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Clinical paper

Short and long-term survival following an in-hospital cardiac arrest in a regional hospital cohort

Zakary Doherty[a,b,*], *Jason Fletcher*[b], *Kim Fuzzard*[b,c], *Rebecca Kippen*[a], *Cameron Knott*[a,b,d,e], *Belinda O'Sullivan*[a,f]

[a] *School of Rural Health, Faculty of Medicine, Nursing and Health Sciences, Monash University, Australia*
[b] *Intensive Care Unit, Bendigo Health, Australia*
[c] *Clinical Learning and Development, Bendigo Health, Australia*
[d] *Intensive Care Unit, Austin Health, Australia*
[e] *Health and Bioinformatics Centre, Department of General Practice, Faculty of Medicine, Dentistry and Health Sciences, University of Melbourne, Australia*
[f] *The University of Queensland, Rural Clinical School, Faculty of Medicine, Australia*

Abstract

Introduction: Evidence about the immediate survival from in-hospital cardiac arrest (IHCA) is well established, however, beyond discharge there is very little describing the long-term outcomes of these patients. Of the few existing studies, all have been conducted in metropolitan centres. Therefore, this study describes survival from IHCA in both the short and long-term in a large regional hospital cohort.

Method: A retrospective cohort study was conducted including all adult patients who suffered an IHCA between 1 February 2000 and 31 December 2017 in a large regional (non-metropolitan) hospital in Victoria, Australia. Characteristics of the arrest and patient were sourced from a prospectively collected database that captures all of the arrests occurring in the hospital. Mortality data after discharge were sourced from the state death registry, censored on 31 January 2018.

Results: A total of 629 patients were included in the study. Of these, 357 (57%) survived the event, and 213 (34%) survived to discharge. At one-year post-arrest 27% of the original cohort were still alive. The age of the patient, arrest rhythm, location and duration of resuscitation were all significantly associated with long-term survival.

Conclusion: Both short and long-term survival following an IHCA in a regional hospital are similar to previously described rates in metropolitan hospitals. Further research is required on the post-discharge correlates of long-term survival.

Keywords: Cardiac arrest, Survival, Long-term, In-hospital cardiac arrest

Introduction

Survival of out-of-hospital cardiac arrest has been widely researched but there is significantly less evidence regarding in-hospital cardiac arrest (IHCA) outcomes.[1–3] Previous research identified approximately half of IHCA patients survive the arrest event and half of these survivors live to discharge.[4–6] However, long-term survival and its correlates beyond discharge are less well known.[5,7–10]

The vast majority of IHCA research published from developed countries is based on large metropolitan hospital cohorts. This is despite the importance of regional hospitals as referral centres for geographically dispersed rural populations. Regional hospitals have typically fewer sub-specialty units and less full time staffing of cardiac

* Corresponding author at: School of Rural Health, Faculty of Medicine, Nursing and Health Sciences, Monash University, Australia.
E-mail address: zak.doherty@monash.edu (Z. Doherty).

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procedural services. As such, their survival outcomes may be different from metropolitan hospitals.

This study examines *short-term* (event and to discharge) and *long-term* (beyond discharge) survival following an IHCA in a regional hospital and relevant factors associated with survival.

Methods

Study design

A retrospective cohort study was performed using prospectively collected hospital data, linked with the Victorian Death Registry (VDR). Ethics approval was from the Monash University (ref: 12353) and Bendigo Health (ref: HREC/17/BHCG/52) Human Research Ethics Committees.

Setting

The study was based at Bendigo Hospital, a large referral hospital for more than 300,000 people in the north-western region (approximately 62,000 km^2) of the state of Victoria, Australia. Bendigo is located 150 km from the state's capital, Melbourne (population 4.8 million).[11] In 2017, Bendigo Hospital had 372 inpatient beds and over 40,000 admissions. A cardiac catheter lab with Percutaneous Coronary Intervention (PCI) capabilities was available since 2010; however, it was not staffed full-time or over weekends.

