Cost-effectiveness and quality-of-life analysis of physician-staffed helicopter emergency medical services

A. N. Ringburg[1], S. Polinder[2], T. J. Meulman[1], E. W. Steyerberg[2], E. M. M. van Lieshout[1], P. Patka[1], E. F. van Beeck[2] and I. B. Schipper[1,*]

Departments of [1]Surgery–Traumatology and [2]Public Health, Erasmus MC, University Medical Centre, Rotterdam

[*]Current address: Department of Surgery–Traumatology, Leiden University Medical Centre, Leiden, The Netherlands

Correspondence to: Dr A. N. Ringburg, Department of Surgery–Traumatology, Erasmus MC, University Medical Centre Rotterdam, PO Box 2040, 3000 CA Rotterdam, The Netherlands (e-mail: a.ringburg@erasmusmc.nl)

Abstract

Background: The long-term health outcomes and costs of helicopter emergency medical services (HEMS) assistance remain uncertain. The aim of this study was to investigate the cost-effectiveness of HEMS assistance compared with emergency medical services (EMS).

Methods: A prospective cohort study was performed at a level I trauma centre. Quality-of-life measurements were obtained at 2 years after trauma, using the EuroQol – Five Dimensions (EQ-5D) as generic measure to determine health status. Health outcomes and costs were combined into costs per quality-adjusted life year (QALY).

Results: The study population receiving HEMS assistance was more severely injured than that receiving EMS assistance only. Over the 4-year study interval, HEMS assistance saved a total of 29 additional lives. No statistically significant differences in quality of life were found between assistance with HEMS or with EMS. Two years after trauma the mean EQ-5D utility score was 0.70 *versus* 0.71 respectively. The incremental cost–effectiveness ratio for HEMS *versus* EMS was €28 327 per QALY. The sensitivity analysis showed a cost–effectiveness ratio between €16 000 and €62 000.

Conclusion: In the Netherlands, the costs of HEMS assistance per QALY remain below the acceptance threshold. HEMS should therefore be considered as cost-effective.

A: Introduction

In most Western countries, helicopter emergency medical services (HEMS) are available to provide on-scene assistance to trauma patients[1]. HEMS can be requested by the dispatch centre or by regular emergency medical services (EMS) already at the accident site. The type and quality of care provided by HEMS may differ depending on local (regional and national) circumstances, needs and appointments. Depending on these conditions, HEMS may be staffed by physicians, flight nurses or paramedics[2]. As these professionals have different levels of certification, they provide different therapeutic options to patients at the accident site. The utilization of HEMS may also differ as a result of topographical and infrastructural diversity (urban, rural or inaccessible areas)[3]. HEMS are used to cover long-distance patient contacts and to transport advanced life support to the scene of an accident, after which a patient is transported to hospital by ambulance or helicopter. Owing to limited conclusive literature, the health effects of HEMS remain uncertain. However, published reviews have reported positive effects of HEMS assistance on survival, as has also been observed in the Netherlands[4–8].

Another important question is the cost of this care. It is well known that prehospital trauma care provided by HEMS is relatively expensive. In an era where healthcare cost savings have a high priority for governments, expensive treatment modalities and health services are monitored carefully.

Studies into the cost-effectiveness of HEMS are limited[4,8–10]. To date, only two studies on survival and quality of life (QoL) in combination with costs per quality-adjusted life year (QALY) have been published[9,11]. These two studies reported costs per QALY for HEMS of between €7300 and €37 700 (US $9300–47 900)[9,11]. The use of costs per QALY as an outcome measure is important and allows comparison of the efficiency of different types of healthcare service with one another. It also may support decisions to restrict investment to services with costs per QALY below a predefined acceptance threshold. The acceptance of cost per QALY is, however, not an absolute figure. Policy-makers and healthcare economists have proposed that costs varying from €25 000 up to €75 000 (US $31 800–95 300) per QALY may be considered acceptable[12–14].

