Resuscitation Predictor Scoring Scale for inhospital cardiac arrests

S Cooper, C Evans

OBJECTIVE ARTICLE

Resuscitation Predictor Scoring Scale for inhospital cardiac arrests

S Cooper, C Evans

Objectives: The purpose of this study was to determine the key factors influencing survival from cardiopulmonary resuscitation attempts and to produce a survival predictor scale for use during a resuscitation attempt.

Method: Bivariate analysis of individual survival predictors and a prospective analysis of survival based on logistic regression models. Included in this seven year study (1993–2000) were 2567 in hospital resuscitation calls of which 1633 received full cardiopulmonary resuscitation. Immediate, 24 hour and discharge survival rates were the main outcome measures with additional analysis for the development of the Resuscitation Predictor Scoring Scale (RPS Scale).

Results: The immediate survival rate was 41%, 28% at 24 hours, and 19% by discharge. Multivariate analysis showed the main factors influencing 24 hour survival to be the duration of the arrest, primary arrhythmia (VT, VF, asystole, or PEA), age, and the primary mode of arrest (respiratory or cardiac). The RPS Scale was developed from these key predictors giving resuscitation teams an accurate prediction of survival 15 minutes into a resuscitation attempt.

Conclusion: Data collection and analysis of cardiopulmonary resuscitation attempts are essential for the formulation of survival indicators. In this case the data have enabled the formulation of a survival predictor scale that will quantify the decision making process regarding the termination of cardiopulmonary resuscitation attempts.

A number of pre-arrest morbidity scales have been developed over the years to aid in “do not attempt resuscitation” (DNAR) decisions. They are all designed for use with a specific “cut off” value above which patients will not survive. However, they tend to be less sensitive when it comes to predicting who will survive below the “cut off” point. This is because there are so many other factors, other than pre-arrest morbidity, that influence survival. Nevertheless they remain useful guides for DNAR decisions.

To date there is no specific tool available to aid decision makers during a resuscitation, decisions that are inevitably complex and subjective. Rien de Vos et al for example concluded that “the point in time to terminate resuscitation is not always rationally chosen” and Meyer and Balck suggest that physicians may have some conflict with their decision making.

The criteria for terminating resuscitation efforts are clearly multifactorial and consequently there is no clear guidance. A recent publication of international guidelines makes the point that “in the absence of mitigating factors, prolonged resuscitation efforts for adults and children are unlikely to be successful and can be discontinued if there is no return of spontaneous circulation at any time during 30 minutes of cumulative ACLS”. However, a later paper within the same publication that considers the termination of out of hospital resuscitation efforts in the asystolic patient, suggests that where basic and advanced interventions have been in place for 10 minutes resuscitation should be discontinued.

With these issues in mind we report on a retrospective analysis of resuscitation survival rates and key predictors of survival. We have also produced a survival predictor scale (to 24 hours) that can be used during an in hospital resuscitation attempt to aid termination decisions.

METHODS

Derriford Hospital, Plymouth (UK) is a 1200 bed district general hospital. The resuscitation team is led by a medical senior house officer (SHO) with the support of a medical house officer (HO), an intensive care SHO, and an intensive care nurse.

The study ran from April 1993 to March 2000 in which time there were 2567 reported resuscitation calls. Data were stored on a Microsoft Access data base and transferred to the Statistics Package for Social Scientists (SPSS) for analysis. As recommended in the Utstein style, excluded from the main body of this study were 354 calls (16%) where the team was not requested, such as a false alarm or where the patient was found to be “not for resuscitation”; 69 calls (3%) to patients in respiratory arrest only; 39 calls (2%) to patients less than 20 years of age; and 472 calls (19%) to 204 patients who arrested more than once during a hospital admission. The remaining 1633 patients received full cardiopulmonary resuscitation (CPR), for a single event.

Immediate CPR success was defined as the return of spontaneous cardiac output for a minimum of 20 minutes. Survival at 24 hours and survival at discharge from hospital, or six weeks, were also calculated. Data collection was coordinated by the resuscitation department with the intensive care doctor responsible for completing an audit form after each call. In some areas, for example, coronary care and accident and emergency, staff were capable of managing a resuscitation attempt without the assistance of the general resuscitation team. In these areas data collection proved more difficult and we estimate that the real number of resuscitation attempts was about 15% higher. With this in mind the following data may be slightly less representative of acute care areas than for general wards.

