Clinical decision making in cardiopulmonary resuscitation

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Chapter 2

Terminating resuscitation

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Decisions to terminate resuscitation.

Resuscitation (in press).
ABSTRACT

To gain more insight into the decision making around termination of resuscitation, we studied factors which influence the time to discontinue resuscitation, and the criteria on which those decisions were based. These criteria were compared with those of the European Resuscitation Council (ERC) and the American Heart Association (AHA). For this study, we reviewed the audiotapes of resuscitation attempts in a hospital.

Thirty-six attempts were studied, involving 27 men and nine women, mean (SD) age 64 (18) years. Nineteen patients received resuscitation on general wards, and 17 on the emergency room after an out-of-hospital circulatory arrest. The median interval time (range) from start to termination was 33 minutes (8 - 81 minutes). Results from multiple linear regression showed that a delay of more than 5 minutes in first Advanced Life Support measures, drawing a sample for biochemical analysis, and the patient's response shown by return of spontaneous circulation were independently associated with a later time of terminating resuscitation. The team used a number of criteria which can be found in the guidelines of the AHA and the ERC, but also used additional criteria. The ERC and the AHA criteria were not sufficient to cover all termination decisions. We conclude that the point in time to terminate resuscitation is not always rationally chosen. Updating of the current guidelines for terminating resuscitation and training resuscitation teams to use these guidelines is recommended.
In hospitals about 40 to 60 % of all resuscitation attempts have to be discontinued so that a patient dies.\textsuperscript{1,2} There are no strict rules about the timing to terminate a resuscitation attempt, but the American Heart Association (AHA) and the European Resuscitation Council (ERC) give general guidelines.\textsuperscript{3,4} Both organizations formulate circumstances which justify the termination, such as the provision of an appropriate attempt with Basic and Advanced Life Support without restoration of the circulation,\textsuperscript{3} or the evidence for cardiac death.\textsuperscript{4} Besides indicating when resuscitation may be discontinued, the ERC underlines conditions which justify the prolongation of resuscitation efforts. Conditions such as drug intoxication, hypothermia and treatment of potentially correctable conditions causing the arrest (e.g. tension pneumothorax). The ERC guidelines are more specific than those of the AHA, but both organizations give no general criteria about the exact moment in time when resuscitation should be terminated. Thus, the guidelines of the AHA and the ERC give foothold for decisions to terminate cardiopulmonary resuscitation, but specific aspects are left to the physician's judgement.

Decisions about termination can be complex, and involve use of medical information, assessment of treatment options and handling of termination rationales. There is little formal knowledge about the practice of termination of in-hospital resuscitation attempts. To get more insight, we studied factors which influence the time to terminate resuscitation, and the criteria for those decisions. These criteria were compared with the guidelines of the ERC and the AHA. For this study, we reviewed the audiotapes of discontinued resuscitation attempts by a hospital resuscitation team.

**PATIENTS AND METHODS**

**Setting**
The study was carried out in the Academic Medical Center in Amsterdam (tertiary care, university teaching hospital, 1030 beds). The hospital has a 24-hours resuscitation team, the members are: a resident anesthesiologist, a resident cardiologist and an anesthesiology-nurse. The team received training in Advanced Life Support according to our hospital protocol, which is in agreement with the Advanced Life Support protocols of the AHA and the ERC.\textsuperscript{5,6} The response time of the team (from alert to arrival) was a median of 3 minutes (range 1 - 8 minutes).

The hospital has 40 standardized crash carts equipped with a defibrillator, 19 of these have built-in tape recorders (LifePak 300, Physio Control, Redmond, Wa, USA), and are located on general wards and the emergency room. These defibrillators automatically record a continuous monitor ECG, critical events related to defibrillation, and sounds (voices) around the
apparatus. The tapes were routinely reviewed by a member of the Resuscitation Committee to collect information about the course of resuscitation.