Data

Consistent with Australian Resuscitation Council (ARC) guidelines, a "Code Blue" team response occurs for all IHCAs in the study hospital. Since the year 2000, clinical staff attending these events collected event data using a standardised form and the data were then entered into a Code Blue database. The data collection, entry and cleaning were supervised by the same senior nurse throughout the study period. Code Blue treatment protocols in the hospital comply with ARC guidelines for cardiac arrest management.[12] Clinical governance and quality assurance is maintained through a monthly multidisciplinary clinical audit and review committee meeting to determine adherence to resuscitation protocols and validate data. To ensure completeness of data, a monthly cross-check of Code Blue call logs is performed. Any discrepancy is investigated and corrected by the abovementioned nurse. Hospital admissions data, used to calculate the annual incidence of IHCA, were obtained from internal hospital reporting systems.

Short-term survival was firstly measured as *event survival*, where patients achieved a return of spontaneous circulation (ROSC) for a period of 20 min or more, and secondly as *survival to discharge*, where patients left the acute hospital campus alive.[13] Covariates of interest included age, gender, date, time and location of the IHCA (Critical Care includes the co-located Intensive Care and Coronary Care Units), initial cardiac arrest rhythm, arrest duration and protocol adherence. All data were recorded at the time of the arrest, except resuscitation protocol adherence, which was recorded after the clinical audit and review committee meetings.

Long-term survival was measured as *survival after discharge*, by linking IHCA cases with the VDR, matched until 31 January 2018. The VDR is managed by Births, Deaths and Marriages Victoria, a government department that registers all deaths in the study state. To avoid over-estimating survival from the VDR (limited to deaths in Victoria), patients who resided interstate prior to the arrest (n = 9) were excluded from analyses of post-discharge survival. We calculated a long-term survival curve for the IHCA cohort. We also calculated a survival curve for the general Australian population matched to the IHCA cohort for age, sex and year using data derived from published life tables to provide a 'mortality baseline' with which to compare the IHCA cohort.[14]

Inclusion criteria

The study included adult in-patients who experienced an IHCA and received a resuscitation attempt from 1 February 2000 to 31 December 2017. Included cardiac arrests were those occurring in the Emergency Department or after hospital admission. All adult cardiac arrests were defined according to Utstein Guidelines as adults aged 20 years or more who were unresponsive, had no palpable pulse and were either apnoeic, taking agonal breaths or breathing with the assistance of a mechanical ventilator.[13] In the case of multiple arrests from the same patient during the study period, only the first (index arrest) was included. Additionally, patients that had a not-for-resuscitation order were excluded. A small number of IHCAs that occurred in the psychiatric ward or the operating theatre complex were excluded, as the manner in which a Code Blue was called in these locations was not consistent over the study period, introducing the possibility of missed arrests. All other locations had a consistent calling method.

Statistical analysis

IHCA incidence

The annual number of IHCAs was divided by the annual number of hospital admissions from 2000 until 2017. This is reported as an annual IHCA incidence per 1000 admissions. A linear trend line was fitted with a calculated R^2 value to determine goodness of fit.

Short-term survival

Univariate and multivariate binary logistic regression was used to investigate the correlates of IHCA short-term survival. The analysis of event survival included all patients. Only those surviving the event were included in the analysis for survival to discharge. All variables described in Table 1 were included in the univariate and multivariate logistic regressions with the addition of calendar year of the IHCA as a continuous variable. Duration of resuscitation was not included in the logistic regression for event survival due to reverse causality; ROSC typically occurs early in the resuscitation, whereas ceasing the resuscitation (due to futility) mostly occurs after a significant period of time. Goodness of fit was determined by the Hosmer and Lemeshow Test.