In 1995, when HEMS were introduced in the Netherlands, a cost–effectiveness study was undertaken[11]. The Dutch trauma system has since been developed and now covers the entire country[15]. The organization of the trauma system, as well as the level of training of HEMS physicians, nurses and the trauma centre doctors, has improved since then. In consequence, a well designed study was needed to measure the effects of HEMS on survival and QoL. This cost–effectiveness analysis is presented here. The study hypothesis was that the costs per QALY for HEMS in the Netherlands were below the acceptance threshold.

+A: Methods

For survival and cost calculations, data were collected from 1 January 2003 to 31 December 2006. During this 4-year study period a prospective cohort study was conducted that included all consecutive patients with polytrauma aged over 13 years with an Injury Severity Score (ISS)[16] greater than 15, who were admitted to the emergency department of a level I trauma centre. Patients identified as dead on arrival at the scene of the accident were excluded from the study.

Data were extracted from the trauma registry, which includes the same variables as in the Major Trauma Outcome Study (MTOS) database[1] (age, Glasgow Coma

Scale (GCS)[17] score, Revised Trauma Score (RTS)[18], mechanism of trauma and details of injuries). Missing data were obtained from the original ambulance charts. All patients receiving on-scene EMS and HEMS assistance were included in the HEMS group. Patients treated only by EMS services were included in the EMS group.

+B: Survival calculations

Estimated survival was determined with the Trauma Injury Severity Score (TRISS) method, which includes the ‘predicted mortality’[19]. The TRISS (logistic regression-based) method is the multivariable approach of choice[20]. The coefficients used in the TRISS model are derived from the MTOS[1]. To compare case mix between the regular MTOS population and this study population, the M statistic must be calculated. Although M does not follow a specific distribution, it is generally considered acceptable to apply the uncorrected TRISS when M is 0.88 or higher[21]. As the value of M in the authors’ population was 0.38, a custom-fitted regression model was used to calculate predicted survival. Construction of the logistic regression was analogous to the method described by Frankema and colleagues[7]. After evaluating variables for their contribution to the model, the following variables were finally included in the regression model: RTS – systolic blood pressure, RTS – respiratory rate, RTS – GCS, ISS[16], mechanism of trauma, age, sex and type of care (HEMS or EMS). The performance of the regression model in terms of goodness of fit was tested with the Hosmer–Lemeshow (HL) statistic, and its discriminative value was assessed by calculating the area under the receiver operating characteristic (ROC) curve. The regression model was used to determine the number of lives saved by HEMS assistance.

+B: Quality-of-life measurements

The EuroQol – Five Dimensions (EQ-5D) was used as a generic measure to determine health status 2 years after trauma. The EQ-5D is generally recommended for economic evaluation of trauma care at a consensus conference[22]. A domain-related scoring algorithm based on empirical valuations from the UK general population and subsequent statistical modelling is available, by means of which each health status description can be expressed as a utility score[23]. This summary score ranges on a scale from 1 to −0.059 (1 and 0 indicate full health and death respectively), and can be used to judge the relative quality of a health status compared with perfect health. Negative values for summary scores (−0.059) are possible because EQ-5D defines states worse than death, such as persistent vegetative health status[23]. Death was defined as within 30 days of the trauma. At 24 months after trauma admission, all included survivors from 2003 until 2005 received a written questionnaire by post. If there was no response after 1 month, patients were telephoned in an attempt to increase participation.

+B: Cost calculations

Medical costs were calculated by multiplying the volumes of healthcare used with the corresponding unit prices in 2006. The costs per in-hospital patient-day (including intensive care stay), emergency department costs, operating costs, costs of diagnostics, and outpatient department visit costs were included in the direct medical cost calculations. Cost volumes were recorded with hospital information systems, and the patient questionnaire. The questionnaire also included questions relating to long-term medical care (rehabilitation costs). In the Netherlands, a detailed ‘fee for service’ system is used for the remuneration of medical interventions and diagnostic procedures[24], enabling calculation of micro-costs. Thus, medical costs were determined by multiplying the volumes of healthcare used per individual patient with the corresponding official Dutch unit prices for each diagnostic or therapeutic procedure. The cost of the HEMS assistance was based on the actual cost as found in the balance of payments of 2003 to 2006.

