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# Arrest in hospital: a study of in hospital cardiac arrest outcomes.

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# Arrest in Hospital: A Study of in Hospital Cardiac Arrest Outcomes

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## Abstract

The effect of advances in cardiac arrest management over the last five decades on in-hospital cardiac arrest survival rates is not clear. Data on 212 arrests between January 2010 and May 2013 were retrospectively analyzed by means of an audit form based upon the Utstein template for in-hospital cardiac arrest, with a view to identifying significant associations between arrest characteristics and return of spontaneous circulation or survival to discharge. Significant associations were identified between return of spontaneous circulation and location (ward, 36patients (38%) vs. ICU, 33 Patients (56%); P=0.032), whether an arrest was witnessed or not (82 patients (52%) vs. 9 patients (30%); P = 0.029), whether the initial rhythm was shockable or non-shockable (28 patients (85%) vs. 38patients (31 %); P<0.001), whether the first dose of adrenaline was administered within 2 minutes of arrest onset or later (13 patients (54 %) vs.12 patients (28%); P = 0.04).

**Introduction**

Despite significant advances in cardiopulmonary Resuscitation (CPR) over the last 5 decades, survival rates from in-hospital cardiac arrest still remain unsatisfactory. At the inception of CPR in the 1950s[1,2], survival to discharge from in-hospital cardiac arrest averaged just 10%.[3] In four decades, that figure rose to 17% by the mid- 1990s.[3] While several recent small scale studies have reported survival to discharge rates of between 12 to 29%,[4-7] larger scale studies[8,9] and an analysis of 70 recent studies, published in 2011,[10] have reported an overall average survival to discharge rate of just 18%.

Notwithstanding significant improvements in life-saving CPR equipment and technology, the greatest determinant in the outcome of in-hospital cardiac arrest is still the prompt detection of the event, and the subsequent immediate action of a team of healthcare professionals who are appropriately trained and able to act.[11] Thus there is a continued need for improvement in in-house cardiac arrest resuscitation procedures. The antecedents and associated characteristics of positive outcome from cardiac arrest are diverse and complex. Complicated by a multitude of reporting styles, definitions and nomenclature, which otherwise make data from different studies almost impossible to compare and contrast meaningfully, a uniform template for recording and reporting such data was proposed in the early 1990s.[12] Known as the "Utstein style", it advocates the use of uniform definitions and standard methodologies to permit useful comparison of data from resuscitation studies.[12]

The aim of this study was to report the use of an audit form for auditing the demographics, frequency and outcomes of in-hospital cardiac arrest events over a 40 month period. We aimed to evaluate the factors affecting outcomes of cardiac arrest by exploring associations between survival rates and event characteristics such as arresting rhythm, performance of the cardiac arrest team and time to delivery of life-saving care.

**Methods**

Beaumont Hospital is an 810 bed academic teaching hospital, providing emergency and acute care services across 54 medical and surgical specialties to a community of 290,000 people. The hospital employs a cardiac arrest team comprising an Anaesthetist, Medical Registrar, Medical Senior House Officer and a Medical Intern. When a patient collapses a member of staff pushes a cardiac arrest button which immediately activates an alarm system via a DECT telephone system carried by the cardiac arrest team members. Each activation of the alarm is logged electronically, and the legitimacy of the call is then verified retrospectively by the resuscitation officer.

Data on 212 distinct cardiac arrest events recorded over a 40 month period were retrospectively analysed by means of an audit form based upon the Utstein template for in-hospital cardiac arrest. The form captures specific information such as patient demographics (age, sex,) and event variables (date, time of day, location, cause, initial rhythm, timing and types of airway provision and other resuscitation interventions such as provision of life-saving drugs and timing to delivery thereof), and was designed to be completed by cardiac arrest team leaders in real time. Overall the detail of the form comprises some 81 distinct possible data points and contains space for documenting each step of the Advanced Cardiac Life Support Algorithm. The form was designed by the Resuscitation Training Officer with multi-disciplinary input and in consultation with an Emergency Medicine Consultant, an advanced nurse practitioner in chest pain assessment, a consultant Anaesthetist and the Resuscitation Advisory Group of the Hospital.