Long-term survival

For patients who survived to discharge, a Kaplan–Meier survival curve was calculated, right-censored at 31 January 2018. Finally, univariate and multivariate Cox regression was employed to investigate correlates of long-term survival. All patients who survived to discharge were included in the Cox regression and Kaplan–Meier survival curve, with the exception of the nine patients who did not reside in the state of Victoria. Visual

Table 1 – Baseline characteristics of IHCA cohort.

	Number (n = 629)	%
Sex		
Male	372	59.1
Female	257	40.9
Age (years)		
80+	173	27.5
70–79	191	30.4
60–69	128	20.3
50–59	76	12.1
<50	61	9.7
IHCA location		
Emergency department	247	39.3
Medical ward	141	22.4
Critical care	119	18.9
Surgical ward	88	14.0
Cardiac catheter lab	14	2.2
Other	20	3.2
IHCA initial rhythm		
Ventricular fibrillation	101	16.1
Ventricular tachycardia	62	9.9
Pulseless electrical activity	257	40.9
Asystole	152	24.2
Other	4	0.6
Unknown	53	8.4
Time of IHCA (hours)		
Morning (0700–1459)	246	39.1
Evening (1500–2259)	198	31.5
Night (2300–0659)	181	28.8
Missing	4	0.6
Protocol followed		
Yes	464	73.8
No	92	14.6
Missing	73	11.6
Duration of resuscitation (minutes)		
0–2	97	15.4
3–5	69	11.0
6–10	72	11.4
11–15	52	8.3
16–20	62	9.9
>20	123	19.6
Missing	154	24.5
Survival		
Event (ROSC > 20 min)	357	56.8
Discharge	213	33.9
Age (years) mean = 70.0		
Duration of resuscitation (minutes) mean = 15.0		

IHCA, In-hospital cardiac arrest; ROSC, return of spontaneous circulation.

inspection of the survival curves was used to ensure that the proportional hazards assumption was not violated.

All patient and arrest characteristics shown in Table 1 were considered clinically significant and were included in the logistic and the Cox regressions (except duration of resuscitation for event survival). Odds ratios (OR — for the logistic regressions) and hazard ratios (HR — for the Cox regressions), 95% confidence intervals and p-values are reported. P-values of less than 0.05 were considered statistically significant. Analyses used SPSS software (IBM Corp. Released 2014. IBM SPSS Statistics for Windows, Version 24.0. Armonk, NY: IBM Corp.).

Results

IHCA incidence

During the 18-year study period the annual incidence decreased from 0.91 arrests per 1000 admissions in 2000 to 0.32 in 2017 (Fig. 1 shows $R^2 = 0.75$), with an average annual incidence of 0.52.

Baseline characteristics

Cohort baseline characteristics are shown in Table 1. Overall, 629 patients met the inclusion criteria. Fifty-nine percent (59%) were male, and mean age was 70.0 years. The most common locations of IHCA were the Emergency Department (39%), Medical Ward (22%) and the Critical Care Unit (19%). The most common initial rhythm was Pulseless Electrical Activity (PEA; 41%) followed by Asystole (24%). One quarter of patients had a shockable rhythm (Ventricular Fibrillation (VF) or Ventricular Tachycardia (VT)). Thirty-nine per cent (39%) of IHCAs occurred during the morning nursing shift, with the remainder evenly divided between the evening and night nursing shifts. Hospital protocol was followed in 74% of IHCAs. Mean duration of resuscitation was 15.0 min, and resuscitation duration was less than 11 min for 38%, 11–20 min for 18% and greater than 20 min for 20% of cases respectively. There were minimal missing data except for duration of resuscitation in 25% of cases (often because the duration was not clear for the attending staff) and protocol adherence in 12% of cases.