Data collection
We studied resuscitation attempts performed on general wards and the emergency room between June 1993 and July 1996, and included all patients of 18 years and older who died of a circulatory arrest. Another criterion was that the resuscitation procedure was recorded with the Lifepak 300. For this study, we wrote full transcriptions of the recordings.

Definitions
A circulatory arrest was deemed as absence of a palpable pulse and loss of consciousness, a resuscitation attempt was defined as application of external chest compressions and artificial ventilation to patients with a circulatory arrest. Time to termination was calculated as the interval in minutes between the time that the defibrillator was switched-on (start Advanced Life Support by the team) and the termination of resuscitation. This was the moment that chest compressions stopped definitively, and the circulatory arrest continued. For resuscitation attempts in the emergency room after out-of-hospital cardiac arrest, we calculated the time interval of the resuscitation in the hospital.

Influencing factors
To study factors which influence the interval between start and terminating resuscitation, we collected data on patient characteristics, resuscitation characteristics and the patients' response to resuscitative efforts.

Patient characteristics were gender and age, and presence of an initial shockable rhythm (ventricular fibrillation and pulseless ventricular tachycardia). We also recorded the reason of hospital admission (cardiac or noncardiac), defined according to the International Classification of Diseases, 9th edition (ICD-9), and the location of resuscitation (hospital wards or emergency room).

In view of the complexity of the medical actions during resuscitation, the resuscitation characteristics were limited to the quick application (< 5 minutes after the arrival of the team) of three first order measures in Advanced Life Support: (a) obtaining monitor ECG for interpretation of initial heart rhythm, (b) endotracheal intubation, and (c) the administration of epinephrine. We also collected information on the use of diagnostic information by the team (bloodgases, biochemistry, and echocardiography). The patient's response was defined as return of spontaneous circulation felt by a palpable pulse and categorized into: no response (< 1 minutes), short response (1-5 minutes), and long response (> 5 minutes).
Decision criteria
To identify the criteria used by the team to terminate resuscitation and to compare these with the guidelines of the ERC and the AHA, we studied the transcripts and the added notes on the reasoning to discontinue CPR. The reasons were compared to the criteria of the guidelines from both organizations.

Statistical analysis
Time was expressed as medians (range), differences were calculated in medians and their approximate 95% confidence limits. Calculations of exact confidence limits for the difference between medians is usually not possible because of the discrete nature of the sampling distribution in non-parametric analysis. The non-parametric Mann-Whitney test was performed to analyze the univariate relation between patient characteristics, resuscitation characteristics, and patients' responses with spontaneous circulation on the one hand, and time of terminating resuscitation on the other hand. The independent impact of these factors on the time of termination was analyzed with multiple linear regression analysis (with a forward selection procedure), using the F-statistics with p ≤ 0.05 as the criterion level for selection. Characteristics with a p-value of ≤ 0.10 (Mann-Whitney) were entered as independent variables into the regression model, the time interval of terminating resuscitation was entered as dependent variable. The strength of the independent association between the patient characteristics, resuscitation characteristics and the patient's response with spontaneous circulation, and the time of termination was expressed in explained variances (R²).

RESULTS
During the study period, 56 terminated resuscitation attempts were audio-taped. Twenty of these tapes could not be analyzed because of a poor audio-quality (n=10), or the maximum tape length (45 minutes) was exceeded and the team did not change the tape (n=10). There were no significant differences between the included and excluded patient data with regard to age and gender, reason for admission, time of the day and location of the attempt.

A total of 36 patients were studied, and the median time interval (range) to terminate resuscitation was 33 minutes (8 - 81 min). Relatively long resuscitation attempts (≥ 60 minutes, n=3) concerned two patients who received thrombolysis during resuscitation, and one patient in whom it was difficult to correct acidosis. Relatively short attempts (≤ 15 minutes, n=2) concerned a 94-years old patient and a patient who received out-of-hospital resuscitation for more than one hour.
Patient characteristics
The mean age (SD) of the patients was 64 years (18), 27 men and nine women. Patient characteristics which suggested an initial good survival prognosis were: age < 75 years (n=24), cardiac reason of admission (n=17), initial ventricular fibrillation or tachycardia (n=7) (Table 2.1). Male gender was the only patient characteristic associated with a later termination of resuscitation (difference 12 minutes, p < 0.01). Age, first recorded ECG (ventricular fibrillation or tachycardia/other), reason for admission, and location of resuscitation did not significantly influence the time of terminating resuscitation (Fig 2.1.).