All statistical analyses were performed with the use of descriptive statistics in Microsoft Excel. Means, Standard Deviations and 95% Confidence intervals (CI)were used for continuous variables (age, time to delivery of medications etc),while frequency tables and cross tabulations were applied for categorical variables (location, gender, initial rhythm, whether an event was witnessed or not, etc.) Fischer's exact test was used to investigate possible associations between categorical variables and the two outcome groups (Return of spontaneous circulation vs. death). In cases where the number of categorical variables numbered 3 or more a chi-squared analysis was used in place of Fischer's exact test.

**Results**

*Demographics and Arrest Characteristics*

Between Jan 2010 and May 2013 the hospital admitted 71,508 patients, of which 2,548 died in hospital. The number of verified cardiac arrests logged during this period was 741, making the frequency of in hospital cardiac arrest during the study period 10.4 per 1000 patients per year. The demographics and arrest characteristics of 212 of these events were captured by the audit form and are shown in Table 1.

**Table 1 Characteristics of Patients suffering Cardiac Arrest**

| Characteristic | Number (%) of Patients | Characteristic | Number (%) of Patients |
|---|---|---|---|
| 1) Gender | | 5) Location | |
| – Men | 120 (56%) | – Ward | 100 (47.2%) |
| – Women | 68 (32%) | – ICU | 59 (27.8%) |
| – Not recorded | 24 (12%) | – CCU | 30 (14.2%) |
| | | – A & E | 5 (2.3%) |
| 2) Mean Age | 65.56 years (95% CI: 63.24-67.88) | – Cath Lab | 5 (2.3%) |
| | | – Other | 5 (2.3%) |
| 3) Witnessed | | – Not recorded | 8 (4.1%) |
| – Yes | 159 (75%) | | |
| – No | 31 (15%) | 6) Timing | |
| – Not recorded | 22 (10%) | – 00:00 – 08:00 | 71 (33.5%) |
| | | – 08:00 – 16:00 | 60 (28.3%) |
| 4) Initial Rhythm | | – 16:00 – 24:00 | 71 (33.5%) |
| – VF/VT | 33 (15.6%) | – Not recorded | 10 (4.7%) |
| – Asystole/PEA | 122 (57.5%) | | |
| – Other | 32 (15.1%) | 7) Staff Present | |
| – Rhythm not recorded | 25(11.8%) | – Anaesthetist | 179 (84.4%) |
| | | – RGN | 177 (83.4%) |
| | | – Registrar | 166 (78.3%) |
| | | – Ward Sister | 113 (53.3%) |
| | | – SHO | 111 (52.4%) |
| | | – Intern | 123 (58%) |
| | | – Consultant | 36 (23.5%) |

VF/VT = Ventricular Fibrillation/Ventricular Tachycardia
PEA = Pulseless Electrical Activity
Other = Bradycardia\perfusing rhythm
ICU = Intensive care unit
CCU = Coronary care unit

*Outcomes*

Return of spontaneous circulation was achieved in 98 cardiac arrests in total (46%; Table 2), in 28 patients (85%) with VF/VT and in 36 patients (29.5%) with asystole/PEA. Of the 98 patients who achieved return of spontaneous circulation, follow up data was available for 73 only. Of these 73, 39 survived to discharge while the remainder died in hospital (Table 2). Thus, the survival to discharge rate in this study was 39 out of 212 patients (18.4%).

