Willingness to Pay for Lives Saved by Helicopter Emergency Medical Services

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Abstract

Introduction Currently, policy makers in the Netherlands are discussing the possibility to expand the availability of Helicopter Emergency Medical Services (HEMS) from 12 hours to 24-hours a day. For this, the preferences of the general public towards both the positive effects and negative consequences of HEMS should be taken into account. Therefore, the willingness to pay (WTP) for lives saved by HEMS was calculated.

Methods A discrete choice experiment (DCE) was performed in order to explore the preferences of respondents towards (expansion of) HEMS availability. The attributes: costs (for HEMS) per household number of additional lives saved (by HEMS), number of noise disturbances (caused by HEMS) during daytime or nighttime were used. A written questionnaire was presented to 150 individuals by convenience sampling.

Result One hundred and thirty-six (91%) of the 150 individuals completed the DCE questionnaire. The marginal WTP for one additional life saved (in a month) was €3.43 (95% CI; 2.96-3.90) per month per household. Overall, the WTP for expansion to a 24-hour availability of HEMS can therefore be estimated at €12.29 (~US$17.50) per household per month.

Conclusion The WTP derived from this study is by far exceeding the 1-1.5 Million-euro necessary per HEMS per year for the expansion from a daytime HEMS to a 24-h availability in the Netherlands. Respondents are willing to pay for lives saved by HEMS in spite of increases in flights and concurrent noise disturbances. These results may be helpful for the decision-making process, and may provide a positive argument for the expansion of HEMS availability.

Introduction

In many western countries Helicopter Emergency Medical Services (HEMS) are available. Although the additional value of HEMS is often subject of debate, international literature demonstrates that HEMS assistance improves survival and outcome of severely injured patients[1-5]. HEMS, however, are a high-visibility, resource-intensive expense. Therefore, cost-effectiveness analyses may be determinative for the decision to introduce or expand HEMS in any national healthcare system. Cost-effectiveness analyses assess the balance between public investments (expressed in monetary terms) versus health gains (usually expressed as live years saved or quality-adjusted live years saved).

HEMS availability during day light hours (7.00-19.00h) was introduced in the Netherlands in 1997 after a pilot study demonstrating a positive balance between costs and health gains[3]. The Dutch trauma system is a well-developed system, with many parallels with other trauma systems (e.g. those of the US). Currently, policy makers are discussing a possible expansion of HEMS to a 24-hour a day availability. To support its decision, the Dutch government has recently started a pilot study to evaluate the cost-effectiveness of this expansion compared with ground transport. Decision-making on the expansion of HEMS, however, should take into account additional factors besides costs and patient outcomes. The Netherlands is a densely populated country with strict regulations on noise disturbance, in particular during nighttime. These regulations may conflict with expansion of HEMS availability for scene missions to nightly hours. Preferences of the general public on both the positive effects (in terms of lives saved) and negative consequences of HEMS (in terms of noise disturbances and costs) should therefore be considered.

Preferences of the general population can be elicited with several methods. One of those is called a discrete choice experiment (DCE), which identifies the wishes and preferences of a specific group of people. The willingness to pay (WTP) for (lifesaving) medical services can be calculated from a DCE, provided that costs are incorporated into that DCE[6]. Worldwide hardly any research has been performed to examine the attitude of the general public towards HEMS, including the marginal willingness to pay for lives saved by HEMS. We therefore conducted a DCE to determine the preferences of Dutch inhabitants towards HEMS availability and to calculate the willingness to pay for lives saved by HEMS. The results of this study may support the decision-making about the nationwide extension of HEMS during nighttime hours in the Netherlands.