Short-term survival

Event survival

Overall, 357 (57%) of the 629 IHCA patients survived the event. Table 2 shows that arrest location, rhythm, time and year, in addition to whether the protocol was followed were significantly associated with event survival in the univariate analysis. After adjusting for covariates in the multivariate logistic regression, these variables remained significant. The Medical Ward had the greatest association with decreased survival compared with the Emergency Department (OR = 0.53, p = 0.008). Both non-shockable rhythms were significantly associated with decreased event survival, however, PEA had the worst survival (OR = 0.17, $p < 0.001$). Evening and night nursing shifts were associated with decreased survival compared with morning. Non-adherence to protocol was significantly associated with decreased event survival (OR = 0.39, $p < 0.001$). Over the study period there was increased event survival (OR = 1.06, p = 0.001). The data were well fitted by the model (p = 0.519).

Survival to discharge

Overall 213 (34%) of the 629 IHCA patients in the cohort survived to discharge. In the multivariate analysis, PEA (OR = 0.24, p = 0.002) was associated with decreased survival to discharge when compared to VF (Table 3). Additionally, as duration of resuscitation increased, the odds of survival to discharge decreased (OR = 0.90, $p < 0.001$). No other variables were significantly associated with survival to discharge in the multivariate analysis.

Long-term survival

At the census date (31 January 2018), 527 (83.8%) of 629 patients in the original cohort were listed as deceased in the VDR.

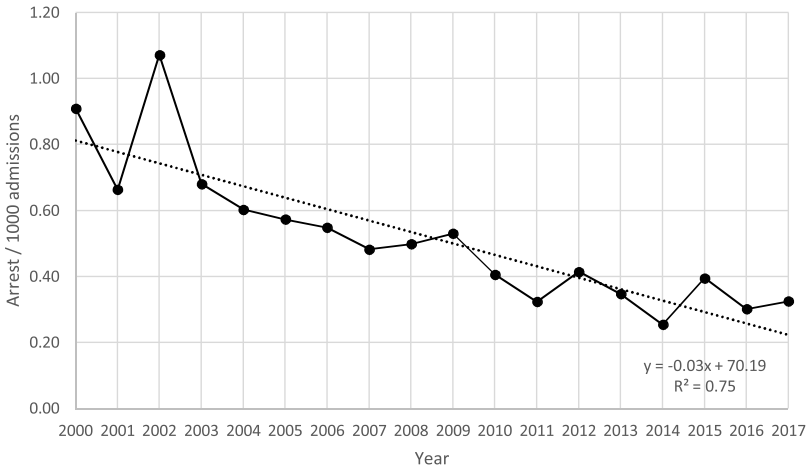

Fig. 1 – Annual incidence of in-hospital cardiac arrests per 1000 admissions. The dotted black line indicates the linear trend line. The derived equation for this line is represented by y, with x representing year as a variable. The solid black line demonstrates the annual incidence per 1000 admissions.

Table 2 – Univariate and multivariate logistic regression for survival of the event.

	Univariate regression (n = 629)			Multivariate regression (n = 629)		
	OR	95% CI	p	OR	95% CI	p
Sex						
Male	Ref			Ref		
Female	1.09	0.79–1.50	0.608	1.41	0.98–2.02	0.066
Age (years) (+1 increase)	0.99	0.98–0.99	0.019	0.99	0.98–1.01	0.217
IHCA location						
Emergency department	Ref			Ref		
Critical care	0.70	0.45–1.10	0.118	0.98	0.60–1.60	0.940
Medical ward	0.49	0.32–0.75	0.001	0.53	0.33–0.85	0.008
Surgical ward	0.47	0.29–0.78	0.003	0.62	0.36–1.07	0.088
Cardiac catheter lab	3.26	0.71–14.91	0.127	1.56	0.31–7.89	0.594
Other	0.54	0.22–1.36	0.192	0.51	0.19–1.40	0.191
IHCA initial rhythm						
Ventricular fibrillation	Ref			Ref		
Ventricular tachycardia	0.90	0.42–1.93	0.787	0.76	0.34–1.69	0.497
Asystole	0.26	0.15–0.47	<0.001	0.24	0.13–0.44	<0.001
Pulseless electrical activity	0.21	0.12–0.36	<0.001	0.17	0.09–0.31	<0.001
Other	0.56	0.26–1.18	0.125	0.74	0.31–1.75	0.488
Unknown	0.79	0.08–7.96	0.840	0.97	0.07–13.45	0.982
Time of IHCA						
Morning (0700–1459)	Ref			Ref		
Evening (1500–2259)	0.54	0.37–0.80	0.002	0.55	0.36–0.84	0.005
Night (2300–0659)	0.46	0.31–0.69	<0.001	0.54	0.35–0.83	0.006
Missing	1.50	0.15–14.65	0.727	3.20	0.26–39.86	0.366
Protocol followed						
Yes	Ref			Ref		
No	0.44	0.28–0.70	<0.001	0.39	0.23–0.66	<0.001
Missing	0.80	0.49–1.31	0.370	0.58	0.32–1.05	0.071
Year of arrest (+1 increase)	1.06	1.02–1.09	0.001	1.06	1.03–1.10	0.001