Abbreviations: DNAR, do not attempt resuscitation; CPR, cardiopulmonary resuscitation; RPS Scale, Resuscitation Predictor Scoring Scale
Table 1 Survival rates related to primary arrhythmia (combined rhythms)

<table>
<thead>
<tr>
<th>Primary arrhythmia</th>
<th>Number of cases</th>
<th>Survival rates %</th>
</tr>
</thead>
<tbody>
<tr>
<td>VT and VF</td>
<td>433</td>
<td>Immediate: 53</td>
</tr>
<tr>
<td></td>
<td></td>
<td>24 Hour: 46</td>
</tr>
<tr>
<td>Asystole and EMD/PEA</td>
<td>962</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Discharge: 36</td>
</tr>
<tr>
<td>Total</td>
<td>1395</td>
<td></td>
</tr>
</tbody>
</table>

Attempted inhospital resuscitations: combination interventions [n = 1633]

Non-VT/VF
- PEA [n = 633]
- Asystole [n = 329]

Initial rhythm VF/VT [n = 433]
- Never achieved ROSC [n = 202]
- Any ROSC [n = 231 (53%)]

Died in hospital ROSC >24 hours [n = 278]
- Discharge alive [n = 155 (36%)]

Figure 1 In hospital Utstein style template: outcome where initial monitored rhythm was VT/VF.

Arrest variables: factors during resuscitation

The primary arrest mode (respiratory or cardiac) was unknown in 98 cases; of the remainder (1535) 19% were identified as respiratory and 81% as cardiac. Immediate survival for patients who had a primary respiratory arrest was significantly higher (56%) than for those who had a primary cardiac arrest (36%) (p<0.001). Survival to 24 hours was also statistically significant for respiratory cases (36%) compared with cardiac (27%) (p=0.001).

The primary arrhythmia was not identified in 238 cases. Survival rates related to rhythm are illustrated in figure 1 and table 1. Immediate survival rates were significantly higher where the primary arrhythmia had been VT or VF (p<0.001). As in the earlier report from our own institution PEA was the most common primary arrhythmia (43%).

The duration of the resuscitation attempt was found to be an essential factor for immediate survival. The time was recorded in 1513 (93%) cases with a range of <1 minute to 120 minutes, a mean of 15.6 and a median of 15 minutes. Of the survivors 62% were resuscitated in less than 14 minutes with only 20% surviving if the resuscitation lasted more than 15 minutes. As an interval variable duration was highly significant (p≤0.001), as a categorical variable the duration was highly significant at 15 minutes (p≤0.001).

Logistic regression analysis

A total of 287 cases were excluded because of missing data leaving 1346 in the model. The factors retained were duration (>or<15 minutes), primary arrhythmia (VT, VF, asystole, or PEA), age group (>or<70 years), and the primary mode of arrest (respiratory or cardiac). Rejected from the model were basic life support within these minutes and sex. The dependent variable was survival to 24 hours, which gave the highest
predictive accuracy. We could not accurately predict survival to discharge from the model, presumably because of the multitude of additional factors that influence survival in the post-resuscitation phase.

**Resuscitation Predictor Scale (RPS Scale)**

Given that the intention of this research was to produce a predictive scale to be used at the 15 minute interval, a cross tabulation of predicted outcome (from the regression analysis) by the actual outcome of all those cases where the duration of the CPR had lasted 15 minutes or more was produced (n=800–59, missing cases =741). In 638 cases (90%) where death was predicted the patient did not survive, leaving 100 cases where death was predicted and the patient survived for 24 hours. In other words the predictive accuracy of the final model for cases lasting 15 minutes or longer is 90%.

The RPS Scale was based on the variables from the logistic regression model and survival rates for those patients who were resuscitated for more than 15 minutes. A detailed version of the RPS Scale is shown in table 2 (Scale A and B) and the final version of the scale in appendix 1 (see the journal web site emjonline.com).