Methods

A discrete choice experiment (DCE) was performed in order to explore the preferences of respondents towards (expansion of) HEMS availability. Respondents had to fill out a questionnaire, choosing their preferred option from sets of scenarios. These scenarios consisted of a set of attributes that described HEMS as a service, *i.e.*, main characteristics of HEMS availability. The following attributes or main characteristics were chosen: costs (for HEMS) per household, number of additional lives saved (by HEMS), number of noise disturbances (caused by HEMS) during daytime, and number of noise disturbances (caused by HEMS) during nighttime (see Table 1). The attributes used were constant in each scenario, but varied over a range of levels. All scenarios in the questionnaire described hypothetical situations with differences in HEMS availability. The steps necessary to carry out a DCE are successively described below.

Definition of attributes and levels

Attributes should cover the important aspects of HEMS dispatch, be meaningful, and avoid double counting of consequences. A scenario should include at least two attributes, but preferably not more than eight. Each attribute is quantified in levels. The levels of the attributes should be plausible, actionable and make respondents willing to make trade offs between combinations of the attributes[7,8]. In this DCE on the value of HEMS, respondents had to choose between two scenarios and an opt-out option within a choice set. Costs are expressed in euros (€1 = US$1.42). The following 4 attributes and levels were used (Table 1); 1) the costs per household each month (€1, €5, €15, and €30); 2) the number of additional lives saved each month (2, 5, 7, and 10 lives); 3) the number of noise disturbances produced by the helicopter during daytime (between 07.00h and 19.00h) in one month (30, 60, 90, and 120 flights); 4) the number of noise disturbances produced by the helicopter during nighttime (between 19.00h and 07.00h) in one month (0, 10, 20, and 30 flights). The attributes cover the aim of the HEMS presence (i.e., additional lives saved) and the main disadvantages (i.e., costs and noise disturbance). The levels were defined with data on the current situation, including the number of lives saved assessed in a previous study[3].

Experimental design

The questionnaire given to each respondent contained 16 choice sets, representing a fractional factorial array. As opposed to a full factorial design (which uses all possible combinations) a fractional factorial design refers to a selection of all possible combinations and levels. The fractional factorial design allows for analysis of the main effects (between 70% and 90% of the explained variance), which are the most important aspect of the decision-making process[9]. In the current study a fractional factorial design was used, containing 16 choice sets existing of two scenarios and an opt-out option. An example of a choice set is given in Figure 1. The two scenarios were presented as regions A and B, which had a different HEMS policy. Respondents were asked to pick the region they would prefer to live in.

The opt-out option offered the possibility to choose a region where no HEMS service is present. This option is the same in each choice set. It is important to include the opt-out option. Otherwise the value for an attribute could be higher than its actual value. If respondents chose the opt-out option, an additional forced choice had to be made between region A and B.

Data collection

A written questionnaire was presented to 150 individuals by convenience sampling. Study approval was obtained of the local Ethics Committee (equivalent of the Institutional Review Board). Relatives of personnel of non-clinical departments distributed the questionnaires among their social network. In this way a study population was approached with no direct link to the principal clinical investigators or the subject matter (i.e HEMS and/or trauma care). In the introduction of the questionnaire, objective background information on the subject of HEMS was presented. An example of a choice set was provided to explain the questionnaire. Next, the 16 choices were presented. One dominant choice set was included in the design in order to examine whether the respondents had understood the questionnaire correctly. This dominant choice set could be answered wrongly. This 'wrong' answer implied that respondents chose to pay much more for fewer lives saved and more noise disturbances during day and night. A sub-analysis was performed for those questionnaires in which the dominant choice set was answered correctly in order to test for a possible bias. The last part of the questionnaire consisted of questions concerning characteristics of the respondents and their attitudes towards HEMS. The attitude towards HEMS was measured on a five-point scale. The score 1 was a very positive attitude towards HEMS.

Data analysis

To get insight into the respondents' trade off behavior between attributes and levels the data were analyzed using a conditional logit model[9]. The results of the forced choice (between scenario A and B in case the opt out option was chosen) were used to determine the preferences of respondents, since it seems realistic that respondents in real life cannot choose an opt out. The results of the unforced choice (between scenario A, B and the opt out) were used to calculate the WTP in order to avoid an overestimation of the WTP. The marginal WTP for the attributes 'lives saved', 'noise disturbance during daytime', and 'noise disturbance during nighttime' was calculated by dividing the coefficients of those attributes with the (negative) coefficient of the attribute cost per household. The marginal WTP therefore indicates the WTP per level change of that attribute. The confidence interval for marginal WTP was calculated using a boot strapping method. Analyses were performed using the Stata Statistical Software (release 9.0; Stata Corporation, Texas, USA).

