



ELSEVIER

Contents lists available at ScienceDirect

Resuscitation

journal homepage: www.elsevier.com/locate/resuscitation

Editorial

The cost of care for cardiac arrest



An estimated 390,000 out-of-hospital cardiac arrests (OHCA) and 200,000 in-hospital cardiac arrests (IHCA) occur annually in the United States [1]. Survival to hospital discharge remains low despite considerable efforts (overall: 11% treated by emergency medical services), but outcomes have improved [2,3]. The observed improvement in survival may be attributed to the development of a systematic and organized approach to the care of the post-cardiac arrest (CA) patient. Such bundles and approaches to care include application of numerous innovative therapies and technologies, including antiarrhythmic medications, hemodynamic support, targeted temperature management, metabolic stabilization, ventilator support and percutaneous coronary intervention [4–6].

To date, much of CA research has focused on “hard” clinical outcomes such as survival and neurological outcome. However, less is known about the in-hospital costs of caring for post-CA patients. Some analyses have reported CA-related healthcare costs for both OHCA and IHCA in the United States [1,7]. Quantifying healthcare costs related to CA is essential as it allows for equitable allocation of scarce resources to areas of post-arrest management that improve outcomes. Specifically, a recent nationwide evaluation of healthcare costs following CA in the United States found temporal increases in the cost of post-CA hospitalizations. The increased year-by-year costs is multifactorial and related to increased length of stay, use of medical procedures and regionalizing systems of care [8–11]. One of the first studies which examined the costs associated with treatment of OHCA in Europe, including both pre-hospital and in-hospital costs, reported a six-month survivor cost of €36,000 expressed in 2013 euros [12]. Further, more recent publications have reported hospital expenditure of €50,000 and €60,000 in 2013 euros for OHCA and IHCA hospital survivors [13].

Although there is evidence evaluating healthcare expenditure for OHCA and IHCA, very little is known about patients who suffer a CA in the intensive care unit (ICU-CA). These patients are admitted to the ICU with a primary diagnosis outside of CA and managed initially for another critical medical illness. To our knowledge, only one prior publication has reported cost data for ICU-CA patients, finding that ICU-related expenses for hospital non-survivors was €54,000 in 2013 euros [14]. Patients who suffer CA in an ICU environment are a heterogeneous, but significant subset of patients with a unique case-mix and clinical course [8,15].

In this issue of Resuscitation, Efendijev et al. [16] present an important study about costs of CA care from a single centre in Finland. They looked at the differential impact of location of CA on cost of CA within the same healthcare system – a particularly unique aspect of the study. The publication reviews expenses associated with hospital or one-year survival among patients with OHCA, IHCA and ICU-CA (subset of IHCA). The study links multiple, national level datasets to collate this data. Overall, the study population totaled over 1000 ICU-treated CA

patients. The total costs for all patients was €50,847,540. With respect to survival, at one year after CA, 59% of OHCA, 44% of IHCA, and 39% of ICU-CA remained alive. Among one-year survivors, 97% of OHCA, 88% of IHCA and 93% of ICU-CAs were found to have favourable neurological outcome. Effective cost per one-year survivor, including with favourable neurological outcome, was highest in ICU-CAs and lowest in OHCA.

This current study helps inform resource allocation and healthcare administration. Given that ICU-CA have the relatively lowest survival rates among all CA, and are the most costly, intensive care physicians and hospital administrators should work to establish early standardized pathways among admitted ICU patients who are most likely to benefit from ongoing intensive care. A similar approach may be applied to IHCA patients who often have initially non-shockable rhythms and thus poor prognoses. At the same time, the authors have reinforced the notion that OHCA survivors continue to have better outcomes than their IHCA or ICU-CA counterparts and cost the healthcare system less from a healthcare expenditure standpoint. This supports recent data in the OHCA population that shows the early risk of adverse events in the pre-hospital setting does not persist following hospital discharge [17,18]. Importantly, this work supports the rationale that ICUs and hospitals should continue to develop and optimize post-CA bundles of care for such patients [4–6]. When comparing outcomes between location of cardiac arrest and cost of post-arrest care, the current study has shown that bundles of care implemented for OHCA costs less and serves a patient population who tend to have improved outcomes. Thus, this data helps to provide some justification of such efforts in the OHCA population, specifically from a healthcare economics perspective.