+B: Cost–effectiveness analysis

Cost-effectiveness was assessed by calculating the incremental cost–effectiveness ratio, defined by the difference in mean costs between the two prehospital emergency care approach strategies (HEMS and EMS) divided by the difference in average health effects. The effect is expressed as quality-adjusted life years (QALYs). A QALY takes into account the premature loss of life from death by using years of life lost, and the length of time without full health for non-fatal conditions as measured by years lived with disability. The QALY provides a means of combining the impact of fatal and non-fatal outcomes in a single measure. The incremental costs of HEMS consisted of the extra costs per HEMS-treated patient compared with patients in the EMS group.

+B: Discounting

It is generally accepted practice in economic evaluations to discount future costs and benefits arising from healthcare interventions to reflect individuals' and society's time preference[25]. To compare the benefits that occur over time, benefits occurring in future years must be adjusted to relate to the 'present value' in which the costs are spent. A discount rate of 1.5 per cent for the benefits was used, as recommended in the Dutch guidelines for economic evaluations in this study[26].

+B: Statistical analysis

As discount rates vary over time and across countries, the effect of using different discount rates on the results obtained by sensitivity analysis was determined. An annual discount rate of 0 and 3.5 per cent for benefits was used because the rate of 3.5 per cent was recommended by the National Institute for Health and Clinical Excellence. Statistical analyses were performed using SPSS® version 12.0 (SPSS, Chicago, Illinois, USA). $P<0.050$ was considered statistically significant.

+A: Results

+B: Effect of helicopter emergency medical services assistance on survival

During the 4-year study interval, 781 patients were admitted to the emergency department of a level I trauma centre. The majority of patients were men (72.6 per cent) and sustained blunt force trauma (91.3 per cent) (*Table 1*). Patients in the HEMS group were younger than those in the EMS group (median age 36 *versus* 43 years respectively), had more disturbed vital parameters (median GCS 3 *versus* 13; median RTS 8 *versus* 12) and were more severely injured (median ISS 29 *versus* 22). In the HEMS population, relatively more patients were artificially ventilated (49.7 *versus* 14.0 per cent in the EMS group). The unadjusted mortality rate for the two groups was comparable (*Table 1*).

The HL statistic showed that the regression model had an appropriate goodness of fit ($R^2 = 6$, $P = 0.650$). The area under the ROC curve was 0.90, indicating excellent discriminative power. The survival analyses showed that that over the study period

HEMS assistance saved a total of 29 additional lives. The TRISS method gave results comparable to those of the regression model used in this study (HEMS saved 27.5 more lives than predicted by TRISS (Z = 4.47, P<0.001; W statistic = 8.86)), although with an M value of 0.38 no reliable conclusions could be drawn based on the TRISS method. The results of the regression model were therefore used for subsequent calculations.

+B: Quality of life

Of the 781 patients with polytrauma (ISS above 15), 654 (from 2003 to 2005) were sent a written questionnaire 24 months after the trauma. Of these, 454 patients had survived their injuries. Follow-up data for 255 patients were obtained (response rate 56.2 per cent). Of the 199 patients who did not participate, 194 were untraceable, one could not be included because of communication difficulties, and four were unwilling to participate. The health status of patients who were finally included showed an EQ-5D summary score of 0.70 2 years after trauma; this was far below that of the Dutch general population norm of 0.87[27]. No statistically significant differences in quality of life were found between patients assisted by HEMS and those assisted by EMS. Two years after trauma, the mean EQ-5D utility score was 0.70 *versus* 0.71 respectively, and the prevalence of physical and physiological limitations for the total patient population was high for all EQ-5D dimensions (mobility, 43.9 per cent; self-care, 18.9 per cent; usual activities, 54.6 per cent; pain and discomfort, 61.4 per cent; anxiety and depression, 40.2 per cent) (*Fig. 1*). There were no significant differences between the two groups for any of the separate health domains measured with the EQ-5D. On some dimensions (mobility, self-care and usual activities) the prevalence of limitations was slightly lower for HEMS than for EMS assistance, but for the others (pain, anxiety/depression and emotion) the reverse was found.

