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van Lieshout, E.J.

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Chapter 4

Decision-making in interhospital IC-transport – national questionnaire survey among critical care physicians -

Erik Jan van Lieshout

Rien de Vos

Jan M. Binnekade

Rob J. de Haan

Marcus J. Schultz

Margreeth B. Vroom

ABSTRACT

Objective

This study assessed the relative importance of clinical and transport-related factors in physicians' decision-making regarding the interhospital transport of critically ill patients.

Methods

The medical heads of all 95 ICUs in The Netherlands were surveyed with a questionnaire using 16 case vignettes to evaluate preferences for transportability; 78 physicians (82%) participated. The vignettes varied in eight factors with regard to severity of illness and transport conditions. Their relative weights were calculated for each level of the factors by conjoint analysis and expressed in beta. The reference value (beta = 0) was defined as the optimal conditions for critical care transport; a negative beta indicated preference against transportability.

Results

The type of escorting personnel (paramedic only: beta = -3.1) and transport facilities (standard ambulance beta = -1.21) had the greatest negative effect on preference for transportability. Determinants reflecting severity of illness were of relative minor importance (dose of noradrenaline beta = -0.6, arterial oxygenation beta = -0.8, level of peep beta = -0.6). Age, cardiac arrhythmia, and the indication for transport had no significant effect.

Conclusions

Escorting personnel and transport facilities in interhospital transport were considered as most important by intensive care physicians in determining transportability. When these factors are optimal, even severely critically ill patients are considered able to undergo transport. Further clinical research should tailor transport conditions to optimize the use of expensive resources in those inevitable road trips.

INTRODUCTION

Interhospital transport of critically ill patient may be indicated if additional care, whether technical, cognitive, or procedural, is not available at the existing location ¹.

Regionalization of intensive care medicine in centers with high patient volumes appears to improve outcome of patients and therefore may further increase the need for these transports ^{2,4}. The risks associated with interhospital transport should be weighted against its potential benefit for each individual critically ill patient ⁵⁻⁷. The use of specialized teams and appropriate equipment might reduce these risks ^{8,9}. Although guidelines have been developed to increase the safety of interhospital transport of critically ill patients clinical evidence lacks on factors determining the transportability of these patients ^{1,4}. Decision-making in interhospital transport involves appraisal of several determinants including patient characteristics, indication for transport, level of escort and transport facilities. The process of appraisal of these variables, however, has never been studied ¹⁰.

The aim of the present study was to assess the relative importance of clinical and transport related determinants influencing doctors' decision-making in interhospital transport of critically ill patients.

METHODS

We sent a national questionnaire survey with paper case descriptions, so-called clinical vignettes, to the medical heads (intensivist or supervising consultant) of all 95 intensive care units (ICU) in the Netherlands. Neonatal and pediatric ICUs were excluded. Questionnaires were anonymous but coded so non-responders could be followed up with a postal reminder two months later. A prepaid envelope was included for its return and a web based version was available for digital responses.

THE QUESTIONNAIRE

The questionnaire consisted of two parts: (a) characteristics of the respondent and its ICU including frequency of interhospital ICU-transport from their hospital; (b) 16 clinical vignettes.

CLINICAL VIGNETTES

The 16 clinical vignettes are showed in table 1. We identified eight potential determinants in decision making of IC-transport which are known from clinical studies and critical care transport experience from the authors [1;6-9;11;12]. The determinants were incorporated in the clinical vignettes: (1) age (30 *versus* 60 *versus* 80 years); (2) arterial oxygenation pressure (7,5 *versus* 16,5 kPa); (3) level of positive expiratory pressure (PEEP) (8 *versus* 18 cm H₂O); (4) dose of noradrenalin infusion (0,12 *versus* 0,60 µg/kg/min); (5) arrhythmia (self-terminating ventricular tachycardia < 24 hours *versus* no arrhythmia within six hours); (6) transport facility (fully equipped Mobile Intensive Care Unit, i.e. IC-ventilator, IC-monitor including invasive blood pressure monitoring and capnography, sufficient number of syringe pumps) *versus* standard ambulance (i.e. transport ventilator without IC-performance, no invasive and capnography monitoring); (7) escorting personnel paramedic (advanced life support paramedic characterized by i.e. protocolised ALS with medication, CPR-intubation) *versus* IC-physician & paramedic *versus* IC-nurse & paramedic *versus* team of IC-physician & IC-nurse & paramedic; (8) indication for transport (shortage of ICU-beds in referring hospital *versus* essential intervention not available in referring hospital).