This study fills some important knowledge gaps. First, as the authors acknowledge, this study was conducted in a setting of government-funded healthcare which largely eliminated selection bias due to socioeconomic factors and personal insurance [16]. Second, detailed analysis of the ICA-CA provides useful information with respect to healthcare costs in this patient population that has, to our knowledge, not been well described. Third, this is one of the few European studies to comprehensively evaluate the cost of CA. Finally, the study lends support to the notion that optimization of prevention strategies and management of ICU-CA, and cardiac arrest in general, is required and would help to improve the overall cost-effectiveness of CA treatment.

However, there are some limitations. For one, we cannot extrapolate the absolute costs to other clinical settings due to the single-centre, country-specific nature of this study. In particular, the study's population was from a single tertiary hospital with a highly efficient and centralized emergency health services (EHS). Furthermore, overall one-year survival rates from hospital admission in the overall population was 58%. This is greater than what has generally been reported in the literature, suggestive of differential patient selection which may not

<https://doi.org/10.1016/j.resuscitation.2018.08.010>

be typical of CA patients elsewhere. While difficult to validate, the authors put forth some potential explanations related to Finland specifically: a highly performing EHS system, standardized in-hospital care of CA, and well-established practice pre-hospital DNAR and termination of resuscitation rules. Finally, in the current study, the authors were unable to separate pre-arrest cost for IHCA (including ICU-CA patients). This may lead to an overestimation of CA-related hospital costs as a majority of the ICU stay may be related to the pre-arrest comorbidity of the critically ill patient.

In conclusion, the present study provides novel insights into the comparative financial burden and outcomes that OHCA, IHCA (including ICU-CA) place on a healthcare system in Finland. The study suggests that ICU-CA patients have the poorest outcomes with respect to survival and the highest cost per one-year of survivorship. Future studies should focus on delineating healthcare costs associated with ICU-CA following CA, including the financial contribution of the pre-arrest ICU stay. Additionally, future work should test prevention and management strategies and their effects on healthcare spending and cost-effectiveness. For example, ICU physicians and hospital administrators should work to establish early standardized pathways to identify which patients are most likely and least likely to benefit from ongoing intensive care. Finally, the authors have reinforced the fact that OHCA survivors continue to have comparatively good long-term outcomes, supporting ongoing efforts to develop and optimize post-CA bundles of care to improve in-hospital survival in this population.

Financial disclosures

Dr. Fordyce reports personal fees from Bayer, Novo Nordisk, Sanofi and Boehringer Ingelheim, outside the submitted work.

Conflict of interest statement

Dr. Stanger reports no disclosures.