+B: Costs

The average medical treatment costs for HEMS-assisted patients were €39 200 (*Table 2*). The main costs related to length of hospital admission (€10 300) and intensive care stay (€16 100). The average costs for an ambulance-assisted patient were significantly lower at €34 500 (*P*=0.016). This difference was due mainly to costs for intensive care and diagnostic modalities, resulting in incremental costs for medical care of €4700 per HEMS-assisted patient.

+B: Cost–effectiveness analysis

The costs for the 4 years of HEMS assistance totalled €11 314 972 (€5 574 878 for personnel and €5 740 094 for material costs). The total incremental costs of medical were €987 000 (€4700 for each of the 210 surviving HEMS patients over 4 years). The total cost for HEMS assistance was calculated as €12 301 972 (actual HEMS cost of €11 314 972 plus the total incremental cost of €987 000). Based on these calculations, when using the recommended discount rate of 1.5 per cent, the costs for HEMS were €28 327 per QALY (*Table 3*). In a sensitivity analysis performed to test the effect of using different discount rates, the costs per QALY for HEMS when using a discount rate of 0.0 or 3.5 per cent were €16 000 and €62 000 respectively.

+A: Discussion

HEMS assistance is effective in saving the lives of moderately and severely injured trauma patients. The study population receiving HEMS assistance was more severely injured than those receiving only EMS assistance. The incremental costs for intramural care were €4700 for HEMS-treated patients, determined mainly by the costs of intensive care stay and diagnostic modalities used. Over the study interval, HEMS assistance saved a total of 29 additional lives. No statistically significant differences in quality of life were found between HEMS and EMS-assisted patients. Two years after trauma, the mean EQ-5D utility score was 0.70 *versus* 0.71 respectively. The incremental cost–effectiveness ratio for the use of HEMS rather than EMS was €28 327 per QALY.

Functional outcome and quality of life of survivors of severe injury do not return to normal 2 years after trauma. The prevalence of specific limitations in this population is high (40–61 per cent), and differences between HEMS- and EMS-assisted patients in the EQ-5D summary score and all specific health dimensions were small, non-significant and inconsistent. In previous studies[28,29], determinants of long-term functional consequences of major trauma have demonstrated good performance of EQ-5D in survivors of major trauma, in terms of discriminative power and sensitivity to change. As well validated instruments were used in the present study, the reported high prevalence of problems is a good reflection of the health situation of patients with major trauma.

The sensitivity analysis showed that the choice of discount rate greatly influenced the findings of the cost–effectiveness analysis. Use of a discount rate of 0 *versus* 3.5 per cent resulted in a cost–effectiveness ratio of €16 000 and €62 000 respectively. Both of these values are below the acceptance threshold of €75 000 per QALY[12–14]. To put these results of costs per QALY into greater perspective, comparison can be made with the costs of other treatment modalities regularly performed in the

Netherlands. For example, for liver, heart and lung transplantation, the costs per QALY are €35 100, €36 800 and €79 500 respectively[30].

The relatively low response rate of 56 per cent could be regarded as a limitation of the present study and may have affected the costs per QALY. Much of the study population was untraceable because the patients were not living in the Netherlands and were consequently lost to follow-up.

When the health status of the study population at 2 years after trauma was compared with quality-of-life measurements at 1 year in a comparable cohort during the same study interval, QoL at 2 years was slightly lower than that reported at 1 year (mean EQ-5D utility score 70 *versus* 73). This finding has been reported previously[31]. A possible explanation is that patients with disturbed health status are more likely to participate in QoL measurements. In this case, the low response rate in the present study could have influenced the QoL score, and the actual health status of the whole study population might have been higher than measured. A better average health status would have resulted in lower costs per QALY.

