Resuscitation 124 (2018) 29–34

Contents lists available at ScienceDirect

Resuscitation

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

Clinical paper

Title: Trends in co-morbidities and survival for in-hospital cardiac arrest –A Swedish cohort study

Patrik Hjalmarsson[a], Mahta Memar[a], Sammy-Jo Geara[a], Mathilde Bouzereau[a], Anna Allberg[a], Abdelaziz Elgadi[a], Eva Piscator[a,b], Therese Djärv[a,b,*]

[a] Function of Emergency Medicine, Karolinska University Hospital, Stockholm, Sweden
[b] Center for Resuscitation Science, Department of Medicine Solna, Karolinska Institutet, Stockholm, Sweden

ARTICLE INFO

Article history:
Received 23 August 2017
Received in revised form
11 December 2017
Accepted 22 December 2017

Keywords:
Charlson co-morbidity index
Acci
30-day survival
Ihca

ABSTRACT

Objectives: Co-morbidities affect survival after in-hospital cardiac arrests (IHCA). The risk population for IHCA, i.e. the hospitalised patients, have a doubled increase in co-morbidities over time. A similar increase in co-morbidities among IHCAs might explain the relatively poor survival ratios despite improved care.
Aim: To assess changes in the burden of baseline age-adjusted Charlson co-morbidity index (ACCI) scores among IHCAs as well as to assess its impact on survival in three time periods.
Material and methods: All patients ≥18 years suffering an IHCA at Karolinska University Hospital between 1st January 2007 and 31st December 2015 were included. Data regarding the IHCA, patient characteristics, ACCI and 30 day survival were obtained from electronic patient records. Parameters included in ACCI were assessed as ICD-10 codes in the medical file at admission to hospital. The median ACCI with interquartile range (IQR) was presented per year. ACCI was categorised into low 0–2points, moderate 3–5points, high 6–8 points and very high ≥9 points. Differences in survival between 2007 and 2009 and 2010–2012 as well as 2013–2015 were stratified per ACCI category and assessed with adjusted logistic regression models and presented as Odds Ratios with 95% Confidence Intervals (OR, 95% CI). Adjustments included hospital site, sex, first rhythm, ECG-surveillance, witnessed or not, and location of the IHCA.
Results: In all, 1373 patients suffered an IHCA, of whom 376 (27%) survived at least 30 days. The ACCI remained almost constant over time at median 4, IQR 3–6. Patients with low or moderate ACCI more than doubled their survival in 2013–2015 compared to 2007–2009 (adjusted OR 2.61 95% CI1.38–4.94 and OR 1.87 95% CI 1.14–3.09 respectively).
Conclusion: This cohort study illuminates an almost constant burden of co-morbidities over time among patients suffering an IHCA. Further, the study highlights that 30-day survival has almost doubled from 2007 to 2009 to 2013–2015 among those with low to moderate *Acc*I.

Introduction

About one third of all cardiac arrests in Sweden occur in hospitals [1,2]. Population-based registries show that for in-hospital cardiac arrests (IHCA) several links in the chain of survival are already optimised, i.e. the majority of IHCAs occur under ECG-surveillance, are witnessed, receive CPR within one minute and are defibrillated within 3 min [1,2]. Still, survival ratios are relatively low despite continuous improvements in guidelines pre-, intra and postarrest [3].

Within this decade, the population at risk for an IHCA, i.e. the hospitalised patient population, has shown a significant increase in both age and multimorbidity[4]. Interestingly, burden of age and co-morbidity have previously been shown to be associated with survival ratios after IHCA [5,6], and an increase similar to the hospitalised population might at least partly explain a lack of increase in survival ratios among IHCAs. However, a similar increase in burden of age and co-morbidities among the IHCAs is not self-evident since both factors are common for clinicians to assess when discussing Do-Not-Attempt-Resuscitation (DNAR) orders [7]. Since resuscitation attempts occur in only a minority of hospitalised patients dying [8], the population suffering an IHCA is highly selected and therefore differ from the background population at risk. Evidence supporting DNAR orders are important to continuously scrutinise and update with accurate prognostic information

* Corresponding author at: Function of Emergency Medicine, Karolinska University Hospital, Stockholm, Sweden.
E-mail address: therese.djarv@ki.se (T. Djärv).

https://doi.org/10.1016/j.resuscitation.2017.12.025
0300-9572/

for co-morbidities [9,10]. Therefore, we conducted a cohort study with the aim of assessing the burden of age-adjusted Charlson co-morbidity index (*Acc*I) scores before an IHCA over three time periods as well as its association with 30-day survival.

Method

Study design and settings

This cohort study took place at Karolinska University Hospital (Karolinska) between 1st January 2007 and 31st December 2015. Karolinska, in Stockholm, home to approximately 2,000.000 people, is one of five large hospitals. Karolinska has two sites 30 km apart, Solna and Huddinge. The Solna site hosts about 750 beds and is a level one trauma unit, has neuro and thoracic surgery units and provides 24/7 angiography for ST-elevation myocardial infarctions. The Huddinge site also hosts about 750 beds and includes a geriatric ward and relatively fewer intensive care unit (ICU) beds. Karolinska as a whole has about 108 000 admissions yearly and 1.8 million patient visits. Karolinska follows Swedish guidelines for resuscitation based on European Resuscitation Councils guidelines.