As 768 case descriptions were needed to present all possible combinations of the 8 determinants and their levels, the number of representative clinical vignettes were reduced to 16 using an orthogonal main-effects design ¹³ This approach permits the statistical testing by conjoint analysis of a suitable fraction of all possible combinations of the factors (determinants) and their levels.

Respondents were asked to rate the degree of transportability, defined as their personal clinical decision if they would let this patient be transported, for each of the 16 critically ill patients described in clinical vignettes. A seven point Likert scale was used ranging from 1 ("entirely not transportable") to 7 ("definitely transportable"). It was emphasized that no true or false answers were sought but their clinical judgment.

Table 1. Characteristics of responding Intensive Care physicians and their hospitals

| Characteristics | value |
|---|-------------|
| N = | 78 |
| Mean age (years) | 45 (SD 6,6) |
| Medical specialty (%) * | |
| Intensive Care Medicine | 66 (86 %) |
| Anesthesiology | 37 (48 %) |
| Internal Medicine | 34 (44 %) |
| Surgery | 1 (1%) |
| Other | 5 (7%) |
| Type of hospital | |
| academic medical center | 13 (17 %) |
| teaching hospital, non-academic | 34 (44 %) |
| regional public hospital | 30 (38 %) |
| Number of beds in ICU | |
| median [range] | 8 [2-42] |
| Number of interhospital transport per month | |
| median [range] | 1 [0,01-12] |

* multiple specialties per physician possible

STATISTICAL ANALYSIS

The means and standard deviations for continuous variables and distributions for frequency of categorical variables were summarized using descriptive statistics.

Conjoint analysis was performed with transportability as dependent variable to calculate the relative weights for each level of the determinants [ref Aiman-Smith ea Organizational Research...]. This results in a utility score for each determinant level expressed in β with 95% confidence interval. These utility scores, estimated through least-squares regression analogous to regression coefficients, provide a quantitative measure of the preference for each determinant level, with larger values corresponding to greater preference.

By considering the individual respondents as random effects, it was taken into account that the preference score originating from 16 repeated measurements. Determinants with a negative β indicated preference against transportability. The reference value, with by definition $\beta = 0$, was defined as the optimal conditions for critical care transport (youngest age, highest PaO₂, lowest dose of noradrenalin, no arrhythmia, fully equipped mobile ICU ambulance, escorting team of IC - and IC-nurse, intervention required not available in own facility). The conjoint analysis was repeated in relation to 1) type of hospital the respondents were working in: regional hospital versus teaching / university

hospital, 2) speciality of the respondent and 3) the method of data collection: paper versus online questionnaire.

RESULTS

Of the 95 questionnaires 78 (=82%) were returned and all were suitable for analysis.

The mean age of the respondents was 45 (\pm 6.6) years (table 2). Most of them (n=66, 86%) were registered as intensivists with either anesthesiology or internal medicine as their medical speciality. The median number of interhospital transport leaving from their ICU was one per month with a considerable range [0.01-12].

The impact of the determinants in the decision making on transportability is displayed in figure 1. Those with the largest negative effects on preference for transportability were the type of escorting personnel (paramedic only: β = -3.1 [-3.7 - -2.5], IC-nurse & paramedic β = -2.1 [-2.5 - -1.7], IC-physician & EMT β = -1.0 [-1.2 - -0.8] and transport facilities (standard ambulance β = -1.21 [-1.7 - -0.8]). Determinants reflecting the critically ill patients' condition and intensity of treatment were scored to be of relative minor importance (dose of noradrenalin β = -0.6 [-1.0 - -0.1], arterial oxygenation β = -0.8 [-1.3 - -0.4], and level of PEEP β = -0.6 [-1.0 - -0.1]). Age (60 years β = 0.1 [-0.2 - 0.3], 80 years β = 0.1 [-0.4 - 0.7]), cardiac arrhythmia (β = 0.1 [-0.4 - 0.5]), and the indication for transport (β = -0.3 [-0.8 - 0.1]) had no significant influence on the preference for transportability (figure 1).