All shaded rows have a p-value of <0.05. OR: Odds ratio; 95% CI: 95% confidence interval for odds ratio; p: p-value; Ref, Reference Category; IHCA, In-hospital cardiac arrest; ROSC, return of spontaneous circulation.

However, nine patients that resided outside of Victoria were excluded from these analyses. The remaining 91 patients were assumed to be alive as of the census date (31 January 2018).

Overall 204 patients were included in the post-discharge analyses with a mean follow-up period of 5.0 years since arrest. Fig. 2 shows the Kaplan–Meier survival curve for patients who survived to discharge. At one-year post-arrest, 26.9% of the original cohort were still alive. Survival at three, five and ten years' post-arrest was 24.2%, 19.7% and 12.9% respectively.

The Cox regression analysis (Table 4) identified that patient age, arrest rhythm, duration of resuscitation and location were all significantly associated with long-term mortality. As both patient

Table 3 – Univariate and multivariate logistic regression for survival to discharge.

	Univariate regression (n = 357)			Multivariate regression (n = 234*)		
	OR	95% CI	p	OR	95% CI	p
Sex						
Male	Ref			Ref		
Female	0.79	0.52–1.21	0.284	0.65	0.34–1.27	0.209
Age (years) (+1 increase)	0.98	0.97–0.99	0.012	0.99	0.96–1.02	0.449
IHCA location						
Emergency department	Ref			Ref		
Critical care	0.53	0.29–0.95	0.032	0.43	0.18–1.01	0.052
Medical ward	0.42	0.23–0.75	0.003	0.58	0.24–1.37	0.213
Surgical ward	0.32	0.16–0.65	0.002	0.44	0.15–1.26	0.126
Cardiac catheter lab		#			#	
Other	0.68	0.18–2.52	0.566	2.62	0.24–28.76	0.432
IHCA initial rhythm						
Ventricular fibrillation	Ref			Ref		
Ventricular tachycardia	0.54	0.24–1.21	0.133	0.53	0.16–1.79	0.306
Asystole	0.44	0.22–0.89	0.022	0.67	0.24–1.86	0.441
Pulseless electrical activity	0.19	0.10–0.36	<0.001	0.24	0.09–0.59	0.002
Other	0.38	0.16–0.89	0.025	0.93	0.22–3.96	0.919
Unknown		#			#	
Time of IHCA						
Morning (0700–1459)	Ref			Ref		
Evening (1500–2259)	1.05	0.63–1.74	0.850	1.71	0.80–3.66	0.167
Night (2300–0659)	0.75	0.45–1.27	0.288	1.43	0.62–3.31	0.402
Missing	1.28	0.11–14.41	0.842		^	
Protocol followed						
Yes	Ref			Ref		
No	0.76	0.38–1.52	0.438	0.90	0.34–2.42	0.842
Missing	0.88	0.45–1.71	0.698	1.42	0.38–5.30	0.606
Duration of Resuscitation (min) (+1 increase)	0.89	0.85–0.94	<0.001	0.90	0.86–0.95	<0.001
Year of arrest (+1 increase)	1.12	1.07–1.17	<0.001	1.05	0.98–1.13	0.146

