Original

Crit Care & Shock (2008) 11 : 54-60

Predictors of Survival in Resuscitation

Glorimar Santos-Llanos, Graciela Latalladi-Ortega, Ángel Galera-Santiago, Alfonso Torres-Palacios, William Rodríguez-Cintrón

Abstract

***Objective*: Study the survival-to-hospital discharge rate for veterans who underwent Advanced Cardiac Life Support (ACLS) and reach a better understanding of the variables that influence their survival after cardiac arrest. To aid in developing strategies directed towards decreasing the risks related to the event.**

***Design*: A retrospective record review of advanced resuscitative attempts during the period of January 1st to December 31st, 2006.**

***Setting*: VA Caribbean Health Care System, San Juan.**

***Patients*: Veterans admitted during the study period who suffered cardiac arrest.**

***Measurements*: Patient's age, sex, diagnosis, initial rhythm, location, time of event and duration of the resuscitation efforts (downtime), were collected.**

***Main results*: There were 128 arrests documented during the study period: 122 (95%) were in-hospital events and 6 involved patients brought to the emergency department during the course of resuscitation. The mean age was 72 years and 98% were males; most events occurred at general medical/surgical wards (61%). Events were mostly of cardiac origin (82.78%), with asystole (AS) and pulseless electrical activity (PEA) being the most common initial rhythms (61%). The most frequent pre-arrest diagnoses were sepsis, community-acquired pneumonia, renal failure and malignancy. Survival-to-hospital discharge was 7.38%; most survivors suffered primarily respiratory arrests while at the general wards. Arrest events were evenly distributed throughout the 24-hour day, and the average downtime in survivors was lower than in non-survivors (12 vs. 22.35 mins respectively, p=0.03).**

***Conclusions*: We found a substantially lower survival rate for in-hospital cardiac arrests than has been previously reported. Possible explanations for this phenomenon include the high incidence of arrhythmias associated with poor outcome (AS, PEA), the frequency of unwitnessed events occurring in general wards, patient's age and underlying diagnoses. Measures for the timely identification of admitted patients who are at risk for poor resuscitative outcomes with these characteristics should be instituted.**

Key words: Resuscitation, survival, ICU, cardiac arrest, veterans.

From San Juan Municipal Hospital (Dr. Glorimar Santos-Llanos), VA Caribbean Health Care System, San Juan, Puerto Rico (Drs. Graciela Latalladi-Ortega, Ángel Galera-Santiago, Alfonso Torres-Palacios, William Rodríguez-Cintrón)

Address for correspondence:
William Rodríguez-Cintrón, MD
Pulmonary/Critical Care Medicine Section
San Juan Veterans Affairs Medical Center
10 Casia St, San Juan PR 00921-3201
Tel: +1-787-641-2970
Fax: +1-787-641-9541
Email: william.rodriguez@va.gov

Introduction

Cardiac arrest has been defined as "the cessation of cardiac mechanical activity confirmed by the absence of a detectable pulse, unresponsiveness and apnea (or agonal respirations)" [1]. The incidence of cardiac arrest in hospitalized patients varies among studies, but is reported to be in the range of 1 to 5 arrests per 1000 patient admissions [2]. The survival-to-hospital

discharge rate after cardiac arrest has been recently reported to be approximately 20%, with published data showing a range between 0% to 42% mainly due to differences in disease severity and the definitions applied.

The Veterans Administration Health Care System (VA) provides an integrated, uniform medical and social support service to the American veteran population throughout the US and its territories. It is the largest comprehensive medical care system in the Western hemisphere. Males represent 94% of the population and 36% are over 65 years of age [3], thus comprising mostly geriatric patients. The VA Caribbean Health Care System Hospital – San Juan cares for 146,001 veterans, 41% being older than 65 years of age. Our hospital is unique among VA facilities because of its larger population of "older" adults (>75 years of age), their higher average number of medical comorbidities and the fact that most of our patients fall under the category of medically indigent. All of these are well-recognized risk factors for higher in-hospital mortality.

We hypothesized that the survival-to-hospital discharge rate of veterans undergoing Advanced Cardiac Life Support (ACLS) at our institution is lower than that previously reported in the literature, mainly due to older population and comorbid conditions.

We believe the information gathered through this investigation will allow us a better understanding of the variables that shape the survival of our veterans after cardiac arrest. Our results may assists in the development of strategies directed towards decreasing the risks related to the occurrence of in-hospital cardiac arrests. Lastly, we expect our data will provide physicians, nurses and families with more information upon which to decide in what situations resuscitative efforts would be most beneficial for the patients.