**DISCUSSION**

This study is one of the largest single site on record, with a sample of 1633 CPR attempts. A valid comparison is the recent UK national study of 1368 cases from 49 hospitals. The discharge survival rate was 18% compared with 19% in this study. Survival rates were also similar to BRESUS where immediate survival of in hospital arrests were 45%, with 41% in Plymouth, 24 hour survival was 32% to 28%, and discharge survival was 21% to 19% respectively. In these comparative studies multiple re-arrests are included in some form. This is an important factor as it inevitably increases the overall survival rate. As required for Utstein guidelines we have removed all multiple arrests and treated them as a separate case load.

There was a wide age range in the study with a significant proportion (39%) in their 70s. As in other reports 70 years was a significant statistical cut off point for survival. Setting an age limit on resuscitation would be inappropriate, but combined with other factors it is a guide to survival.

Basic life support should be started within the first three minutes of cardiac arrest. Inhospital basic life support should be started immediately; in this study only 7% were delayed for a relatively short period, which is probably why as a predictor of survival this variable was not statistically significant.

In BRESUS those patients whose primary mode of arrest was respiratory were more likely to survive (47%), compared with primary cardiac arrests where the survival rate was lower (42%). These results match our own; we found that patients who had a primary respiratory arrest were significantly more likely to survive (56%) compared with primary cardiac (36%). A good example would be an asthmatic patient, where there is no cardiac abnormality. With prompt CPR they will perhaps be easier to resuscitate than a patient who has arrested after a myocardial infarction.

As in many other reports patients who had suffered VT/VF arrests were significantly more likely to survive than those who had asystolic/PEA arrests. However, the most common primary arrhythmia was PEA, 43%.

Supported by other studies the duration of the resuscitation attempt was an important factor in predicting survival where there was no return of spontaneous circulation (ROSC); becoming highly significant at 15 minutes (<0.000). If there is a ROSC, at any stage of resuscitation, the latest consensus opinion indicates that it may be appropriate to consider extending the resuscitative effort.

**The RPS Scale**

Decisions to terminate resuscitation attempts are often subjective and are inevitably based on a myriad of factors, the final decision being the responsibility of the doctor in charge after consultation with the team. We wanted to increase the objectivity of the decision by developing a validated statistical measure from which a resuscitation team could evaluate the chances of survival, at a specific time interval, during the resuscitation attempt.

The final scale (appendix 1) made up of three tables, table A is based on the primary arrhythmia and the patients age, factors that are usually available to decision makers at an inhospital resuscitation. Table B includes the primary arrhythmia and the patients age but also the primary mode of arrest (respiratory/cardiac). The latter is not always known so this table should only be used where the mode of arrest has been identified. Finally Table C lists additional variables, from other studies that should be taken into account before terminating a resuscitation. Resuscitation teams should first consider using the tool 15 minutes into a resuscitation. It can be used at a later stage but the survival rates illustrated are likely to be reduced.

It is clear from the final scale that the percentage survival is directly related to the weighting score (table 2) and correlated appropriately to each variable. For example, in Scale A a patient of 80 years in asystole is significantly less likely to survive than a patient of 60 years in VF. The variables selected for

---

**Table 2 RPS Scale**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Odds ratio (<em>the weighting</em>)</th>
<th>Alive 24 hours (%)</th>
<th>Total (number of patients in each category)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PEA/Asystole + &gt;70 years</td>
<td>1</td>
<td>48</td>
<td>357</td>
</tr>
<tr>
<td>PEA/Asystole + 69 years</td>
<td>6</td>
<td>8.4</td>
<td>176</td>
</tr>
<tr>
<td>VT/VF + &gt;70 years</td>
<td>7</td>
<td>14.1</td>
<td>142</td>
</tr>
<tr>
<td>VT/VF + &lt;69 years</td>
<td>12</td>
<td>28.8</td>
<td>66</td>
</tr>
<tr>
<td>PEA/Asystole + &gt;70 years + primary cardiac</td>
<td>3.8</td>
<td>289</td>
<td></td>
</tr>
<tr>
<td>PEA/Asystole + 69 years + primary cardiac</td>
<td>6</td>
<td>6.1</td>
<td>131</td>
</tr>
<tr>
<td>PEA/Asystole + &gt;70 years + primary respiratory</td>
<td>20</td>
<td>9.6</td>
<td>52</td>
</tr>
<tr>
<td>PEA/Asystole + 69 years + primary respiratory</td>
<td>25</td>
<td>16.7</td>
<td>36</td>
</tr>
<tr>
<td>VT/VF + &gt;70 years + primary cardiac</td>
<td>7</td>
<td>12.1</td>
<td>132</td>
</tr>
<tr>
<td>VT/VF + 69 years + primary cardiac</td>
<td>12</td>
<td>28.3</td>
<td>60</td>
</tr>
<tr>
<td>VT/VF + &gt;70 years + primary respiratory</td>
<td>26</td>
<td>28.6</td>
<td>7</td>
</tr>
<tr>
<td>VT/VF + &lt;69 years + primary respiratory</td>
<td>31</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