Results

One hundred and thirty-six (91%) of the 150 individuals who received a questionnaire participated in this discrete choice experiment (Table 2). The average age of the respondents was 42 years (range 18-82 years). Forty-six percent of the respondents were male. The largest group of respondents (42%) had completed a secondary (vocational) education, followed by the group with a Bachelor degree (31%). The monthly net incomes per household were subdivided into three categories. These categories; < €2000 (30%), €2000 - €3000 (35%) and > €3000 (31%) were almost equally represented in the participating population. Five out of the 136 respondents (4%) preferred not to answer the ‘income’ question. Most respondents had a partner and no children (40%), closely followed by the group with a partner and one or more children (37%). In comparison with the Dutch population age and sex were almost equally distributed. The educational level and net income per household were higher in the study group, compared with the average Dutch population.

Preferences of respondents

The attribute ‘cost per household’ had a negative coefficient, indicating that respondents preferred low cost for HEMS (Table 3). The positive coefficient for the attribute ‘lives saved’ showed a positive preference of respondents towards the number of additional lives saved due to HEMS availability. The attributes ‘noise disturbance produced by the helicopter during daytime and nighttime’, related to the expansion of HEMS, were also valued positively. This suggests that respondents had a positive attitude towards more noise disturbance. Although the coefficients were near to zero, these positive signs requested further analysis. Fourteen subjects answered the dominant choice set ‘wrongly’ and might have misunderstood the questionnaire. Excluding their data from the analysis did not change the positive preferences towards noise disturbance. The positive value of respondents towards the attributes noise disturbance may be explained by with their attitude towards HEMS. A subgroup analysis was performed for respondents with a very positive and respondents with a less positive attitude towards HEMS. The purpose of this subgroup analysis was to exclude the influence of the attitudes of respondents towards HEMS on the attributes noise disturbance during daytime and nighttime. The overall preference structure was similar for both groups.

Willingness to pay

The outcomes of the conditional logit model for the unforced choice were used to calculate the WTP (Table 4). In this model for the unforced choice the attribute ‘noise disturbance during daytime’ did not statistically significantly affect the WTP (p=0.059), unlike the other three attributes. Therefore, noise disturbance during the day was not included in the WTP calculation.

The marginal WTP for 1 additional life saved (in a month) was €3.43 (95% CI; 2.96-3.90) per month per household. Based upon a previous study it is estimated that 5.1 additional lives will be saved per 100 HEMS dispatches in the Netherlands[3]. In the Netherlands the annual number of HEMS dispatches during daytime is approximately 1900. Based on a pilot study, the expansion to a 24-hour availability of HEMS is expected to result in 500 additional dispatches each year (i.e., 41.7 dispatches per month)[10] on average, resulting in 25.5 additional lives saved per year (500 dispatches * 5.1 lives saved / 100 dispatches). Respondents were willing to contribute on average €0.12 (95% CI; 0.02-0.23) per month per additional noise disturbance, i.e. per additional flight, at night.

Overall, the WTP for expansion to a 24-hour availability of HEMS can therefore be estimated at €12.29 (~US$17.50) per household per month ((€0.12 * 41.7 dispatches during nighttime per month) + (€3.43 * 25.5 lives saved / 12 months))).

Discussion

In this study the preferences for HEMS availability were measured using a discrete choice experiment, where respondents made explicit trade-offs between costs, lives saved, and noise disturbance during the day and night. The results of this study revealed that respondents are willing to pay €3.43 per live saved by HEMS per household per month and €0.12 per additional HEMS flight during nighttime per household per month (that causes noise disturbance) in the situation of a future 24-hour HEMS availability. Based upon the results of the current study and the anticipated additional number of 500 HEMS dispatches per year, the WTP for HEMS expansion towards nighttime was estimated at €12.29 per household per month. This shows that respondents from the general Dutch population are willing to pay substantially for HEMS.