With calculated incremental costs for medical care of €4700 per HEMS-assisted patient, the costs per QALY for HEMS in the Netherlands remain below the acceptance threshold. Thus, HEMS should be considered as cost effective.

Acknowledgements

The authors are grateful to S. P. G Frankema for help with the survival calculations.

The authors declare no conflict of interest.

References

1 Champion HR, Copes WS, Sacco WJ, Lawnick MM, Keast SL, Bain LW Jr *et al*. The Major Trauma Outcome Study: establishing national norms for trauma care. *J Trauma* 1990; **30**: 1356–1365.

2 Baxt WG, Moody P. The impact of a physician as part of the aeromedical prehospital team in patients with blunt trauma. *JAMA* 1987; **257**: 3246–3250.

3 Ringburg AN, de Ronde G, Thomas SH, van Lieshout EM, Patka P, Schipper IB. Validity of helicopter emergency medical services dispatch criteria for traumatic injuries: a systematic review. *Prehosp Emerg Care* 2009; **13**: 28–36.

4 Gearhart PA, Wuerz R, Localio AR. Cost-effectiveness analysis of helicopter EMS for trauma patients. *Ann Emerg Med* 1997; **30**: 500–506.

5 Thomas SH. Helicopter emergency medical services transport outcomes literature: annotated review of articles published 2000–2003. *Prehosp Emerg Care* 2004; **8**: 322–333.

6 Thomas SH. Helicopter EMS transport outcomes literature: annotated review of articles published 2004–2006. *Prehosp Emerg Care* 2007; **11**: 477–488.

7 Frankema SP, Ringburg AN, Steyerberg EW, Edwards MJ, Schipper IB, van Vugt AB. Beneficial effect of helicopter emergency medical services on survival of severely injured patients. *Br J Surg* 2004; **91**: 1520–1526.

8 Oppe S, De Charro FT. The effect of medical care by a helicopter trauma team on the probability of survival and the quality of life of hospitalised victims. *Accid Anal Prev* 2001; **33**: 129–138.

9 <B>Nicholl J, Turner J, Stevens K, O’Keeffe C, Cross L, Goodacre S *et al*. *A Review of the Costs and Benefits of Helicopter Emergency Ambulance Services in England and Wales: Final Report to the Department of Health*. University of Sheffield, Medical Care Research Unit: Sheffield, 2003.

10 Snooks HA, Nicholl JP, Brazier JE, Lees-Mlanga S. The costs and benefits of helicopter emergency ambulance services in England and Wales. *J Public Health Med* 1996; **18**: 67–77.

11 <B>Hübner BL. Evaluation of the immediate effects of preclinical treatment of severely injured trauma patients by Helicopter Trauma Team in the Netherlands. Thesis. Vrije Universiteit Amsterdam: Amsterdam, 1999.

12 <B>World Health Organization. *Macroeconomics and Health: Investing in Health for Economic Development. Report of the Commission on Macroeconomics and Health*. WHO Commision on Macroeconomics and Health: Geneva, 2001.

13 de Hollander AE, Melse JM, Lebret E, Kramers PG. An aggregate public health indicator to represent the impact of multiple environmental exposures. *Epidemiology* 1999; **10**: 606–617.

14 Towse A, Pritchard C. National Institute for Clinical Excellence (NICE): is economic appraisal working? *Pharmacoeconomics* 2002; **20**(Suppl 3): 95–105.