Materials and methods

The Institutional Review Board approved the study. We performed a retrospective review of advanced resuscitative attempts at the VA Caribbean Health Care System during the period of January 1st to December 31st, 2006. Hospital policy requires that a specific document be filled for every cardiac arrest event; the form includes information such as the victim's age, sex, primary diagnosis, ward location, who recognized the event, time of event, type of arrest, initial rhythm, outcome and downtime and medications administered. Two copies of this form are made, one for the patient's record and another one that is filled at the Department of Nursing Services. A data collection sheet including all of these recorded elements was created to tally the information while ensuring information security to protect patient privacy. Most of the data was reported as descriptive statistics. Statistical comparisons for different time periods were done using the Chi-square test and the Student's t-test. A p value of 0.05 was required for statistical significance.

Results

We identified 128 documented arrests during the study period: 122 (95%) were in-hospital events and 6 (5%) involved patients brought to the emergency department. **Table 1** shows the demographic information, location and time of events and the identified rhythms. The population's mean age was 72 years and 98.3% were males. Most cardiac arrests occurred at general medical/surgical wards (61%); of these, 71 (58%) occurred in the medical ward and 39% in the intensive care unit. The types of arrests were mostly of cardiac origin 83% and 17% of respiratory origin. The most common initial rhythm for cardiac arrest events were AS and PEA representing a 61%. The most common pre-arrest diagnosis were sepsis, community acquired pneumonia and malignancy.

The survival to discharge rate was 7.38%; most survivors suffered cardiac arrest of primarily respiratory origin while at the general wards. As shown in **Figure 1**, patients who underwent cardiac arrest during the 15:01-23:00 hour interval had a highest survival rate than patients during the 23:01-7:00, although the difference did not reach statistical significance ($p = 0.06$). The downtime among survivors was less than in non-survivors, 12 mins vs. 22.35 mins respectively ($p = 0.03$).

Although arrests occurred almost evenly throughout the 24 hour period, we did find two peaks of higher frequency of events: from 4:00 to 8:00 hrs and from 13:00 to 17:00 hrs (**Figure 2**), with a higher survival during these peaks as well, but not statistically significant (p =0.344).

Discussion

Survival after cardiac arrest is related to several factors that can be divided into two groups: patient and event variables. Patient variables include age, gender, race and comorbid conditions. There have been conflicting results regarding the effect of age on survival mainly due to differences in study designs; many studies have included both adult and pediatric populations [4,5,6]. Other studies have further separated young and old adults based on arbitrary ages. Nevertheless, there is general consensus that survival is decreased in older patients, and that children have a higher survival rate [7,8]. This statement considers that the predominant form of cardiac arrest in children is of respiratory origin [7], as well as the fact that coronary artery disease is unlikely in this age group. The patients in the study would be categorized as older adults, and survival in the group was low in accordance with prior studies [7,8].

Only two females had cardiac arrests during the study period and neither survived, their rhythms were bradycardia and AS respectively. A study from 2001 which evaluated gender influences on survival after cardiac arrest [9] noted that although women were less frequently found in ventricular tachycardia (VT) or fibrillation (VF) at the time of cardiac arrest they had a better chance for survival [10,11]. Comorbid conditions such as sepsis, metastatic cancer, renal failure and stroke have all been associated with poor outcomes after cardiac arrest [12]. These were the most common diagnoses found in the population studied and could explain the poor outcome observed.

Considering event variables, the documented initial rhythm is a well established predictor of survival [13]. VT/VF has been consistently identified as the rhythm associated with the best outcome [5,13]. However, VT/VF is identified in only 20-35% of in-hospital cardiac arrest victims [14]. We were able to identify this rhythm in only 12% of our patients, a much lower frequency than previously reported. AS and PEA were the rhythms most frequently identified (48.36%), and both are known to be associated with decreased survival [15]. PEA and AS are likely to result from the degeneration of an unidentified episode of VT/VF, signaling that a considerable time elapsed between the onset of the arrhythmia and the time the patient is found in cardiac arrest. Documentation of the initial rhythm at the time of arrest was not available for 21% of our population, evidencing the need for improved documentation of events.

The duration of the resuscitation efforts (commonly known as "downtime" and measured from the initiation of ACLS to the recovery of a perfusing rhythm), the patient's location at the time of arrest and whether they are witnessed or unwitnessed arrests are other variables known to have an impact on outcome [16]. In our study the average downtime of survivors was significantly lower than that observed in non-survivors (12 vs. 22 mins, p =0.03). Duration of the resuscitative effort is a known determinant of the likelihood of survival; in other words, the longer a resuscitation effort goes on for, the lesser the meaningful recovery of the victim. In a patient with a prolonged downtime the favorable outcome would be reduced based on the known fact that neuronal cell death starts after 4 to 6 minutes of hypoxia and survival is believed to be affected by it. Moreover, there is a tendency among ACLS providers to stop resuscitative efforts after an average of 20 minutes in victims of in-hospital cardiac arrests; more prolonged efforts may produce less survivors as the resuscitation itself become a self-fulfilling prophecy scenario.