Repeated analyses did not demonstrate significant differences in relative weights of the determinants in relation to respondents' working location (regional hospital versus large teaching hospital or academic medical center), type of medical speciality nor method of data collection (paper vs. online).

Table 2. The 16 case vignettes

Basic structure of each case vignette:

Patient admitted to ICU after initial presentation in the emergency department with severe sepsis (probably pneumococcal), APACHE-II of 18, mean arterial pressure of 70 mmHg after adequate fluid-resuscitation, endotracheally intubated and mechanically ventilated with 50% FiO₂ and after six hours in the ICU need for interhospital transport.

| Case vignettes | | | | | | | | |
|--------------------------|---------|------------------|---------------------|--------------|----------------------|-----------------|-------------------------|--------------------------|
| Patients characteristics | | | | | Transport conditions | | | |
| | age | paO ₂ | PEEP | noradrenalin | arrhythmia | Equipment | Escorting personnel | Indication for transport |
| nr | (years) | (kPa) | cm H ₂ O | µg/kg/min | | | | |
| 1 | 30 | 16.5 | 18 | 0.12 | VT* < 24 hrs | MICU** trolley | IC-nurse | lack of ICU beds |
| 2 | 30 | 16.5 | 8 | 0.12 | none | basic ambulance | IC-physician & IC-nurse | intervention elsewhere |
| 3 | 30 | 16.5 | 18 | 0.6 | none | basic ambulance | paramedic | lack of ICU beds |
| 4 | 30 | 7.5 | 8 | 0.6 | none | basic ambulance | IC-physician | lack of ICU beds |
| 5 | 30 | 7.5 | 8 | 0.12 | VT < 24 hrs | MICU trolley | IC-physician & IC-nurse | lack of ICU beds |
| 6 | 80 | 7.5 | 8 | 0.6 | VT < 24 hrs | basic ambulance | IC-nurse | intervention elsewhere |
| 7 | 80 | 16.5 | 8 | 0.12 | VT < 24 hrs. | basic ambulance | paramedic | lack of ICU beds |
| 8 | 60 | 7.5 | 8 | 0.12 | none | MICU trolley | paramedic | intervention elsewhere |
| 9 | 30 | 7.5 | 18 | 0.12 | none | basic ambulance | IC-nurse | intervention elsewhere |
| 10 | 30 | 7.5 | 18 | 0.60 | VT < 24 hrs | MICU trolley | paramedic | intervention elsewhere |
| 11 | 30 | 16.5 | 8 | 0.60 | VT < 24 hrs | MICU trolley | IC-physician | intervention elsewhere |
| 12 | 60 | 16.5 | 18 | 0.60 | VT < 24 hrs | basic ambulance | IC-physician & IC-nurse | intervention elsewhere |
| 13 | 80 | 16,5 | 18 | 0.12 | none | MICU trolley | IC-physician | intervention elsewhere |
| 14 | 60 | 7,5 | 18 | 0.12 | VT < 24 hrs | basic ambulance | IC-physician | lack of ICU beds |
| 15 | 60 | 16.5 | 8 | 0.60 | none | MICU trolley | IC-nurse | lack of ICU beds |
| 16 | 80 | 7.5 | 18 | 0.60 | none | MICU trolley | IC-physician & IC-nurse | lack of ICU beds |

* VT = ventricular tachycardia (self terminating)

** MICU = Mobile Intensive Care Unit

focuses on the technical and organizational aspects of transport^{1;9;12,14}. The use of specialized transport teams and appropriate equipment may result in a decrease in transport associated morbidity and mortality by creating an intensive care environment in a vehicle – ground ambulance or aircraft^{8;9;15;16-18}.

