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# BMJ Open Accuracy of prehospital clinicians' perceived prognostication of long-term survival in critically ill patients: a nationwide retrospective cohort study on helicopter emergency service patients

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## ABSTRACT

**Objectives** Prehospital critical care physicians regularly attend to patients with poor prognosis and may limit the advanced therapies. The aim of this study was to evaluate the accuracy of poor prognosis given by prehospital critical care clinicians.

**Design** Cohort study.

**Setting** We performed a retrospective cohort study using the national helicopter emergency medical services (HEMS) quality database.

**Participants** Patients classified by the HEMS clinician to have survived until hospital admission solely because of prehospital interventions but evaluated as having no long-term survival by prehospital clinician, were included.

**Primary and secondary outcome** The survival of the study patients was examined at 30 days, 1 year and 3 years.

**Results** Of 36 715 patients encountered by the HEMS during the study period, 2053 patients were classified as having no long-term survival and included. At 30 days, 713 (35%, 95% CI 33% to 37%) were still alive and 69 were lost to follow-up. Furthermore, at 1 year 524 (26%) and at 3 years 267 (13%) of the patients were still alive. The deceased patients received more often prehospital rapid sequence intubation and vasoactives, compared with patients alive at 30 days. Patients deceased at 30 days were older and had lower initial Glasgow Coma Scores. Otherwise, no clinically relevant difference was found in the prehospital vital parameters between the survivors and non-survivors.

**Conclusions** The prognostication of long-term survival for critically ill patients by a prehospital critical care clinician seems to fulfil only moderately. A prognosis based on clinical judgement must be handled with a great degree of caution and decision on limitation of advanced care should be made cautiously.

## INTRODUCTION

The main purpose of prehospital critical care is to provide potentially life-saving treatment to patients in emergency situations in which, a disturbance in vital functions before

## STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ This is the first multicentre study to examine prehospital prognosis assessment based on clinical judgement.
- ⇒ A total of 36 715 patients were screened for the study.
- ⇒ The data for this study was gathered in one country only.

reaching a hospital might be fatal. In addition, improving patient experience through advanced analgesia is an important benefit of a critical care team, as is the ability to bypass local facilities to triage and transfer a patient to directly definitive care. Demanding task of prehospital critical care clinicians is to decide on the intensity of prehospital interventions. In addition to factors related to present trauma or illness, factors affecting a patient's personal recovery potential must be considered. These include, for example, age, medical history and earlier physical and mental performance.<sup>1-3</sup>

Prognostication of long-term survival is one of the key elements used to target most intensive treatment modalities to those patients who would benefit from them the most.<sup>4</sup> Furthermore, committing of scarce resources like helicopter emergency medical services (HEMS) to treat and transport futile patients should be avoided. Also, the ethical guidelines recommend refraining from treating patients whose prognosis is clearly futile.<sup>5 6</sup> Even though pain, anxiety and misery need to be treated.

The prehospital prognostic values of single patient-related variables or scoring systems are reported in the existing literature,<sup>7-9</sup> as are the outcomes of patients in certain



subgroups such as trauma,<sup>10 11</sup> sepsis<sup>12 13</sup> or out-of-hospital cardiac arrest (OHCA).<sup>14–16</sup> Nonetheless, no scoring system alone is sufficient and clinical judgement is also needed. And yet, the inclusion of the clinical judgement process as part of prognostication of long-term survival in critically ill emergency medical patients in prehospital settings has neither been studied nor evaluated.

In this study, the prognostication of long-term survival among patients receiving life-saving treatment from HEMS was examined. We aimed to estimate the survival rate in patients considered to have no long-term survival by the prehospital clinicians. Secondary, we compared the characteristics of survivors and non-survivors among who had been considered to have no long-term survival by the prehospital clinician. Our hypothesis was that the prognoses established during the prehospital phase are subject to several confounding factors, and thereby may not reflect the actual survival.