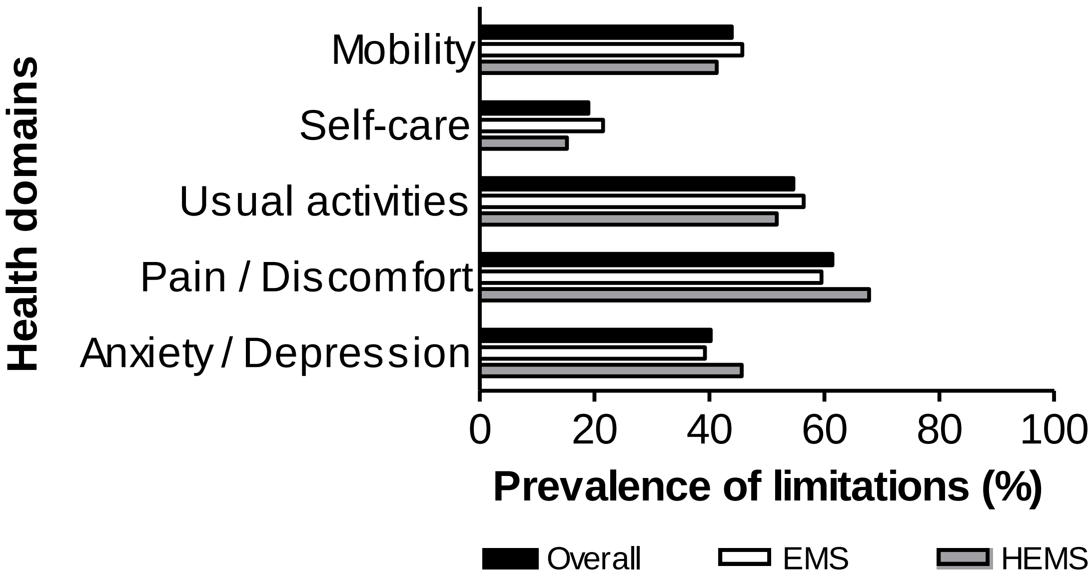
15 ten Duis HJ, van der Werken C. Trauma care systems in the Netherlands. *Injury* 2003; **34**: 722–727.

16 Baker SP, O’Neill B, Haddon W Jr, Long WB. The injury severity score: a method for describing patients with multiple injuries and evaluating emergency care. *J Trauma* 1974; **14**: 187–196.

17 Teasdale G, Jennett B. Assessment of coma and impaired consciousness. A practical scale. *Lancet* 1974; **2**: 81–84.

18 Champion HR, Sacco WJ, Copes WS, Gann DS, Gennarelli TA, Flanagan ME. A revision of the Trauma Score. *J Trauma* 1989; **29**: 623–629.
19 Boyd CR, Tolson MA, Copes WS. Evaluating trauma care: the TRISS method. Trauma Score and the Injury Severity Score. *J Trauma* 1987; **27**: 370–378.
20 Glance LG, Osler TM, Dick AW. Evaluating trauma center quality: does the choice of the severity-adjustment model make a difference? *J Trauma* 2005; **58**: 1265–1271.
21 Joosse P, Goslings JC, Luitse JS, Ponsen KJ. M-study; arguments for regional trauma databases. *J Trauma* 2005; **58**: 1272–1276.
22 Bouillon B, Kreder HJ, Eypasch E, Holbrook TL, Kreder HJ, Mayou R *et al*. Quality of life in patients with multiple injuries – basic issues, assessment, and recommendations. *Restor Neurol Neurosci* 2002; **20**: 125–134.
23 Dolan P. Modeling valuations for EuroQol health states. *Med Care* 1997; **35**: 1095–1108.
24 <B>Oostenbrink JB, Bouwmans CAM, Koopmanschap MA, Rutten FFH. *Handleiding voor Kostenonderzoek Methoden en Standaard Kostprijzen voor Economische Evaluaties in de Gezondheidszorg*. College voor Zorgverzekeringen: Diemen, 2004.
25 <B>Drummond M, Sculpher M, Torrance G, O'Brien B, Stoddart G. *Methods for Economic Health Care Programmes* (3rd edn). Oxford University Press: Oxford, 2005.
26 <B>*Richtlijnen voor Farmaco-Economisch Onderzoek, Geactualiseerde Versie*. College voor Zorgverzekeringen: Diemen, 2006.
27 Hoeymans N, van Lindert H, Westert GP. The health status of the Dutch population as assessed by the EQ-6D. *Qual Life Res* 2005; **14**: 655–663.
28 Holtslag HR, van Beeck EF, Lindeman E, Leenen LP. Determinants of long-term functional consequences after major trauma. *J Trauma* 2007; **62**: 919–927.
29 Vles WJ, Steyerberg EW, Essink-Bot ML, van Beeck EF, Meeuwis JD, Leenen LP. Prevalence and determinants of disabilities and return to work after major trauma. *J Trauma* 2005; **58**: 126–135.
30 <B>Rutten FFH. Interpretation and use of cost-effectiveness analysis. In *From Cost to Effects: a Manual for Evaluation Studies in Health Care*, Rutten-van Mölken MPMH, Busschbach JJV, Rutten FFH (eds). 2000.
31 Polinder S, van Beeck EF, Essink-Bot ML, Toet H, Looman CW, Mulder S. Functional outcome at 2.5, 5, 9, and 24 months after injury in the Netherlands. *J Trauma* 2007; **62**: 133–141.

