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One-year mortality of patients admitted to the intensive care unit after in-hospital cardiac arrest: a retrospective study

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ABSTRACT

Purpose: Little is known about long-term survival after In-Hospital Cardiac Arrest (IHCA). The purpose of this study is to report the one-year survival of patients after IHCA and to identify predicting factors.
Methods: Single-center retrospective study of all adult in-hospital CPR attempts conducted between 2003 and 2014 in a tertiary teaching hospital. Demographic and clinical variables of patients were obtained at 24 h pre-arrest, during CPR and post-CPR. All patients were tracked one year after discharge from hospital.
Results: CPR was performed for IHCA on 417 patients. Return of spontaneous circulation (ROSC) was achieved in 283 (68%) patients, 234 were admitted to ICU. Overall, 95 (23%) patients survived one year after discharge, The survival rate of patients who were admitted to ICU after IHCA was 38% (89/234) at hospital discharge and 26% (61/234) at one year. Univariate analysis showed numerous variables are associated with one-year survival, for example comorbidity index and time to ROSC.
Discussion: One-year survival of patients admitted to the ICU after IHCA was 26%. Severity of disease pre-arrest and at ICU-admission could prove useful in prognostication. No multivariate model could be constructed and large prospective studies are needed to elicit the role of pre-arrest factors on survival.

1. Background

In-hospital cardiac arrest (IHCA) is one of the major adverse events in hospitalized patients, with a reported incidence of 1 to 5 per 1000 admissions [1-4]. For a patient to regain a sufficient circulation, or return of spontaneous circulation (ROSC), cardiopulmonary resuscitation (CPR) can be attempted according to life support guidelines [5,6]. Patients with ROSC are most often transferred to an intensive care unit (ICU) for additional treatment.

The survival to discharge of patients after IHCA is currently 18–27% [4,7,8], compared with studies performed in the 1980s and 1990s which showed a 15% survival rate [9,10]. A limited number of studies have reported the long-term outcome, in which the one-year survival of patients who were discharged alive varied between 59% and 86% [1,11-23]. When considering the trend of survival rates, survival to discharge shows improvement in time, whereas long-term survival remains nearly unchanged [1-23].

Only a few patient factors have been found to be associated with one-year survival, e.g., lower age [20,22] and the level of patient monitoring [20]. An initial arrest rhythm of ventricular fibrillation (VF) or ventricular tachycardia (VT) is associated with a higher one-year survival [4,21,22]. The prediction of survival is preferably based on pre-arrest variables such as age and type of admission. Co-morbid disease can also be a relevant factor because it has been shown to influence 30-day survival[35] Evidence however is still conflicting regarding the role of comorbidity and age and its interactions [22,23,35]. Other factors that could affect one-year survival include post-arrest factors such as ICU treatment, subsequent complications and neurologic status upon discharge. One-year survival has been shown to be lower among the

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group of patients discharged with neurologic impairment, defined as severe disability or coma [16,22]. This is 10–20% of the patients in younger cohorts [1,4,14,15] and up to 56% in older cohorts [22,23].

These data indicate that the likelihood of survival after IHCA is still low and little is known about its contributing factors. The objectives of this study were to obtain information on the one-year survival of patients admitted to the ICU after IHCA in the last 10 years and to identify possible predictors of one-year survival. Within the IHCA population, we assessed the mortality of the entire cohort and of patients not admitted to the ICU separately. Secondly we made a comparison to survival in the general population. The results from this retrospective study will aid in the design of a prospective cohort study.

2. Methods

2.1. Setting

This retrospective chart study of patients with IHCA was performed between January 6, 2003 and February 6, 2014. This study was conducted at the Onze Lieve Vrouwe Gasthuis (OLVG) hospital in Amsterdam, The Netherlands, a tertiary teaching hospital with 555 beds, including 24 mixed ICU beds. An average of 26,022 patients per year are admitted and hospitalized for a mean duration of 5.0 days. The ICU has 1646 admissions per year, with an average length of stay (LOS) of 4.1 days per admission. In 2009 a rapid response system was introduced using a set of vital parameters to identify patients at risk for adverse events, including IHCA. Initial response was done by a physician on the ward, who could ask for intervention of the intensivist. All patients with an IHCA were screened for inclusion in this retrospective analysis. Patients were excluded if no CPR had been performed defined by lack of chest compressions. We excluded children (<18 years) and patients in whom OHCA had occurred the same day and in whom IHCA was clearly of the same etiology. Additional exclusion criteria were IHCA in the operating theatre (OR), emergency department (ER) or ICU. Although part of the Utstein definition of IHCA [5], data control in these patient groups are poor, as many reanimations in these departments are short, only consist of defibrillation without performing CPR, CPR is giving shortly for low circulation status (instead of no circulation) and most of the times the ALS team is not called in for support.