*Insufficient data.

---

[www.emjonline.com](http://www.emjonline.com)
use within the scale have a predictive accuracy of 90%, a high figure considering the limited number of key factors. The survival rates listed are taken from a single hospital site, for resuscitations that lasted more than 15 minutes (n=741). However, we would argue that these figures are reasonably representative of inhospital resuscitation in the United Kingdom. Our survival rates are matched by the national BRESUS study,\textsuperscript{1,3}\textsuperscript{3}\textsuperscript{3}\textsuperscript{1,4}\textsuperscript{1,5}\textsuperscript{1,14}\textsuperscript{1,15} and we comply with Resuscitation Council (UK) guidelines for the management of cardiac arrests.

In developing the RPS Scale we have been able to demonstrate that 15 minutes into a resuscitation is an acceptable point at which to first consider termination (where there has been no ROSC). For example, an 80 year old whose primary arrhythmia was asystole has a very poor chance of survival (5%). Clearly however there are important ethical issues involved in using such a tool, in some situations a 5% chance of survival would be deemed sufficient to continue resuscitation. In another situation the clinician may have substantial evidence to support cessation of resuscitation where the RPS Scale indicates that there is a 29% chance of survival. However, we have been able to meet our objectives with the production of an accurate tool for clinicians that should be used to aid resuscitation termination decisions.

\textbf{ACKNOWLEDGEMENT}

Many thanks to Dr Steve Shaw, Department of Mathematics and Statistics, University of Plymouth, UK, for his advice and feedback on the statistical methods used in this study.

\textbf{Contributors}

Simon Cooper initiate the research, discussed core ideas, participated in the protocol design and coordinated and assisted in the data collection. He assisted in the analysis and interpretation of the data and wrote and edited the paper. Chris Evans discussed core ideas, participated in the protocol design, undertook the data entry, assisted in the data analysis and edited the paper. Steve Shaw advised on and approved the statistical techniques. The guarantor of the paper is Simon Cooper.

\textbf{REFERENCES}

8 A statement for health care professionals from the American Heart Association, the European Resuscitation Council, the Heart and Stroke Foundation of Canada, the Australian Resuscitation Council and the Resuscitation Councils of Southern Africa. Recommended Guidelines for reviewing, reporting, and conducting research on in-hospital resuscitation: The in-hospital ‘Utstein Style’. Resuscitation 1997;34:151–83.

\textbf{Authors’ affiliations}

S Cooper, C Evans, Resuscitation Training, Derriford Hospital, Plymouth, UK

\textbf{Additional information relating to this paper is on the journal web site \texttt{emjonline.com}}}
Resuscitation Predictor Scoring Scale for inhospital cardiac arrests

S Cooper and C Evans

doi: 10.1136/emj.20.1.6

Updated information and services can be found at:
http://emj.bmj.com/content/20/1/6

*These include:*

**Supplementary Material**
Supplementary material can be found at:
http://emj.bmj.com/content/suppl/2003/02/11/20.1.6.DC1

**References**
This article cites 17 articles, 0 of which you can access for free at:
http://emj.bmj.com/content/20/1/6#BIBL

**Email alerting service**
Receive free email alerts when new articles cite this article. Sign up in the box at the top right corner of the online article.

**Topic Collections**
Articles on similar topics can be found in the following collections

Resuscitation (606)

Notes

To request permissions go to:
http://group.bmj.com/group/rights-licensing/permissions

To order reprints go to:
http://journals.bmj.com/cgi/reprintform

To subscribe to BMJ go to:
http://group.bmj.com/subscribe/