Despite the growth of interhospital transport due to regionalization of intensive care medicine the process by which IC-physicians identify patients transportability is not well known^{3;10}. Transportability as a result of a professional analysis of the balance between risks and potential benefits of an individual transport is hard to define.

The accumulating literature on improved outcome associated with ICUs treating larger volumes of patients (e.g., with severe sepsis or mechanical ventilation) is not adequately accompanied by research on clinical parameters determining transportability in such conditions^{19;20}. In a study of Lee et al, a questionnaire with clinical scenarios was used before and after a program including a 15 minute-training in the use of interhospital transfer rules¹⁰. After the start of the program clinical staff was able to make appropriate decisions by using these guidelines focusing on diagnosis and physiology. However, mimicking decision-making in interhospital transport with appraisal of several realistic and detailed determinants as in daily clinical practice (i.e. as those in tested in this conjoint analysis) by experienced intensivists who endorse such transports has, to our knowledge, never been studied.

Age is an important prognostic factor for mortality rates are higher in elderly than in younger ICU-patients²¹. This has not been studied in transported IC-patients but it is conceivable that intensivist would weigh this determinant in their transportability decision. The finding of the present study that the age levels studied did not influence decision-making for transportability is remarkable. The same holds true for the level of PEEP which seems representative for severity of oxygenation and is known to be a critical factor in transport²². IC-physicians however, seem to appreciate factors associated with severity of illness (age, PEEP, noradrenaline dose, oxygenation) as less important compared to transport conditions. The international guidelines underlines the importance of these conditions but clinical transport studies and recommendations are lacking to address the issue of transport-related morbidity and mortality of extreme critical ill patients despite optimal expertise and equipment^{7;9;17; 22}.

One of the limitations of this study is the intrinsic shortcoming of the vignettes methods. Paper case descriptions, so-called clinical vignettes, have been recognized as a valid policy capturing tool to assess preferences in clinical practice^{24;25}. However, it is impossible to overcome the sentinel effect in which the physicians know they are being evaluated. Due to this Hawthorne effect, there might be discrepancy between doctors' decisions in practice and their answers to vignettes with hypothetical patients. Another limitation is the choice of content of the vignettes with eight determinants of transportability. The content of vignettes survey is limited to a number of determinants with their

corresponding levels as an intrinsic element of conjoint analysis to generate an optimal number of vignettes a respondent would still adequately evaluate.

The chosen set of determinants used in this study is based only on literature and critical care transport experience and could therefore be biased ^{1;7;9;22;26;27}. Other unknown influencing determinants could not be studied as critical in transport. Those factors would only be revealed in clinical transport studies documenting all clinical parameters and relate them with clinical outcome after transport. Finally, this national questionnaire survey is limited by the Dutch situation where, due to geography, interhospital transport is executed with ground ambulance without air medical transport. It is conceivable that the choice of vehicle is a crucial determinant in the decision making in combination with the interhospital distance ²⁸.

CONCLUSIONS

This policy capturing study indicates the importance of optimal escorting and transport facilities in interhospital transport as appreciated by IC-physicians. These conditions are considered to be essential and enable even severe critically ill patients to be transported. Further clinical (transport) research should reveal which levels of expertise and transport facilities are indicated for which category of critically ill patients to tailor the use of expensive resources required for those inevitable road trips ^{9;17}.

LIST OF ABBREVIATIONS

ICU = Intensive Care Unit

COMPETING INTERESTS

The authors declare that they have no competing interests.

AUTHORS' CONTRIBUTIONS

EJvL designed the study, performed the measurements, assisted in the statistical analyses and drafted the manuscript. RdV designed the study, performed the statistical analysis and participated in drafting the manuscript. JMB performed the statistical analysis and participated in drafting the manuscript. RdH participated in the statistical analysis and

drafting the manuscript. MJS and MBV participated in the study design and drafting the manuscript. All authors read and approved the final manuscript.

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