2.2. Resuscitation calls

In the event of cardiac arrest, the ward nurse calls a central number, which dispatches the resuscitation team. This team is available 24/7 and consists of an intensivist, an emergency physician, a cardiologist, an emergency department nurse and a cardiac care nurse. Patients with ROSC admitted to the coronary care unit (CCU) or thoracic surgery high care unit and in whom a cardiac etiology was suspected, could remain in these departments after evaluation by the on-call intensivist. The decision to not transport a patient to ICU is mainly influenced by time to ROSC, initial post-arrest Glasgow Coma Scale (GCS) and hemodynamic stability. All other patients were transported to ICU. All the resuscitation calls were documented in Metavision Patient Data Management System (PDMS) v5.45.64 (iMDsoft, Needham, MA, USA), and each record was individually checked for validity.

2.3. Outcome

The primary outcome was one-year survival. Secondary outcome measures were initial survival, ICU-survival, survival to discharge and factors that could predict one-year survival. Initial survival was defined as a patient who had ROSC after the IHCA arrest and did not have an unfavorable prognosis that led to death within 24 h after the initial arrest. The death dates were obtained from the Dutch municipal records system, which registers each death and links it to a national database. The patients were considered to have died post discharge if the date of death was 1 day or more after the date of discharge, allowing for a delay in registration or incorrect registration. The likelihood of one-year survival for post-CPR patients was compared to the likelihood of survival in the general population, for whom survival statistics were provided by the Dutch National Statistics Agency(CBS).

2.4. Data collection

The demographic and clinical variables collected included age, sex, the medical specialty for which a patient was admitted, type of ward (i.e. monitored or non-monitored), first documented cardiac rhythm and outcome of CPR. The clinical data on patients admitted to the ICU were gathered at three time points: 24 h before cardiac arrest, at the time of ICU admission and upon discharge from the ICU. Such data was not fully available for patients not transferred to ICU. To ensure data completeness we only investigated predictive factors for patients after IHCA who were transferred to ICU. The pre-arrest Charlson Comorbidity Index (CCI) to compare comorbidities was retrospectively calculated by the authors (MS, HE) using the medical records of the patients. This score is a measure for the burden of comorbidities and most commonly used in comparative research [29]. Using CCI and stratifications of age an Age-combined Charlson Comorbidity Index (ACCI) was calculated. This score has been used in prior research to combine comorbidity and age in prognostication of outcome [29,35]. Although an updated version is available we used the version of [29] for comparison to other studies [29,35,36]. The calculation of this score is summarized in Table 1.

2.5. Statistical analyses

Dichotomous variables were analyzed using crosstabs and χ^2 tests with continuity correction or Fisher's exact test. The Mann-Whitney-U test was used to assess difference of continuous data. Age stratification per decade was performed to assess differences in age groups. All of the statistical analyses were performed using the SPSS statistics processor v18 (IBM corp., Chicago, IL, USA).

2.6. Ethical considerations

The study protocol was approved by the local medical ethics board which granted a waiver for informed consent on account of its non-interventional design. This study was registered as WO 14.006.

3. Results

A total of 417 patients underwent a CPR attempt for an IHCA during the study period. Table 2 displays baseline characteristics. The median age was 70 years (IQR, 62–79), and 261 (61%) were male. Of all patients, 183 (44%) had initially been admitted to the department of cardiology and 119 (29%) to another non-surgical specialty; 263 (63%) were in a non-monitored nursing ward at the time of cardiac arrest. The initial arrest rhythm was pulseless electrical activity in 197 (47%) of these 417 patients, followed by asystole in 91 (22%). Shockable rhythms (VF/VT) comprised 86 (21%) patients.

3.1. Initial IHCA survivors

As shown in Fig. 1, a total of 283 (68%) patients survived the initial arrest (i.e., initial IHCA survivors). Characteristics of these initial IHCA survivors versus non-survivors are summarized in Table 2. A shockable rhythm was the only statistically significant univariate predictor of initial survival of CPR (ROSC) (87% survival vs. 65% survival for non-shockable rhythms; $p < .001$).