References

- [1] Halpern NA, Pastores SM. Critical care medicine in the United States 2000–2005: an analysis of bed numbers, occupancy rates, payer mix, and costs. *Crit Care Med* 2010;38:65–71.
- [2] Merchant RM, Yang L, Becker LB, Berg RA, Nadkarni V, Nichol G, et al. Incidence of treated cardiac arrest in hospitalized patients in the United States. *Crit Care Med* 2011;39:2401–6.
- [3] Wissenberg M, Lippert FK, Folke F, Weeke P, Hansen CM, Christensen EF, et al. Association of national initiatives to improve cardiac arrest management with rates of bystander intervention and patient survival after out-of-hospital cardiac arrest. *JAMA* 2013;310:1377–84.
- [4] Girotra S, Nallamothu BK, Spertus JA, Li Y, Krumholz HM, Chan PS, et al. Trends in survival after in-hospital cardiac arrest. *N Engl J Med* 2012;367:1912–20.
- [5] Tian J, Kaufman DA, Zarich S, Chan PS, Ong P, Amoateng-Adjepong Y, et al. Outcomes of critically ill patients who received cardiopulmonary resuscitation. *Am J Respir Crit Care Med* 2010;182:501–6.
- [6] Peberdy MA, Ornato JP, Larkin GL, Braithwaite RS, Kashner TM, Carey SM, et al. Survival from in-hospital cardiac arrest during nights and weekends. *JAMA* 2008;299:785–92.
- [7] Damluji AA, Al-Damluji MS, Pomenti S, Zhang TJ, Cohen MG, Mitrani RD, et al. Health care costs after cardiac arrest in the United States. *Circ Arrhythm Electrophysiol* 2018;11:e005689.
- [8] Fischer M, Fischer NJ, Schuttler J. One-year survival after out-of-hospital cardiac arrest in Bonn city: outcome report according to the 'Utstein style'. *Resuscitation* 1997;33:233–43.
- [9] Girotra S, Chan PS. Trends in survival after in-hospital cardiac arrest. *N Engl J Med* 2013;368:680–1.
- [10] Lindner T, Vossius C, Mathiesen WT, Soreide E. Life years saved, standardised mortality rates and causes of death after hospital discharge in out-of-hospital cardiac arrest survivors. *Resuscitation* 2014;85:671–5.
- [11] Neumar RW, Nolan JP, Adrie C, Aibiki M, Berg RA, Bottiger BW, et al. Post-cardiac arrest syndrome: epidemiology, pathophysiology, treatment, and prognostication. A consensus statement from the International Liaison Committee on Resuscitation (American Heart Association, Australian and New Zealand Council on Resuscitation, European Resuscitation Council, Heart and Stroke Foundation of Canada, Inter American Heart Foundation, Resuscitation Council of Asia, and the Resuscitation Council of Southern Africa); the American Heart Association Emergency Cardiovascular Care Committee; the Council on Cardiovascular Surgery and Anesthesia; the Council on Cardiopulmonary, Perioperative, and Critical Care; the Council on Clinical Cardiology; and the Stroke Council. *Circulation* 2008;118:2452–83.
- [12] Jakobsson J, Nyquist O, Rehnqvist N, Norberg KA. Cost of a saved life following out-of-hospital cardiac arrest resuscitated by specially trained ambulance personnel. *Acta Anaesthesiol Scand* 1987;31:426–9.
- [13] Naess AC, Steen PA. Long term survival and costs per life year gained after out-of-hospital cardiac arrest. *Resuscitation* 2004;60:57–64.
- [14] Graf J, Muhlhoff C, Doig GS, Reinartz S, Bode K, Dujardin R, et al. Health care costs, long-term survival, and quality of life following intensive care unit admission after cardiac arrest. *Crit Care* 2008;12:R92.
- [15] Bloom HL, Shukrullah I, Cuellar JR, Lloyd MS, Dudley Jr. SC, Zafari AM. Long-term survival after successful in-hospital cardiac arrest resuscitation. *Am Heart J* 2007;153:831–6.
- [16] Ilmar Efendijev DF, Rajb Rahul, Reinikainen Matti, Pekkarinen Pirkka T, Litiunsa Erik, Skrifvarsad Markus B. Outcomes and healthcare-associated costs one year after intensive care-treated cardiac arrest. *Resuscitation* 2018;131:128–134.
- [17] Fordyce CB, Wang TY, Chen AY, Thomas L, Granger CB, Scirica BM, et al. Long-term post-discharge risks in older survivors of myocardial infarction with and without out-of-hospital cardiac arrest. *J Am Coll Cardiol* 2016;67:1981–90.
- [18] Kragholm K, Wissenberg M, Mortensen RN, Fonager K, Jensen SE, Rajan S, et al. Return to work in out-of-hospital cardiac arrest survivors: a nationwide register-based follow-up study. *Circulation* 2015;131:1682–90.

Dylan E. Stanger, Christopher B. Fordyce*

Division of Cardiology, University of British Columbia, Vancouver, British Columbia, Canada

E-mail address: cfordyce@mail.ubc.ca (C.B. Fordyce)

* Corresponding author at: 2775 Laurel St – 9th Floor, Vancouver, British Columbia, Canada.