## METHODS

We performed a retrospective cohort study using a national HEMS quality database. The survival of the study patients was examined at 30 days, 1 year and 3 years.

### Setting

The Finnish nationally organised HEMS operates from six bases, five of which are staffed by a physician and one by an advanced paramedic. The physicians are mostly senior anaesthesiologists with extensive experience in prehospital critical care. The HEMS teams are dispatched by the emergency communication centre along with other emergency medical services units based on predefined criteria or as requested on site by ambulance staff. The most common mission types include major trauma, OHCA and unconsciousness (eg, intracranial haemorrhage or intoxication). The Finnish HEMS units provide wide range of critical interventions, such as rapid sequence intubation, blood transfusions, surgical airway management, thoracostomy and even prehospital thoracotomy if needed. The HEMS unit located in the rural northern area of Finland is staffed by critical care paramedics, opposite to physician. However, the staff in this unit are trained to perform identical critical interventions as the other HEMS units, excluding thoracotomy. The precise nature and range of Finnish emergency medical services has been precisely described in the recent literature.<sup>17</sup>

Detailed operational and clinical data are entered into a quality database, the FinnHEMS database (FHDB), shortly after each mission by the clinician responsible for the treatment of patients. Recorded data include operational event descriptors, patient descriptors, process mapping and quality indicators and mission outcomes, as per/exceeding international guidelines.<sup>18 19</sup> Patient descriptors include a grading system (HEMS Benefit Score, HBS) that rates the subjective benefit of the prehospital treatment in the mission.<sup>20</sup>

## Participants and outcome measures

We included all patients that had been assigned to HEMS Benefit Score Category 5 by the treating HEMS physician or paramedic instantly after the mission. This HBS category indicates that according to the estimation of the treating HEMS physician or paramedic, the treated patient had survived until hospital admission only because of prehospital care but was considered to have no long-term survival.<sup>20</sup>

The study period was 1 January 2012 to 8 September 2019. Mortality data were acquired from the Population Register Centre on 11 November 2019. Primary endpoints were mortality at 30 days and 3 years after the HEMS dispatch. Patients were followed until death, emigration, 30-day and 3-year follow-up, or 11 November 2019, whichever came first.

We were unable to obtain data on some confounding factors, including the decision to discontinue or limit life-sustaining care for patients who were deceased before hospital admission as well as interoperator variability in intensity of care or futile prognostication.

## Statistical methods

For normally distributed values, means with SD are reported, while non-normally distributed values are reported with medians and quartiles (25th and 75th quartiles, expressed as Q1/Q3). Proportions are reported as n (%). For comparisons between the groups, the Mann-Whitney U test was used for non-normally distributed numeric variables, whereas a two-sample t-test was used for normally distributed variables and  $\chi^2$  was used for categorical variables. For the test, a p value of <0.05 was used to guide the analysis of statistical importance. We used the SD of the means and IQRs, respectively, to assess the statistical and clinical implications in light of the status of the null hypothesis. A Kaplan-Meier graph was used to illustrate the long-term survival of the patient groups. These analyses were performed using IBM SPSS Statistics V.25 (IBM Corporation, Armonk, New York, USA). The mortality rates among diagnostic groups were estimated by calculation with GraphPad Prism for Mac V.8.41 (GraphPad Software, California, USA).

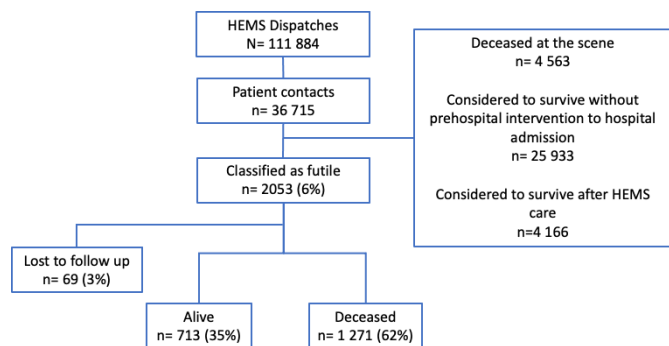
Data were anonymised before the authors accessed them for the purpose of this study. Strengthening the Reporting of Observational Studies in Epidemiology guidelines were followed in the reporting of the study.