**Table 2 Outcomes of In-Hospital Cardiac Arrest**

| Cause of arrest (rhythm) | Return of Spontaneous Circulation | Deceased | Discharged* | Discharge status not available |
|---|---|---|---|---|
| VF/VT | 28/33 (85%) | 5/33 (15%) | 15/33 (45%) | 9/33 |
| Asystole/PEA | 38/122 (31%) | 84/122 (69%) | 9/122(7.3%) | 12/122 |
| Other/ Rhythm not recorded | 32/57 (56%) | 25/57 (44%) | 15/57 (30%) | 4/57 |
| Overall | 98/212 (46%) | 114/212 (54%) | 39/212 (18.4%) | 25/212 |

*Of the 98 patients who achieved Return of Spontaneous Circulation, data concerning discharge was not available in 25.

**Table 3 Cardiac arrest team performance in minutes in Beaumont Hospital, Dublin**

| Arrest event | Mean time (minutes) | 95% Confidence Interval |
|---|---|---|
| Arrival of Cardiac Arrest Team | 3.05 | 2.66-3.44 |
| First dose of Adrenaline (all patients) | 5.21 | 3.59-6.83 |
| First dose of Ardenaline (Asystole/PEA patients only) | 4.44 | 3.03-5.85 |
| First dose of Atropine (all patients) | 9.16 | 6.13-12.19 |
| Intubation | 15.85 | 13.33-18.37 |

*Cardiac arrest team performance*

The mean time to arrival of the cardiac arrest team (CAT) in all patients was 3.05 minutes (95% CI 2.66-3.44; Table 3). The mean time to arrival of the CAT in those who achieved return of spontaneous circulation was 3.1 minutes (95% CI 2.55-3.64),very similar to the mean time in those who did not (2.96 minutes; 95% CI 2.40-3.53). Regarding those patients who had a presenting rhythm of asystole/PEA, the first dose of adrenaline was given within five minutes (meantime to delivery 4.44 minutes; 95% CI 3.03-5.85; Table 3).

**Table 4 Significant Associations of Characteristics with Outcome**

| Characteristic | Return of Spontaneous Circulation | Deceased | P value |
|---|---|---|---|
| *Witnessed arrest (n=187)* | | | |
| – Yes (n=157) | 82 (52%) | 75 (48%) | 0.029 |
| – No (n=30) | 9 (30%) | 21 (70%) | |
| *Initial rhythm (n=155)* | | | |
| – VF/VT (n=33) | 28 (85%) | 5 (15%) | <0.001 |
| – Asystole/PEA (n=122) | 38 (31%) | 84 (69%) | |
| *First Dose Adrenaline (n=67)* | | | |
| – ≤ 2 minutes (n=24) | 13 (54%) | 11 (46%) | 0.040 |
| – > 2 minutes (n=43) | 12 (28%) | 31 (72%) | |
| *Location of arrest (n=154)* | | | |
| – Ward (n=95) | 36 (38%) | 59 (62%) | 0.032 |
| – ICU (n=59) | 33 (56%) | 26 (44%) | |
| **Characteristic** | **Survival to discharge** | **Deceased** | **P value** |
| *Age of Patient (n= 170)* | | | |
| – ≤ 65 years (n=68) | 19 (28%) | 49 (72%) | 0.029 |
| – > 65 years (n=102) | 14 (13.7%) | 88 (86.3%) | |
| *Initial Rhythm (n=155)* | | | |
| – VF/VT (n=33) | 15 (45%) | 9 (27%) | <0.001 |
| – Asystole/PEA (n=122) | 9 (7.3%) | 101 (83%) | |

*Significant associations with outcomes*

Regarding the two primary outcomes (Return of spontaneous circulation vs. death from cardiac arrest) Fisher's exact test revealed a significant association between whether a cardiac arrest was witnessed, whether the presenting rhythm was shockable, whether the arrest occurred on the ward or the ICU, and whether the first dose of adrenaline was delivered within 2 minutes of arrest onset (Table 4). With regard to survival to discharge, significant associations were observed between whether the patient's age was less than 65 years or not, and whether the presenting rhythm was shockable or not (Table 4).