Table 2.1. Characteristics of patients undergoing resuscitation (n=36)

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>age</td>
<td>24/12</td>
</tr>
<tr>
<td>&lt; 75 years/≥ 75 years</td>
<td></td>
</tr>
<tr>
<td>gender</td>
<td>27/9</td>
</tr>
<tr>
<td>- male/female</td>
<td></td>
</tr>
<tr>
<td>reason for admission</td>
<td>17/19</td>
</tr>
<tr>
<td>- cardiac/noncardiac</td>
<td></td>
</tr>
<tr>
<td>location of resuscitation</td>
<td>19/17</td>
</tr>
<tr>
<td>- wards/emergency room</td>
<td></td>
</tr>
<tr>
<td>first recorded ECG</td>
<td>7/29</td>
</tr>
<tr>
<td>- ventricular fibrillation or tachycardia/other</td>
<td></td>
</tr>
</tbody>
</table>

Resuscitation characteristics: first order measures
For two of the 36 patients, an ECG trace was not available within 5 minutes after arrival of the team, because these patients were not connected to the defibrillator. Delayed ECG was not statistically associated with a later termination of resuscitation. One of the 17 patients on the emergency room was not intubated by the ambulance personnel; whereas two of the 19 patients on the wards were not intubated within 5 minutes after arrival of the team. Delayed intubation (n=3) tended to be associated with a later termination of resuscitation (difference 20 minutes, p=0.07).

In six of the 36 patients, epinephrine was not given within 5 minutes after the arrival of the team. This delay was associated with a later termination of resuscitation than for those who received epinephrine within 5 minutes (difference 13 minutes, p=0.03) (Fig 2.1). Grouping delayed first order measures, representing a delay in one or more first-order measures (ECG, intubation,
### Patient characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>age &lt; 75 years</td>
<td>(24)</td>
</tr>
<tr>
<td>males</td>
<td>(27)</td>
</tr>
<tr>
<td>ventricular fibrillation / tachycardia</td>
<td>(7)</td>
</tr>
<tr>
<td>cardiac admission diagnosis</td>
<td>(17)</td>
</tr>
<tr>
<td>location of resuscitation: wards</td>
<td>(19)</td>
</tr>
</tbody>
</table>

### Resuscitation characteristics

**delay in first order measures**
- ECG > 5 minutes: (2)
- intubation > 5 minutes: (3)
- epinephrine > 5 minutes: (6)

**utilization of diagnostic information**
- bloodgas sample drawn: (34)
- bloodgas results known: (30/34)
- biochemistry sample drawn: (28)
- biochemistry results known: (17/28)
- echocardiography: (18)

### Response of patient

**return spontaneous circulation**
- response > 5 minutes: (8)

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Figure 2.1.

**Patient and resuscitation characteristics in relation to the time to terminate resuscitation**

Time measured as interval in minutes since the defibrillator was switched-on. Differences between groups were calculated as difference in medians, their 95% confidence interval was approximated. An asterix indicates that no confidence limits could be calculated, because of a small sample size (< 4), a Mann-Whitney p-value is given. The dot bisected by a horizontal line indicates median difference in minutes and approximate 95% confidence limits.
epinephrine), showed that such delay was significantly associated with a later termination of resuscitation (difference 11 minutes, p=0.01).

**Resuscitation characteristics: diagnostic information**
During resuscitation, bloodgas samples were drawn of 34 of the 36 patients. Drawing a bloodgas sample tended to be associated with a later termination of resuscitation (difference 15 minutes, p = 0.09). Before the outcome of the test was known, the resuscitation attempt was terminated in four patients. Knowing the outcome of the test tended to be associated with a later time to terminate resuscitation (difference 6 minutes, p = 0.07).