## Patient and public involvement

No patients were involved.

## RESULTS

During the study period, HEMS participated in the care of 36 715 patients. A total of 2053 patients met the inclusion criteria and were consequently eligible for the study (figure 1). A total of 69 (3%) patients were lost to follow-up, either because of a lack of a valid social security



**Figure 1** Flow chart of the study patients. Percentages denote percentages of subgroups. HEMS, helicopter emergency medical services.

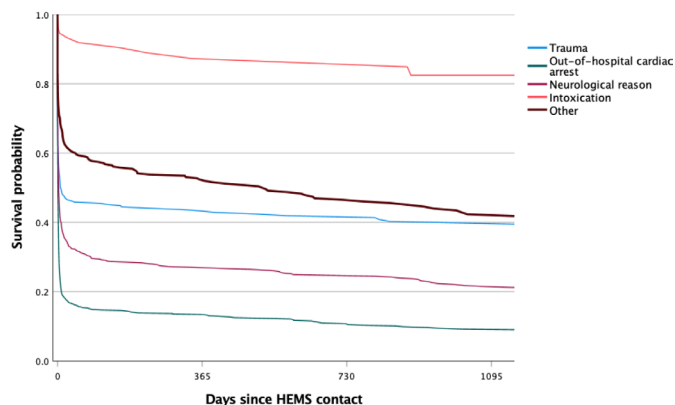
number or emigration. The characteristics of the patients are presented in [table 1](#).

The survival rate of the patients is presented in [figure 2](#). At 30 days, 713 (35%, 95% CI 33% to 37%) of the patients were still alive. Furthermore, at 1 year 524 (26%) and at 3 years 267 (13%) of the patients were still alive. The comparison between surviving and non-surviving patients is given in [table 1](#).

Prehospital critical care was more intense among non-survivors: drug-assisted endotracheal intubation was performed in 997 (79%) and 264 (37%) of non-survivors and survivors, respectively ( $p<0.001$ ). Vasoactive drugs were used in 742 (58%) and 218 (31%) of non-survivors and survivors, respectively ( $p<0.001$ ).

## DISCUSSION

The main results of this study include, first, that the overall accuracy of prognostication of critically ill patients by a prehospital critical care clinician is moderate, which carries a noteworthy risk of harm as it potentially leads to lower



**Figure 2** Kaplan-Meier survival comparison between patients classified not to survive without prehospital care but having no long-term survival. HEMS, helicopter emergency medical services.

intensity of treatment in patients exhibiting a change in survival prognosis.<sup>21</sup> A study performed in the same national HEMS demonstrated that prehospital clinicians limit treatment in cases considered futile due to serious medical history with deteriorated physical and/or mental performance.<sup>4</sup> In the current study, we were unable to evaluate the frequency of limiting treatment. Furthermore, some patients who died before hospital arrival may have died as a consequence of limiting or withdrawing high-intensity treatment, which was presented in a prior study among Finnish HEMS patients, where 4218 (13%) of a total of 33 499 patients met by the HEMS teams were declared deceased on scene.<sup>17</sup>