All shaded rows have a p-value of <0.05. * — patients with missing data for a continuous variable were removed from the multivariate analysis. # — could not be calculated as all patients in this category survived. ^ — all cases with in this category were removed due to missing data in any of the continuous variables. OR: Odds ratio; 95% CI: 95% confidence interval for odds ratio; p: p-value; Ref, Reference Category; IHCA, In-hospital cardiac arrest; ROSC, return of spontaneous circulation.

age (HR = 1.04, p = 0.002) and duration of resuscitation (HR = 1.06, p = 0.005) increased there was a significant association with increased long-term mortality. VT was significantly associated with increased mortality when compared to VF (HR = 2.85, p = 0.014). Finally, arrests occurring on the Medical Ward (HR = 2.32, p = 0.027) were significantly associated with increased long-term mortality compared to those occurring in the Emergency Department.

Discussion

This study provides the first empirical evidence of short- and long-term survival outcomes following an IHCA in a regional hospital cohort. Additionally, it is one of the first to investigate multiple patient and arrest characteristics influencing survival at three distinct follow-up periods, providing important information for clinical quality improvement, decision-making and advance care planning initiatives. It indicates comparative survival rates with other IHCA studies.

Incidence

A 2016 systematic review of Australian and New Zealand IHCA found incidence of between 0.58 to 6.11 IHCAs per 1000 hospital admissions.[4] The studies reviewed covered periods from the 1990s up to 2012. The average annual incidence in our study cohort between 2000–2012, of 0.59/1000, was within the incidence range reported in the systematic review. This suggests, that despite being the first study conducted in a regional area the incidence of IHCA was similar to metropolitan areas.

Multiple hospital initiatives may have influenced incidence reduction over the study period, including the introduction of a Medical Emergency Team in 2005 to prevent arrests occurring, and the use of advance care planning (ACP) to identify patients who do not wish for cardio-pulmonary resuscitation (CPR).

Short-term survival

Survival of the event was 57% and survival to discharge was 34%, similar to the survival rates at these stages reported by the abovementioned systematic review of 46% and 25% using Australian data from metropolitan hospitals.[4] Two national registries based in United States and United Kingdom identified lower survival to discharge rates than this study of 24% and 18% respectively.[5,6] These differences suggest patients in regional settings may have better outcomes from IHCA than their metropolitan counterparts.

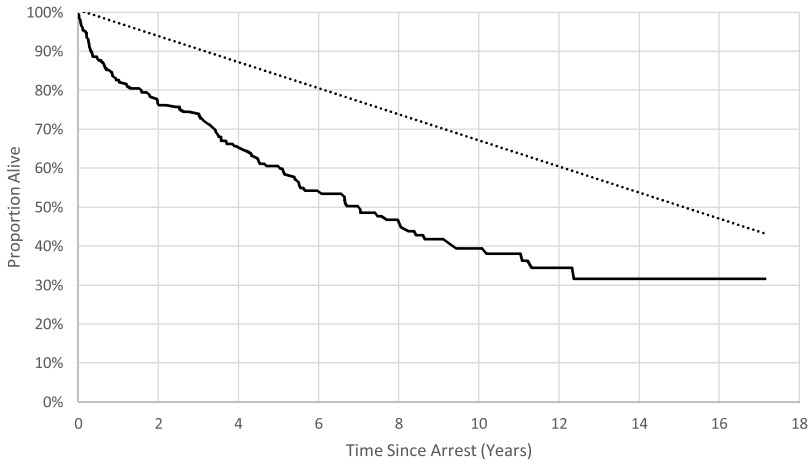

Fig. 2 – Kaplan Meier survival curve for survivors to hospital discharge (n = 204). The black line represents all patients that survived to hospital discharge that were residents of the study state, Victoria. All patients that were not present in the state death registry on the 31 January 2018 were censored on this date. The dotted black line is the standard Australian cohort matched on age, sex and year.