Although it is believed that a patient being monitored in an intensive care unit (ICU) has a better chance for survival than a patient located in a general medical/ surgical ward, where timely identification of the event may be difficult, we found that patients whose arrest occurred in a general ward had a better survival. The type of arrests, being mostly of respiratory origin, and the lower severity of illness of ward patients when

compared to ICU patients could explain these findings. The presence of ICU nurses trained in the provision of ACLS is an additional factor affecting patient outcome [17]. In our institution the nursing staff that provides ACLS is formally trained and is an integral part of the "code team". Such team though, is located at the intensive care unit of the institution, and timely arrival to the site of the event needs to be considered.

The actual time of the day at the onset of cardiac arrest may influence outcome. In 2002, Brindley et al [14] found that patients who suffer cardiac arrest during the day are almost twice more likely to survive than patients whose events occurred at night [18]. Although availability of trained personnel, witnessing of the event and other factors may very well explain this finding, other studies failed to demonstrate such relationship [15,19]. We were able to show two peaks for frequency of events (4-8 hr and 13-17 hr) during the 24 hour period, but the time of arrests in our patients held no statistically significant impact in survival. Interestingly, we were able to demonstrate that the survival rate outside these two peaks was reduced. Definitive reasons for the observed trend could be related to factors previously described.

Even though many studies report survival-to-hospital discharge as the main measured outcome, the neurological recovery of these patients is of utmost importance since the goal of resuscitation is "to reverse premature death, not prolong inevitable one" [20]. We were not able to measure the neurological recovery due to the retrospective nature of the study, which will clearly require further study.

Our population had a lower survival rate after cardiac arrest, which we believe is a consequence of being older and with many comorbid conditions that are known to be associated with poor outcome. Measures for the timely identification of admitted patients who are at risk for poor resuscitative outcomes with these characteristics should be instituted. Also, the adequacy of the resuscitative effort should be reviewed after each event to improve the competence of ACLS providers. Additional studies will allow us to better inform patients and their relatives regarding survival after cardiac arrests, in order to improve their decision-making processes involving life-supportive measures.

Acknowledgment

No affiliations with organizations with financial interest and no conflicts of interest were involved in this study. Supported by: Sociedad de Investigación Científica, Inc. (SODEINC), PO Box 33060, Veterans Plaza Station, San Juan, PR 00933-0060

Table 1. PATIENT CHARACTERISTICS

Age	
<51	4 (3.27%)
51-60	15 (12.29%)
61-70	20 (16.39%)
71-80	56 (45.90%)
> 80	27 (22.13%)
Sex	
Male	120 (98.36%)
Female	2 (1.64%)
Location	
Intensive Care Unit	47 (38.52%)
General Ward	75 (61.47%)
Medical	71
Surgical	4
Time of arrest	
07:01 - 15:00	44 (36.06%)
15:01 - 23:00	37 (30.32%)
23:01 - 07:00	41 (33.60%)
Type of arrest	
Respiratory	21 (17.21%)
Cardiac	101 (82.78%)
Asystole	59 (48.36%)
Pulseless electrical activity	16 (13.11%)
Ventricular fibrillation/tachycardia	15 (12.30%)
Bradycardia	4 (3.28%)
Complete AV block	2 (1.64%)
Unknown	26 (21.31%)