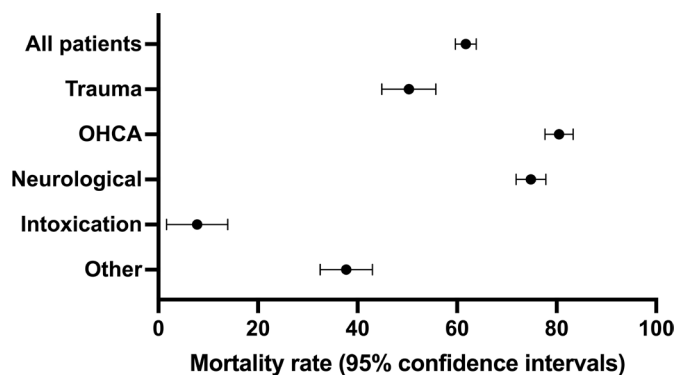
We observed significant differences in the prognostication of long-term survival between the diagnostic patient groups ([figure 3](#)). This observation has several possible explanations. The most accurately identified patient groups, including patients treated for OHCA<sup>16 22</sup> or trauma,<sup>9 10</sup> are

**Table 1** Characteristics of patients considered futile by a prehospital critical care physician. Data are presented as medians (first quartile/third quartile) or n (%)

	Considered futile (n=2053)	Alive at 30 days (n=713)	Deceased at 30 days (n=1271)	P values
Age, years (IQR)	68 (55/79)	62 (43/77)	72 (61/81)	<0.01
Sex, male (%)	1 290 (63)	451 (63)	801 (63)	0.97
Patient category, n (%)				
Trauma	322 (16)	141 (20)	162 (13)	<0.01
OHCA	748 (36)	122 (17)	603 (47)	<0.01
Neurological	581 (28)	188 (26)	379 (30)	<0.01
Intoxication*	78 (4)	69 (10)	5 (0.4)	<0.01
Other	324 (16)	193 (27)	122 (10)	<0.01
First vital signs (IQR)				
Heart rate	91 (73/110)	95 (79/110)	90 (70/110)	<0.01
Systolic blood pressure	134 (107/165)	130 (110/155)	139.5 (105/174)	<0.01
Oxygen saturation	96 (90/98)	97 (92/99)	96 (90/98)	<0.01
Glasgow Coma Scale	3 (3/7)	8 (3/15)	3 (3/5)	<0.01

\*Including alcohol, drugs of abuse, prescription drug overdose or combination of these.  
OHCA, out-of-hospital cardiac arrest.





**Figure 3** Mortality in different diagnostic groups among patients considered having no long-term survival after prehospital intervention. OHCA, out-of-hospital cardiac arrest.

characterised by well-described factors affecting the prognoses. These include, for example, time-delays, patient age, frailty, primary rhythm and type of trauma.<sup>23–25</sup> Adversely, the recognition of no long-term survival among neurological patients was poor. The difficulties in identifying these neurological patients might be due to heterogeneity in the causes of neurological symptoms. Also, patients considered as having no long-term survival may ultimately survive, but their neurological recovery and performance status might be clearly compromised.

The subgroup ‘Other’ occurred as a significant patient group in this study. Patients with reports such as chest pain, breathing difficulties or obstetrical and gynaecological emergencies were included in this group; but were minor proportions as individual subgroups and therefore not studied separately. In addition, the subgroup of intoxicated patients is heterogeneous as it includes alcohol, drugs of abuse, prescription drug overdose or combination of these, intoxications. Prognostication difficulties among intoxicated patients may result from the fact, that at prehospital stage the intoxication is the leading symptom and cause for interventions, but actually there could be underlying disorders, such as head trauma, acute psychiatric diseases or other medical incidents affecting the futility. Also, FHDB does not allow to specify whether the cause for the intoxication is an accidental recreational overdose or suicidal intent.

Patients deceased at 30 days were 10 years older on average and had lower Glasgow Coma Scores on scene. Otherwise, no clinically relevant difference was found in the prehospital vital parameters between the study groups. In general, patient age is often a single significant parameter when survival after critical medical incident is considered.<sup>5</sup> This is supported by the findings of this study.

Interestingly, the patients considered having poor prognosis received more resuscitative and invasive manoeuvres in the current study. One explanation could be that patients deceased at 30 days are in fact more ill. The level of consciousness in this group is primarily lower, and there seems to be more OHCA situations compared with the 30-day survivor group. These aspects might be related

to higher number of intubations and vasoactive medication. Other explanations for the findings include the possibility that some of the patients were treated actively as potential organ donors. Although the main goal is always to cure patients, should the condition progress after arrival to hospital, organ donation can literally save other lives.<sup>26</sup> Still, the different definitions of long-term survival may also play a role.

