

The study contributes to a growing body of evidence that rejects the notion that OHCA occurs without warning and in apparently healthy individuals.<sup>7–11,16,17</sup> Rates of prior myocardial infarction and heart failure were common, and the overwhelming majority of patients had received an echocardiogram, angiogram, stress test or cardiac catheterisation in the previous five years, indicating that most were perceived to be at-risk individuals.<sup>14</sup> Although implantable cardioverter defibrillators (ICD) are the mainstay of sudden cardiac death prevention,<sup>18</sup> only a small number of patients in this study would have been perceived as suitable candidates for an ICD before the event. This perhaps highlights the intrinsic difficulty in estimating the long-term risk of suffering an OHCA, and supports the need for novel approaches in risk-stratification that combine phenotypic, biological and non-invasive clinical markers.<sup>18</sup>

It also highlights an opportunity to develop short-term preventive strategies that target at risk individuals with education on the appropriate response to warning symptoms. Marijon et al. recently demonstrated that patients who called EMS in response to OHCA warning symptoms experienced a five-fold improvement in the odds of survival to hospital discharge compared to patients who did not respond to symptoms.<sup>10</sup> Interestingly, 78% of the patients who activated EMS in response to symptoms suffered an OHCA before the arrival of EMS personnel, highlighting that even minor reductions in delays can have a dramatic impact on patient outcomes. Similarly, a study conducted in paramedic witnessed OHCA patients showed that longer delays to

activation of EMS personnel after the onset of warning symptoms was associated with a reduction in the odds of survival to hospital discharge.<sup>11</sup> In Australia, a public awareness campaign targeting the community's knowledge of heart attack warnings symptoms was associated with a 21% increase in EMS activations for chest pain symptoms and a 16.6% reduction in fatal OHCA events.<sup>19,20</sup> Public awareness campaigns had a greater effect on reducing the incidence of unwitnessed and initial non-shockable arrests, which are associated with poorer resuscitation outcomes.<sup>19</sup>

This body of work provides more evidence that OHCA may be prevented by way of early identification of populations at risk and greater use of interventions that mitigate the short-term risk of developing an OHCA.

## Conflicts of interest

None to declare.

## Sources of funding

ZN is supported by a National Health and Medical Research Council (NHMRC) Early Career Fellowship (#1146809).

## REFERENCES

- Cummins RO, Ornato JP, Thies WH, Pepe PE. Improving survival from sudden cardiac arrest: the "chain of survival" concept. A statement for health professionals from the Advanced Cardiac Life Support Subcommittee and the Emergency Cardiac Care Committee, American Heart Association. *Circulation* 1991;83:1832–47.
- Fridman M, Barnes V, Whyman A, et al. A model of survival following pre-hospital cardiac arrest based on the Victorian Ambulance Cardiac Arrest Register. *Resuscitation* 2007;75:311–22.
- Takei Y, Inaba H, Yachida T, Enami M, Goto Y, Ohta K. Analysis of reasons for emergency call delays in Japan in relation to location: high incidence of correctable causes and the impact of delays on patient outcomes. *Resuscitation* 2010;81:1492–8.
- Nehme Z, Andrew E, Cameron P, et al. Direction of first bystander call for help is associated with outcome from out-of-hospital cardiac arrest. *Resuscitation* 2014;85:42–8.
- Berdowski J, Berg RA, Tijssen JG, Koster RW. Global incidences of out-of-hospital cardiac arrest and survival rates: Systematic review of 67 prospective studies. *Resuscitation* 2010;81:1479–87.
- Huikuri HV, Castellanos A, Myerburg RJ. Sudden death due to cardiac arrhythmias. *N Engl J Med* 2001;345:1473–82.
- Muller D, Agrawal R, Arntz HR. How sudden is sudden cardiac death? *Circulation* 2006;114:1146–50.
- Nishiyama C, Iwami T, Kawamura T, et al. Prodromal symptoms of out-of-hospital cardiac arrests: a report from a large-scale population-based cohort study. *Resuscitation* 2013;84:558–63.
- Norris RM. Circumstances of out of hospital cardiac arrest in patients with ischaemic heart disease. *Heart* 2005;91:1537–40.
- Marijon E, Uy-Evanado A, Dumas F, et al. Warning symptoms are associated with survival from sudden cardiac arrest warning symptoms and sudden cardiac arrest. *Ann Intern Med* 2015;164:23–9.
- Nehme Z, Bernard S, Andrew E, Cameron P, Bray JE, Smith K. Warning symptoms preceding out-of-hospital cardiac arrest: do patient delays matter? *Resuscitation* 2018;123:65–70.
- Nolan J, Soar J, Eikeland H. The chain of survival. *Resuscitation* 2006;71:270–1.
- Deakin CD. The chain of survival: not all links are equal. *Resuscitation* 2018;126:80–2.
- Shuvy M, Koh M, Qiu F, et al. Health care utilization prior to out-of-hospital cardiac arrest: a population-based study. *Resuscitation* 2019;141:158–65.
- Nichol G, Thomas E, Callaway CW, et al. Regional variation in out-of-hospital cardiac arrest incidence and outcome. *JAMA* 2008;300:1423–31.
- de Vreede-Swagemakers JJM, Gorgels APM, Dubois-Arbouw WI, et al. Out-of-hospital cardiac arrest in the 1990s: a population-based study in the Maastricht area on incidence, characteristics and survival. *J Am Coll Cardiol* 1997;30:1500–5.
- Weeke P, Folke F, Gislason GH, et al. Pharmacotherapy and hospital admissions before out-of-hospital cardiac arrest: a nationwide study. *Resuscitation* 2010;81:1657–63.
- Fishman GI, Chugh SS, Dimarco JP, et al. Sudden cardiac death prediction and prevention: report from a National Heart, Lung, and Blood Institute and Heart Rhythm Society Workshop. *Circulation* 2010;122:2335–48.
- Nehme Z, Andrew E, Bernard S, et al. Impact of a public awareness campaign on out-of-hospital cardiac arrest incidence and mortality rates. *Eur Heart J* 2017;38:1666–73.
- Nehme Z, Cameron PA, Akram M, et al. Effect of a mass media campaign on ambulance use for chest pain. *Med J Aust* 2017;206:30–5.

Ziad Nehme<sup>a,b,c</sup>

<sup>a</sup>Centre for Research and Evaluation, Ambulance Victoria, Doncaster, Victoria, Australia

<sup>b</sup>Department of Community Emergency Health and Paramedic Practice, Monash University, Frankston, Victoria, Australia

<sup>c</sup>Department of Epidemiology and Preventive Medicine, Monash University, Prahran, Victoria, Australia

Karen Smith<sup>a,b,c,d,\*</sup>

<sup>a</sup>Centre for Research and Evaluation, Ambulance Victoria, Doncaster, Victoria, Australia

<sup>b</sup>Department of Community Emergency Health and Paramedic Practice, Monash University, Frankston, Victoria, Australia

<sup>c</sup>Department of Epidemiology and Preventive Medicine, Monash University, Prahran, Victoria, Australia

<sup>d</sup>School of Primary, Aboriginal and Rural Health Care, University of Western Australia, Crawley, Western Australia, Australia

\* Corresponding author at: Centre for Research and Evaluation, Ambulance Victoria, 375 Manningham Road, Doncaster, Victoria, 3108 Australia.

E-mail address: karen.smith@ambulance.vic.gov.au (K. Smith).

<http://dx.doi.org/10.1016/j.resuscitation.2019.05.039>

© 2019 Elsevier B.V. All rights reserved.