Figure 1. SURVIVAL TO DISCHARGE RATE AFTER CARDIAC ARREST BY TIME SHIFTS

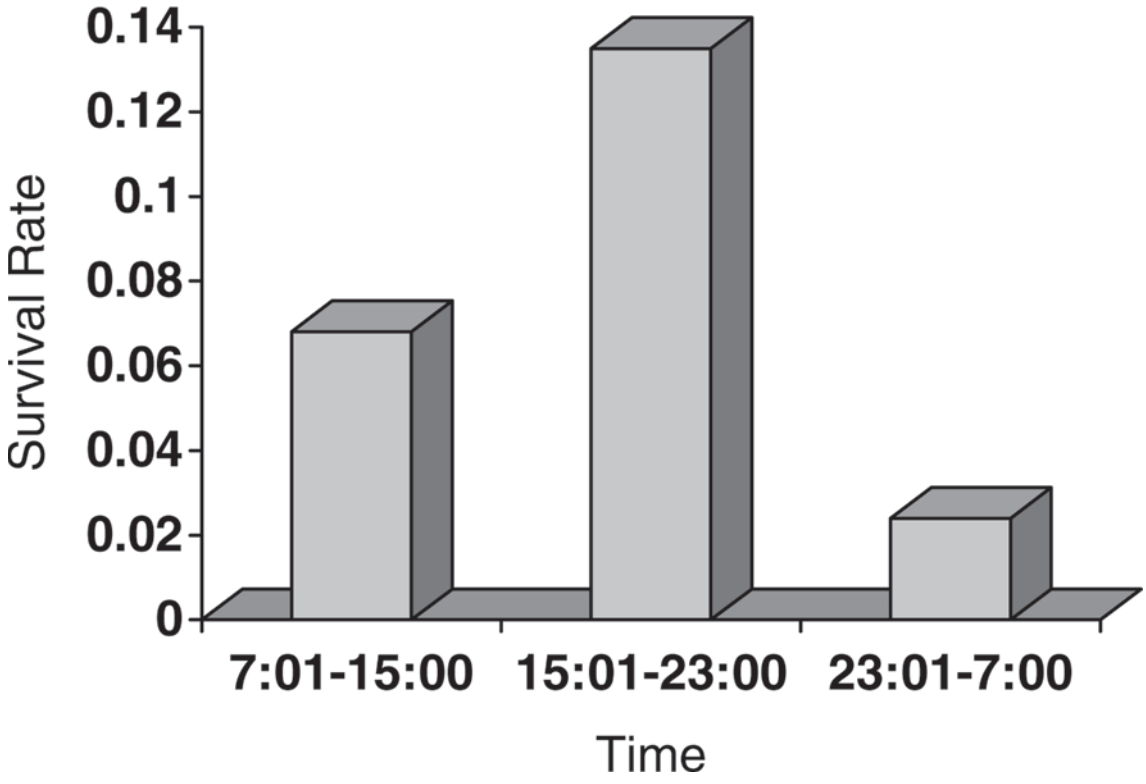
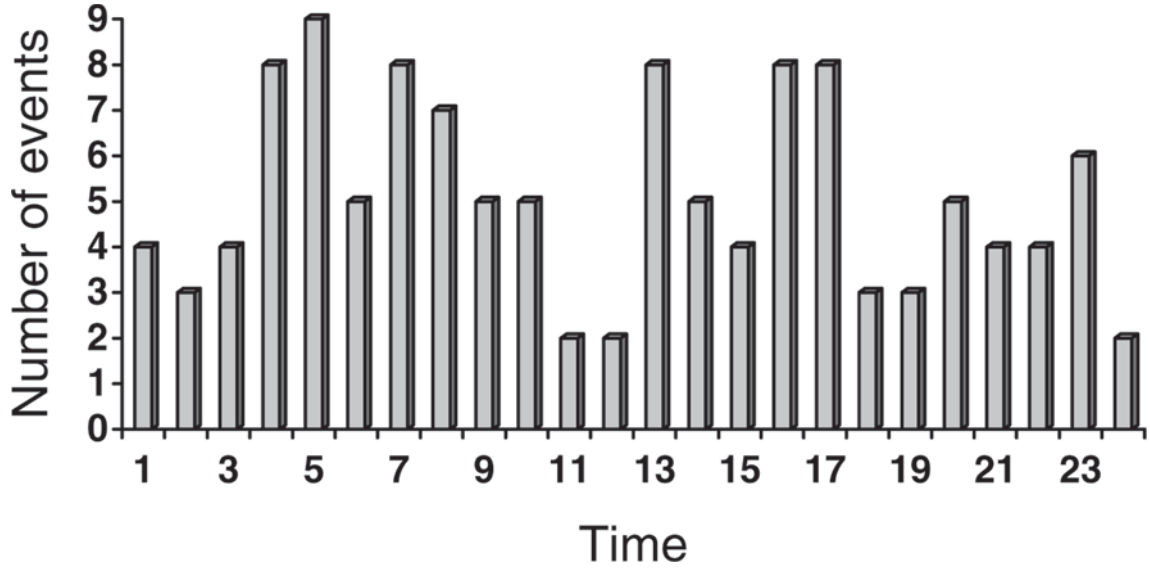