As far as we know, this is the first multicentre study to examine prehospital prognosis assessment based on clinical judgement.<sup>27–29</sup> The capability of HEMS physicians and paramedics to render a prognosis of patients considered as having no long-term survival who receive major benefits from prehospital intervention seems to be at best moderate. For this reason, a prognosis based on clinical judgement must be handled with a great degree of caution. However, it is also important to keep in mind that our research data were gathered in one country only; as such, different perspectives, cultural characteristics and clinical practices could affect the generalisability of these results. In addition, the data were not originally collected for the purposes of this retrospective study, which could affect the results on prognostication of long-term survival. Further studies will be needed to find the best ways to estimate long-term survival in a prehospital setting.

#### LIMITATIONS

This study has several limitations. At first, the research data were not collected specifically for study purposes; instead, the analyses were performed based on the recorded patient data of daily HEMS missions and mortality data gathered by the Population Register Centre. However, the FHDB served as an abundant source of realistic mission data covering all Finnish HEMS bases for several years.

In addition, we aimed to investigate the ability to prognosticate long-term survival in a prehospital setting. Our study focused on the long-term survival among patients considered to have received major benefits from prehospital intervention, but the FHDB did not include data concerning the limitations of treatments made either beforehand or during HEMS missions. We were also unable to include patients deceased before hospital arrival and therefore do not know how many of these patients were estimated to be futile by the prehospital clinician. Furthermore, patient comorbidities and prior frailty are a major aspect of prognostication. Even though this study focused merely on prehospital setting and knowledge of comorbidities or prior frailty is limited, patient background should be considered in future study settings. To evaluate prognostication ability fully, it would have been beneficial to also study patients evaluated as having no long-term survival but treated only in a palliative manner due to treatment limitations.

Finally, estimating the long-term survival of neurological patients proved to be especially difficult. In this study, we explored only mortality; however, data concerning neurological recovery or quality of life would have clarified this issue more thoroughly.

## CONCLUSION

The accuracy of the prognostication of critically ill patients by prehospital critical care clinicians was moderate. This needs to be taken into account in decision-making to avoid inadequately limiting or withdrawing vital treatment. This study underlines the uncertain nature of prehospital prognostication and decision-making.

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**Contributors** AH, JB, MT, TI, HJ and JN contributed to the conception and design of the study. AH, JB, MT, TI, HJ and JN contributed to the acquisition of data and provided substantial contributions to the drafting and revision of the manuscript. AH, JB and JN contributed to the analysis of the data. AH, JB, MT, TI, HJ and JN read and approved the final manuscript. JN was responsible for the overall content and acted as guarantor. AH, JB, MT, TI, HJ and JN agreed to be personally accountable for their own contributions and to ensure that questions related to the accuracy or integrity of any part of the work, even those in which the author was not personally involved, were appropriately investigated and resolved and that the resolution was thereafter documented in the literature.

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**Competing interests** None declared.

**Patient and public involvement** Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

**Patient consent for publication** Not applicable.

**Ethics approval** Study permission was requested and granted by all the participant hospital districts (Oulu University Hospital 200/2019 2.7.2019, Helsinki University Hospital HUS/280/2019 9.7.2019, Turku University Hospital J30/19 4.8.2019, Hospital District of Lapland 32/2019 22.8.2019, Kuopio University Hospital RPL 102/2019 22.8.2019, Tampere University Hospital RTL-R19580 2.9.2019). Ethical permission was requested and granted by the Ethical Board of the University of Helsinki (HUS/3115/2019 §194).

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**Data availability statement** Data are available upon reasonable request. The data sets analysed during the current study are available from the corresponding author on reasonable request.

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