Fig. 1 Prevalence of physical and physiological limitations (moderate or severe) in the each of the EuroQol – Five Dimensions health domains 2 years after trauma according to type of prehospital trauma care: helicopter emergency medical services (HEMS) *versus* emergency medical services (EMS). There were no statistically significant differences between the groups (χ^2 test)



Health domains
Mobility
Self-care
Usual activities
Pain / Discomfort
Anxiety / Depression
0
20
40
60
80
100
Prevalence of limitations (%)
Overall
EMS
HEMS

Table 1 Characteristics of patients assisted by helicopter emergency medical services or emergency medical services

	Overall (*n*=781)	HEMS (*n*=310)	EMS (*n*=471)	*P*
Men*	567 (72.6)	233 (75.2)	334 (70.9)	n.s.†
Age (years)	41 (25–62)	36 (23–57)	43 (27–66)	0.008‡
Blunt trauma*	713 (91.3)	289 (93.2)	424 (90.0)	n.s.†
GCS score	11 (3–15)	3 (3–15)	13 (5–15)	< 0.001‡
Revised Trauma Score	11 (8–12)	8 (8–12)	12 (9–12)	< 0.001‡
Injury Severity Score	25 (18–33)	29 (22–38)	22 (17–26)	< 0.001‡
Prehospital intubation*	220 (28.2)	154 (49.7)	66 (14.0)	< 0.001†
Mortality*	228 (29.2)	100 (32.3)	128 (27.2)	n.s.†

Values are median (interquartile range) unless indicated otherwise; *values in parentheses are percentages. GCS, Glasgow Coma Scale; n.s., not significant. †Fisher's exact test; ‡Mann–Whitney *U* test.

Table 2 Average costs for medical treatment per patient with polytrauma according to type of prehospital care

	HEMS costs (€)	EMS costs (€)	*P**
Hospital stay (ward)	10 300	10 200	n.s.
Intensive care stay	16 100	12 400	0.003
Outpatient clinic	2 400	1 900	n.s.
Emergency department	1 500	1 500	n.s.
Surgery	3 400	3 100	n.s.
Diagnostics	3 600	2 800	0.002
Rehabilitation/nursing home	1 900	2 600	n.s.
Total	39 200	34 500	0.016

HEMS, helicopter emergency medical services; EMS, emergency medical servicesn.s., not significant. *Mann–Whitney *U* test.

Table 3 Model of the costs for helicopter emergency medical services per quality-adjusted life year

	Regression model
No. of lives saved	29.0
Average life expectancy (years)*	38.4
Total life years gained	1112.5
QALY saved (utility 0.706)	785.3
QALY saved after discounting†	434.3
Total costs for HEMS (€)	12 301 972
Costs per QALY (€)	28 327

For these calculations the EuroQol – Five Dimensions summary score of 0.706 was used to correct for quality of life. *Calculated by using a life expectancy table for the general Dutch population (corrected for age and sex): average life expectancy = mean life expectancy in the Netherlands − mean age of research population. †Discount rate of 1.5 per cent, as recommended in the Dutch guidelines for economic evaluations with $t = 38.4$. QALY, quality-adjusted life year; HEMS, helicopter emergency medical services.