Biochemical analysis (sodium, potassium) was another frequently requested laboratory test (n=28). Drawing such a sample was significantly associated with a later termination of resuscitation (difference 12 minutes, p = 0.01). Before the outcome of this test was known, the resuscitation attempt was already terminated in 11 patients. Knowing the results of the test was significantly associated with a later time of terminating resuscitation.

**Return of spontaneous circulation**
A total of 12 patients temporarily responded to therapy with return of spontaneous circulation for more than 1 minute. The median duration (range) between start of resuscitation and return of spontaneous circulation was 9 minutes (1-13). Four of the 12 patients responded 1 to 5 minutes, eight patients responded for more than 5 minutes. This relatively long response was significantly associated with a later termination of resuscitation (14 minutes, p = 0.05), than in case of a short response or no response at all.

**Time of termination explained by independent characteristics**
A total of seven variables with a p-value of < 0.10 were entered in a multivariate linear regression model (gender, delay in first order measures, drawing bloodgas and biochemistry samples and known outcome of the tests, and patient response). Independently associated with a later time of terminating resuscitation were: a delay in first-order measures, drawing a sample for biochemical analysis and a relatively long patient's response. Of the total amount of variance explained (R² 45%), 16% was explained by a delay of first-order measures, 15% by drawing a biochemistry sample, and 14% by the patient's response for more than 5 minutes.

**Criteria to terminate resuscitation**
Of the 10 criteria of the European Resuscitation Council, four were used to motivate the decision to terminate resuscitation. The most used criterion was the evidence of cardiac death (16 patients), defined by our hospital resuscitation team as the presence of an asystole or an electromechanical dissociation
Table 2.2. **Criteria for the termination of resuscitation of the European Resuscitation Council and American Heart Association and, the application by the resuscitation team**

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Applied in patients (n=36)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Guidelines European Resuscitation Council</strong></td>
<td></td>
</tr>
<tr>
<td>- Environment and access to emergency medical service</td>
<td>0</td>
</tr>
<tr>
<td>- Interval time between cardiac arrest and application of Basic Life Support</td>
<td>0</td>
</tr>
<tr>
<td>- Interval time between Basic Life Support and Advanced Life Support</td>
<td>0</td>
</tr>
<tr>
<td>- Evidence of cardiac death</td>
<td>16</td>
</tr>
<tr>
<td>- Evidence of cerebral damage</td>
<td>0</td>
</tr>
<tr>
<td>- Potential prognosis and underlying disease process</td>
<td>5</td>
</tr>
<tr>
<td>- Age</td>
<td>4</td>
</tr>
<tr>
<td>- Temperature</td>
<td>1</td>
</tr>
<tr>
<td>- Drug intake prior to cardiac arrest</td>
<td>0</td>
</tr>
<tr>
<td>- Remediable precipitating factors</td>
<td>0</td>
</tr>
<tr>
<td><strong>Guidelines American Heart Association</strong></td>
<td></td>
</tr>
<tr>
<td>- Appropriate Basic Life Support and Advanced Life Support without restoration of circulation and breathing</td>
<td>16</td>
</tr>
<tr>
<td>- Deteriorating vital functions (before resuscitation)</td>
<td>0</td>
</tr>
<tr>
<td>- No survivors after CPR have been reported in well designed studies</td>
<td>0</td>
</tr>
</tbody>
</table>

**Terminating resuscitation**
after a complete resuscitation attempt. In five patients, the team considered the potential prognosis and the underlying disease process a reason to terminate resuscitation. In four patients, old age was mentioned as reason for termination. A low body temperature was a reason to prolong resuscitation of one patient in the emergency room (Table 2.2.). Of the three criteria of the American Heart Association, one was used to motivate the decision to terminate resuscitation. The team explicitly considered their Advanced Life Support as appropriate in 16 cases and concluded that circulation and breathing could not be restored.