Figure 2. NUMBER OF ARREST EVENTS OVER THE 24 HOUR PERIOD OF THE DAY



References

1. Cummins RO, Chamberlain D, Hazinski MF, Nadkarni V, Kloeck W, Kramer E, Becker L, Robertson C, Koster R, Zaritsky A, Bossaert L, Ornato JP, Callanan V, Allen M, Steen P, Connolly B, Sanders A, Idris A, Cobbe S (1997) Recommended guidelines for reviewing, reporting, and conducting research on in-hospital resuscitation: the in-hospital 'Utstein style'. American Heart Association. Ann Emerg Med 29:650-679
2. Sandroni C, Ferrero G, Santangelo S, Tortora F, Mistura L, Cavallaro F, Caricato A, Antonelli M (2004) In-hospital cardiac arrest: survival depends mainly on the effectiveness of the emergency response. Resuscitation 62:291-297
3. Census 2000 Veteran Data. Available online at: http://www1.va.gov/vetdata/page.cfm?pg=1
4. Swor RA, Jackson RE, Tintinalli JE, Pirrallo RG (2000) Does advanced age matter in outcomes after out-of-hospital cardiac arrest in community-dwelling adults? Acad Emerg Med 7:762-768
5. Parish DC, Dane FC, Montgomery M, Wynn LJ, Durham MD (1999) Resuscitation in the hospital: differential relationships between age and survival across rhythms. Crit Care Med 27:2137-2141
6. Skrifvars MB, Rosenberg PH, Finne P, Halonen S, Hautamäki R, Kuosa R, Niemelä H, Castrén M (2003) Evaluation of the in-hospital Utstein template in cardiopulmonary resuscitation in secondary hospitals. Resuscitation 56:275-282
7. Nadkarni VM, Larkin GL, Peberdy MA, Carey SM, Kaye W, Mancini ME, Nichol G, Lane-Truitt T, Potts J, Ornato JP, Berg RA; National Registry of Cardiopulmonary Resuscitation Investigators (2006) First documented rhythm and clinical outcomes from in-hospital cardiac arrest among children and adults. JAMA 295:50-57
8. Di Bari M, Chiarlone M, Fumagalli S, Boncinelli L, Tarantini F, Ungar A, Marini M, Masotti G, Marchionni N (2000) Cardiopulmonary resuscitation of older, inhospital patients: immediate efficacy and long-term outcome. Crit Care Med 28:2320-2325
9. Herlitz J, Rundqvist S, Bång A, Aune S, Lundström G, Ekström L, Lindkvist J (2001) Is there a difference between women and men in characteristics and outcome after in hospital cardiac arrest? Resuscitation 49:15-23
10. Herlitz J, Engdahl J, Svensson L, Young M, Angquist K, Holmberg S (2004) Is female sex associated with increased survival after out-of-hospital cardiac arrest? Resuscitation 60:197-203
11. Arrich J, Sterz F, Fleischhackl R, Uray T, Losert H, Kliegel A, Wandaller C, Köhler K, Laggner AN (2006) Gender modifies the influence of age on outcome after successfully resuscitated cardiac arrest: a retrospective cohort study. Medicine (Baltimore) 85:288-294
12. O'Keefe S, Ebell MH (1994) Prediction of failure to survive following in-hospital cardiopulmonary resuscitation: comparison of two predictive instruments. Resuscitation 28:21-25
13. Weil MH, Fries M (2005) In-hospital cardiac arrest. Crit Care Med 33:2825-2830
14. Brindley PG, Markland DM, Mayers I, Kutsogiannis DJ (2002) Predictors of survival following in-hospital adult cardiopulmonary resuscitation. CMAJ 167:343-348
15. Sandroni C, Nolan J, Cavallaro F, Antonelli M (2007) In-hospital cardiac arrest: incidence, prognosis and possible measures to improve survival. Intensive Care Med 33:237-245
16. Skrifvars MB, Castrén M, Aune S, Thoren AB, Nurmi J, Herlitz J (2007) Variability in survival after in-hospital cardiac arrest depending on the hospital level of care. Resuscitation 73:73-81
17. Moretti MA, Cesar LA, Nusbacher A, Kern KB, Timerman S, Ramires JA (2007) Advanced cardiac life support training improves long-term survival from in-hospital cardiac arrest. Resuscitation 72:458-465
18. Jones-Crawford JL, Parish DC, Smith BE, Dane FC (2007) Resuscitation in the hospital: circadian variation of cardiopulmonary arrest. Am J Med 120:158-164
19. Cooper S, Cade J (1997) Predicting survival, in-hospital cardiac arrests: resuscitation survival variables and training effectiveness. Resuscitation 35:17-22
20. (2000) Guidelines 2000 for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. Part 2: ethical aspects of CPR and ECC. Circulation 102: I12-21