Ethics

This study used a database and registry: all survivors are informed about their participation at 6 months after their IHCA and can at any time afterwards withdraw their inclusion in the registry. Since the start of the registry in 1990 only a handful of patients have withdrawn their participation. Non-survivors are included without informed consent. Further, by accepting care at Karolinska, patients are informed where they can find information about ongoing studies including withdrawal of participation. The Regional Ethical Review Board in Stockholm, Sweden approved the study, Dnr 2013/1959-31/4.

Participants

All cases of IHCA among adults, i.e. patients aged at least 18 years, occurring between January 1st 2007 and December 31th 2015 were eligible for inclusion in the study and were identified through the hospital's cardiac arrest report sheet. Karolinska participates in the Swedish Registry for Cardio-Pulmonary Resuscitation (SRCR) [1,11] which collects data according to Utstein [12], and the SRCRs definition of IHCA was used in the current study, i.e. a hospitalised patient who is unresponsive with apnoea (or agonal, gasping respiration) where CPR and/or defibrillation have been initiated. No patients or location of the IHCA were excluded. In the case of multiple IHCAs, only the first event was included.

Age-adjusted charlson Co-morbidity index

The *Acc*I is a weighted score of co-morbidities based on the relative risk of one-year mortality that has been used in IHCAs [5,13]. The concept of the *Acc*I was developed in 1984 and has since then been used and cited in over 5500 articles in various subgroups and therefore stated as the most feasible and used measure of the burden of co-morbidities within research [14]. The latest version is from 2011 [15] and includes 12 groups of diagnoses defined as specified International Classification of Diseases (ICD-10) codes. In total the patients can have 0–26 points due to co-morbidities and additional scores based on age as follows; 1 point per decade over 40 years up to 4 points for those aged at least 80 years.

Data collection and categorisation

Patients were identified through the hospital's cardiac arrest report sheet, where data on the following variables were collected: sex, age (collected in years, categorised in 10-year intervals according to ACCI[5] starting at 18–50, 51–60 and further on to >81 years), location of IHCA (general ward, intermediate care unit, intensive care unit (ICU), angio lab/operation theatre or other area including emergency department and radiology department), and first documented heart rhythm (VT/VF or PEA/asystole). Thereafter by entering the hospital's electronic patient record (Take Care version 14.2.9) information on co-morbidities was gathered based on ICD-10 codes available at least at admission to the hospital and assessed according to the *Acc*I [13,14] and categorised into "*Low burden of age-combined co-morbidities*" if the *Acc*I was 0–2 points, "*Moderate burden of age-combined co-morbidities*" if the *Acc*I was 3–5 points, "*High burden of age-combined co-morbidities*" if the *Acc*I was 6–8 points or "*Very high burden of age-combined co-morbidities*" if receiving at least 9 points. Information on the outcome, i.e. 30-day survival (yes or no) was retrieved through the electronic patient record which is linked to the Swedish total population registry and automatically updated within a maximum delay of three days, which enables a complete follow-up [16]. Year of the IHCA was categorised into three time periods (2007–2009, 2010–2012 and 2013–2015).

Statistical analyses

Characteristics of patients surviving at least 30 days and those who were deceased were compared using the two-sided Chi[2] test and a *p*-value of $\leq$0.05 was interpreted as statistically significant. Missing data fields were not excluded or imputed. Distribution of *Acc*I over the year was presented as median score with interquartile range (IQR) as well as interdecile range (IDR). Survival ratios per *Acc*I point were presented per time period. In order to assess an increased 30-day survival over time, logistic regression models were used to estimate the association between the first time period, i.e. 2007–2009, versus later time periods, i.e. 2010–2012 and 2013–2015. Data was stratified per *Acc*I category and expressed as odds ratios (OR) with 95% confidence intervals (95% CI) with adjustment a priori decided and for known confounders: 1) sex, 2) witnessed 3) ECG-surveillance 4) first documented heart rhythm, 5) location of IHCA, and 4) hospital site. All analyses were performed with the statistical package STATA 10.2 for Windows (STATA Corp, College Station, TX).

Results

Study participants

In all, 1373 patients suffered an IHCA at Karolinska during 2007–2015 and the overall 30-day survival ratio was 27%. There was no difference between the sexes regarding survival (Table 1). Two thirds of survivors were aged below 70 years while two thirds of the deceased patients were aged above 71 years (p-value < 0.01). Regarding burden of co-morbidities, 86% of the survivors had a low or moderate *Acc*I while 43% of the deceased patients had a high or very high *Acc*I prior to the IHCA (Table 1, p-value < 0.01).

In terms of the location of the IHCA, nearly half of the deceased patients suffered their IHCA in a general ward while survivors were more scattered. The majority of survivors were under ECG-surveillance while the majority of the deceased were not. Regarding the first documented heart rhythm, survivors had shockable rhythm, i.e. VT/VF, equally often as they had non-shockable rhythm,