Apart from the criteria of the European Resuscitation Council and the American Heart Association, the team used four others to motivate their decision to terminate resuscitation (Table 2.3.). In 20 of the 36 patients, the team specifically mentioned that there were no important bloodgas and/or biochemistry values which needed correction. In eight patients, the team considered possible alternative interventions other than stated in the Advanced Life Support protocol, but concluded that no other therapeutic options were available.

The cause of the arrest was considered incompatible with the survival of 13 patients, who suffered from a massive pulmonary embolism or cardiac tamponade after myocardial infarction. The bloodgas and biochemistry parameters in three patients showed a deterioration of the condition of the patient despite all resuscitation efforts, whereafter resuscitation was terminated.

Table 2.3. Additional criteria used by the team to terminate resuscitation other than those of the European Resuscitation Council or American Heart Association

<table>
<thead>
<tr>
<th>Criteria</th>
<th>applied in patients (n=36)</th>
</tr>
</thead>
<tbody>
<tr>
<td>- no important bloodgas or biochemistry deviations</td>
<td>20</td>
</tr>
<tr>
<td>- no therapeutic options available</td>
<td>8</td>
</tr>
<tr>
<td>- cause of arrest incompatible with survival, regardless resuscitation</td>
<td>13</td>
</tr>
<tr>
<td>- deterioration during resuscitation</td>
<td>3</td>
</tr>
</tbody>
</table>
Discussion

Decisions to stop resuscitation are frequently taken and are associated with emotional and ethical problems. To evaluate the process of decision making, we looked into the decisions of our team and showed that the time of termination varied considerably. As can be expected, the response of the patient proved to be an important determinant of this point in time, but there were also less obvious factors, such as the adequacy of first order Advanced Life Support measures and taking biochemistry samples. The criteria used by the resuscitation team to motivate the decision to terminate were similar to those of the European Resuscitation Council and the American Heart Association, but the team used also other criteria to justify the termination of resuscitation.

There are several ways to study decisions to terminate resuscitation, for example by questionnaire or by interviews. We studied decisions in daily practice. The audiotapes came from the general wards and emergency room where defibrillators with audio-tapes were used. We did not evaluate decisions on other locations, such as the catheterization laboratory or operating theatre. On these locations resuscitation is less frequent and associated with a good outcome. Nevertheless, decisions whether or not to terminate resuscitation can be different from those investigated, if the cardiac arrest is directly related to a medical intervention (catheterization or operation). Some tapes could not be analyzed for technical reasons, such as resuscitation attempts of long duration, and we may have underestimated the variability in the duration of resuscitations.

Termination of resuscitation in our study happened generally after about 30 minutes, but with a considerable variability (8 - 81 minutes). This is not uncommon. A recent study of Mohr et al. showed that 64% of the interviewed emergency personnel would terminate unsuccessful resuscitation after 20 to 45 minutes, whereas 30% would continue for a longer period. This, despite suggestions that such long efforts have little or no effect, or may lead to neurological complications.

The only patient characteristic which independently determined the time of termination was a circulatory response of the patient. Other patient characteristics which generally indicate a potentially good prognosis had no influence on the time of termination: age < 75 years, cardiac reason of hospital admission, and initial ventricular fibrillation. This policy seems reasonable, because indicators of an initially good prognosis lose their significance when Advanced Life Support is applied for 30 minutes or more; the absence of a patient response becomes the overriding decision principle. However, also indicators of a poor prognosis such as a cardiac arrest after out-of-hospital resuscitation (emergency room) had no influence on the time of termination. This policy seems less reasonable, because there is no sense...
in desperately trying to restore circulation in patients with little or no hope of survival. However, care should be taken that the indicators of an initially poor prognosis could become a self-fulfilling prophecy if Advanced Life Support is not fully employed. Why did the resuscitation team continue in these patients with little or no hope? The answer is that the protocol of the ambulance services in the Amsterdam region have no strict criteria which patients should be transported to the hospital, other than those who had had return of spontaneous circulation in the field. In case of persistent ventricular fibrillation, young age, hypothermia, trauma or intoxication, the ambulance services generally transport patients during resuscitation. Not all the patients presented to our emergency room fulfilled these criteria. For psychological reasons, it remains difficult not to start resuscitation in the emergency room when the ambulance crew has made all physical and emotional efforts to maintain Advanced Life Support up to the time of admission to our hospital. On the emergency room and in retrospect, it is relatively easy to judge that all the efforts of the ambulance crew were in vain. At the time that the crew had made the decision to continue and to transport the patient, the outcome was probably less certain. In all, the policy to continue resuscitation after out-of-hospital resuscitation on the emergency room may not seem very rational, but is quite understandable given the current situation.