## Discussion

This study has reported the use of an audit form based upon the Utstein reporting style for documenting the patient characteristics and event variables of 212 in-hospital cardiac arrests over a 26 month period. Whilst 741 verified cardiac arrests were logged during the study period, only 212 forms were completed, giving an uptake rate of just 28.6% for form usage. This low uptake probably reflects the inherently fast-paced and high pressure situation of a cardiac arrest, which makes it difficult for a cardiac arrest team leader to prioritise the completion of an audit form in real time. The low rate of uptake is a key limitation in this type of study, and reflects the need to refine the audit form for easier completion in the future.

The overall rate of return of spontaneous circulation (46%) observed in this study is similar to that seen in other recent studies.[13-15] In contrast to some similar studies however, no significant associations between the rates of return of spontaneous circulation and gender or age were identified.[13,14] This may represent a population difference, or may simply be due to the lower number of patients documented in this study. Age was shown to be an important determinant in whether a patient will survive to discharge following cardiac arrest, with significantly more patients aged 65 years or less achieving discharge when compared to those older than 65 years (28% vs 14%; P = 0.029; Table 4). Patients were less likely to achieve return of spontaneous circulation if their arrest occurred on the ward when compared to the ICU (38% vs. 56%; P =0.032; Table 4). This may reflect more intensive monitoring, such as telemetry, in the ICU environment, or may be due to more readily available IV access facilitating speedier delivery of adrenaline. Of note the mean time to administration of adrenaline in those patients suffering cardiac arrest on the ward was 8.2 mins, in contrast to 2.5 mins for those patients in the ICU (data not shown).

Also observed was a significant association between return of spontaneous circulation and witnessed cardiac arrests when compared to non-witnessed arrests (52% vs 30%; P = 0.029). This observation has been seen in other studies to date,[16,17] and highlights the inherent danger in isolating patients at high risk of cardiac arrest in single rooms or small wards. The subset of patients with the highest number achieving return of spontaneous circulation post cardiac arrest are those that presented with a rhythm of VF/VT (85%). This finding is in agreement with what has been reported previously,[13,14] and reflects the well documented life-saving ability of early defibrillation for shockable arrest rhythms. However, while the proportion of patients achieving return of spontaneous circulation is far higher in those presenting with VF/VT, this subset represents only a small number of the total patients presenting with cardiac arrest (33; 16%).

As demonstrated by this study, the majority of patients suffering in-hospital cardiac arrest are presenting with an initial arrest rhythm of asystole/PEA (122; 58%). The proportion of these patients achieving return of spontaneous circulation was much lower than in the VF/VT subset (31%vs. 85%; P<0.001; Table 4).

There are many possible reasons for this difference. Firstly, it may simply reflect a high level of co-morbidities in this group of patients, with asystolic heart failure representing the end stage of multiple disease processes in hospitalized patients. Secondly, it may reflect the limitations of current treatments for non-shockable cardiac arrest rhythms. In the absence of defibrillation, the responder is limited to the use of chest compressions, airway provision and administration of cardioactive drugs such as adrenaline. Thirdly, it may reflect a need to shorten the time interval to administration of the first dose of adrenaline in asystole/PEA. The present study identified a significant association between the percentage of patients who achieved return of spontaneous circulation and the percentage that received the first dose of adrenaline within two minutes versus those that did not (54% vs. 28%; P= 0.04; Table 4). With regard to survival to discharge, data were available for only 73 of the 98 patients who achieved return of spontaneous circulation. Of the total 212 patients, 39 survived to discharge, giving a survival to discharge rate of 18.4%. Multiple studies have also shown that survival to discharge rates currently range from12% to 29%, with the average in larger studies being 18%[4-10].

Patients suffering in-hospital cardiac arrest are more likely to achieve return of spontaneous circulation if their arrest is witnessed and the initial arrest rhythm is shockable. However, the majority of patients suffering in-hospital cardiac arrest in this study presented with a non-shockable rhythm and these patients are more likely to achieve return of spontaneous circulation if the first dose of Adrenaline is administered within two minutes of arrest onset.

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