Table 4 – Univariate and multivariate cox regression for mortality beyond discharge.

	Univariate regression (n = 204)			Multivariate regression (n = 138*)		
	HR	95% CI	p	HR	95% CI	p
Sex						
Male	Ref			Ref		
Female	1.20	0.81–1.77	0.372	0.74	0.42–1.33	0.318
Age (years)	1.04	1.02–1.05	<0.001	1.04	1.01–1.06	0.002
IHCA location						
Emergency department	Ref			Ref		
Critical care	1.07	0.62–1.86	0.806	0.95	0.44–2.06	0.897
Medical ward	1.81	1.08–3.02	0.024	2.32	1.1–4.90	0.027
Surgical ward	2.28	1.02–5.09	0.044	2.72	0.90–8.17	0.075
Cardiac catheter lab	0.89	0.35–2.22	0.795	1.31	0.47–3.69	0.610
Other	1.54	0.48–4.98	0.469	2.55	0.65–9.97	0.179
IHCA initial rhythm						
Ventricular fibrillation	Ref			Ref		
Ventricular tachycardia	2.14	1.15–4.01	0.017	2.85	1.24–6.56	0.014
Asystole	1.58	0.96–2.95	0.072	1.64	0.77–3.50	0.200
Pulseless electrical activity	2.36	1.33–4.17	0.003	2.18	0.92–5.20	0.077
Other	1.62	0.72–3.64	0.247	0.80	0.24–2.62	0.714
Unknown	0.65	0.09–4.83	0.674		#	
Time of IHCA						
Morning (0700–1459)	Ref			Ref		
Evening (1500–2259)	0.38	0.78–1.94	0.377	1.26	0.66–2.39	0.479
Night (2300–0659)	1.31	0.80–2.15	0.289	1.30	0.62–2.73	0.487
Missing	1.87	0.45–7.75	0.387		^	
Protocol followed						
Yes	Ref			Ref		
No	0.54	0.25–1.18	0.124	0.56	0.23–1.40	0.216
Missing	1.25	0.63–2.49	0.991	1.05	0.34–3.20	0.933
Duration of Resuscitation (min) (+1 increase)	1.04	1.01–1.08	0.007	1.06	1.02–1.10	0.005
Year of arrest (+1 increase)	0.98	0.93–1.03	0.351	1.06	0.98–1.14	0.147

All shaded rows have a p-value of <0.05. * — patients with missing data for a continuous variable were removed from the multivariate analysis. # — could not be calculated as all patients in this category survived. ^ — all cases with in this category were removed due to missing data in any of the continuous variables. HR: Hazard ratio; 95% CI: 95% confidence interval for odds ratio; p: p-value; Ref: Reference category, IHCA; In-hospital cardiac arrest.

Many patient and arrest characteristics were related to short-term survival. For event survival specifically, a strong association was found between the IHCA occurring in the evening or night, and lower event survival, compared to morning shift events. This may relate to variation in hospital nurse-to-patient ratios (morning 1:4, evening 1:6 and night shift 1:8) which could influence the surveillance and assessment of patients. Due to this difference fewer IHCAs occurring in the evening and night shifts may be

witnessed, previously reported as associated with decreased survival.[19] This aligns with the finding that Medical Ward arrests were associated with the worst outcomes, an area that typically has lower levels of patient monitoring compared with the Emergency Department and Critical Care areas. Increasing patient monitoring and improving nurse–patient ratios on inpatient wards may improve immediate survival from IHCA. Unfortunately, whether the arrest was witnessed, or the patient had cardiac monitoring was not available for this study.