Besides the circulatory response of the patient, a failure to provide quick and adequate first order Advanced Life Support measures was another independent factor which was decisive for the time of termination. Such data suggest either a compensation mechanism by giving longer treatment after an inadequate start, or point to unstructured resuscitation attempts without clear views about the timing of further efforts.

The third factor which determined the delayed time of termination was taking a biochemistry sample. This demonstrates the influence of infrastructural factors on the decision making and related types of delays: (a) to decide whether a biochemical test is necessary, (b) sampling, (c) transport to the laboratory, (d) processing in the laboratory, (e) and access to the outcome. If a sample is drawn late and the results arrive late, these will have no significant impact on the survival after resuscitation. Specific measures in the biochemistry laboratory or on-site measurement may shorten this undesired delay of about 10 minutes (Figure 2.1.).

The criteria to check whether resuscitation could be stopped were not systematically used by our team. For example, the team used the criterion of ‘evidence of cardiac death’ in 16 of the 36 patients, but when we additionally analyzed our data we found this evidence in 33 patients.

The guidelines of the AHA or ERC turned out to be insufficient to justify the termination of resuscitation in every patient. To cover all situations, the team
used four other criteria which are not mentioned by either organization. The fact that not all criteria of the European Resuscitation Council were considered by our team is understandable because some criteria merely apply to out-of-hospital cardiac arrests, whereas our study was about in-hospital resuscitation.

Looking more closely at the criteria of the guidelines of the AHA or ERC, some are either not clear, or not generally accepted. The guidelines of the AHA appear global and defensive. The criterion that termination of resuscitation is (only) justified if no survivors are reported in well-designed studied, has opponents. They argue that these studies do not exist, but also argue that future studies will never give this evidence because a zero survival can not be derived from statistical evidence.\textsuperscript{18} The ERC guideline of ‘evidence for cerebral damage’ is controversial, because there is generally no formal indicator for cerebral damage during resuscitation, also pupil size is not a reliable indicator.\textsuperscript{19}

Based on the study, we conclude that the resuscitation attempts lasted sufficiently long to expect response of the patients, but were sometimes prolonged without evidence that success could be expected. The moment to terminate was not always rationally chosen, and the criteria to take such a decision were not systemically used. The data suggest that there is room for improvement. One can question whether or not it is possible or even advisable to have (improved) guidelines. Is the experienced based medical judgement not enough or even better? We acknowledge the value of clinical experience, but think that there is a need for guidelines. This because the experiences of health care workers who treat patients in cardiac arrest may differ and might ultimately lead to opposite decisions in similar patients. Such a situation can not be considered as an advantage to patients in general. Nevertheless, guidelines are not a rule of thumb and the criteria should be applied with sufficient background knowledge and with a good clinical judgement. Training of resuscitation teams in the handling of decision criteria could help to meet these requirements. Which criteria should be applied remains to be discussed. It seems not sufficient to implement the current guidelines of the ERC, which proved to be more applicable than those of the AHA. Here, there is also room for improvement. To cover all situations seen in clinical practice, additional criteria may be needed, whereas existing criteria need modification. To be useful in daily practice, the guidelines to terminate resuscitation should thus be redrawn. In such a process, the validity of the drafted guidelines has to be assessed, discussed, established and accepted before the implementation in daily practice.
REFERENCES