Arrests where clinical care departed from protocol were also associated with decreased event survival. Ornato et al. previously related certain errors in the management of cardiac arrest to decreased survival. These included medication errors and delay to defibrillation.[20] Future research could better record the nature of protocol non-adherence to determine how to intervene.

Arrests with a non-shockable rhythm were also strongly associated with worse event survival than those with a shockable rhythm; consistent with previous research.[10,14–18] In particular, asystole was associated with greater survival to, and beyond discharge than PEA, whereas previous research suggests asystole is associated with the worst survival of all rhythms.[15,17] Further work may be required to investigate the aetiologies of these rhythms for IHCA. Longer resuscitation duration was also related to a lower rate of survival to discharge. Whilst there was no specific protocol at the study hospital regarding cessation of resuscitation (due to futility), this may be an area for future quality improvement.

Long-term survival

For longer-term survival, our study provides follow-up over a period of up to 18 years, with a mean follow-up period of 5.0 years since arrest. The 1-year post-arrest survival rate was 27%, in-line with a range of 21.8–27.8% reported in the only other Australian study which assessed survival up to this point.[7] A recent meta-analysis of global IHCA studies found a pooled 1-year survival rate of 13.4%.[21] This meta-analysis included studies as early as 1985, which may explain some of the difference seen. We recognise that the long-term survival of our cohort was quite high, however, this was the first study of a regional cohort so there is no specific benchmark for comparison.

Patient co-morbidities and socio-economic indicators, as well as discharge locations may be important to include in future studies of regional patients. In particular, research about the propensity for regional patients to be transferred to other hospitals is important to pursue. Post-hoc examination of our data showed that 56% of survivors to discharge were transferred to another hospital. There are three main scenarios in which these transfers occur: first, lack of staffing coverage 24/7 for procedural units; second, if a patient requires intervention/s not available in the hospital; and finally, if the patient requested treatment closer to home, typically a smaller rural hospital applicable for recuperation or prolonged care. As such, survival to discharge requires further validation as a measure and may not be an appropriate metric for all IHCA studies, particularly in regional or rural settings, where discharge does not necessarily equate to ceasing in-patient care.

Better long-term survival prospects were associated with younger IHCA patients, particular rhythms (VF), shorter resuscitation durations and particular locations (ED). Greater attention could be paid to the older patient cohort in deciding who would be appropriate for a resuscitation attempt. This could be in the form of increased utilisation of advance care plans, which commonly preference against CPR.[22]

Our study has several limitations. Firstly, the VDR only records deaths that occur in one state (Victoria). If deaths occurred interstate they would not be linked in the study. However, based on the median age and likely poor health status of the cohort, we believe it unlikely that cohort members relocated to a different state.

A further limitation is the linkage process between our database and the registry does not have perfect accuracy. As such, some patients who survived to discharge and subsequently died may not have been identified due to this limitation. Unfortunately, it is not possible to quantify the impact of this as there is no method to determine if patients not matched with the registry were alive (and thus not present in it) or deceased and not successfully matched.

This study was based on a single large regional hospital cohort in Australia over a very long time period, so the generalisability of the results may be limited. As a single-centre study, the sample was restricted in size. Despite these limitations, our study includes a large cohort as the first study of IHCA survival in a regional setting. It provides a rich contextualised comparison against which other hospitals can measure IHCA outcomes.

Conclusion

This study of IHCA short and long-term survival in a regional hospital setting showed equivalent or marginally better outcomes to those reported in metropolitan settings. Key factors for consideration in clinical protocols to improve IHCA short- and long-term survival have been identified using linked databases. The study shows that survival is related to an interplay of patient and cardiac arrest characteristics. Further work is required to investigate the influence of patient co-morbidities and inter-hospital transfer pathways on long-term survival within regional hospital cohorts.

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