Limitations and future studies

These results, however, should be interpreted with great care. As each study design has strengths and weaknesses, this DCE has also a number of methodological limitations. First of all, it must be considered that stated preferences (and not revealed preferences) were measured, and that the results may not be representative for the general Dutch population. As the number of households with a high net income was overrepresented in our study population, the WTP for HEMS availability might have been overestimated.

In addition, we found some unexpected results also leading to an increased WTP for HEMS. Surprisingly, the attributes covering noise disturbance, both during daytime and during nighttime, were valued positively. Additional analyses showed that these positive preferences of noise disturbance could not be explained by the attitude of the respondents towards HEMS. Moreover, this could not be explained by potential misunderstanding of the questionnaire. The 14 subjects who answered the dominant choice set 'wrongly' might have misunderstood the questionnaire, but excluding their data from the analysis did not change the positive preferences towards noise disturbance.

The positive valuing of noise disturbance could imply that there is an unobserved systematic component in the chosen attributes. Respondents may associate the expansion of HEMS availability (i.e., additional lives saved and subsequent increased noise disturbance) with the possibility of improved quality of life or an extended life span. These characteristics were not included in the one-dimensional measure of effect ‘number of lives saved’. Another explanation could be that respondents unconsciously find the presence of a physician and the fast transportation element of trauma helicopters a reassuring thought. One could also hypothesize that our study sample had only little experience with noise disturbance and has therefore underestimated its impact. Especially, since HEMS is currently unavailable during nighttime in the studied region, the impact of noise disturbance during the night could be underestimated.

The discussion of how to interpret the positive valuing of noise disturbance raises the question whether or not it is appropriate to include this preference in the WTP. Because positive values for noise disturbance are counter-intuitive, one might argue that it is not appropriate to include a positive value in calculations of WTP and might prefer to ignore the result. However, although the coefficients of noise disturbance were near to zero (Table 3), their effect on WTP is substantial. Neglecting the positive preferences for noise disturbances (i.e. estimating these preferences at zero) in the calculations yields a WTP estimate for expansion of HEMS towards nighttime at €7 per household per month.

The current DCE was not set up to compare HEMS with other treatment programs. It is known that evaluation of a single program requires more cognitive exercise to evaluate the single option to judgment of respondents[11-13]. In joint evaluation (i.e., comparison with other programs) respondents can ask themselves which program they prefer and how much they prefer it. Future studies on willingness to pay for HEMS should therefore compare the WTP for HEMS with WTP for other treatment programs (i.e. kidney transplantation, chemotherapy etc) or a non-HEMS alternative (e.g. EMS). This might put the outcome in a more realistic perspective. This way, the respondents can make explicit trade-offs in a more realistic context, in comparison with a governmental (societal) perspective. Protiere and Luchine have shown for example that in comparison with programs for heart disease and breast cancer, the WTP for HEMS was valued lower[13,14]. They also demonstrated that WTP was influenced by the introductory information given to the respondents, stressing the importance of keeping this information as objective as possible. Olsen et al[15] showed that the WTP for HEMS and heart operations was equal and significantly higher compared to WTP for hip operations.

A straightforward comparison of the results of our study with other estimates on the willingness to pay to prevent fatal injuries is very difficult if not impossible, since the values obtained depend on the type of payment vehicle, elicitation format, initial level of risk and the anticipated risk decline[16]. To support decision-making in road traffic policy, the WTP for preventing one road traffic fatality with road safety measures in the Netherlands has been estimated at €2-10 million[16]. Assuming a WTP of €7-12 per household per month, 7 million households in the Netherlands and 25 lives saved per year, the WTP for preventing one fatal injury outcome by HEMS can be estimated at €23-40 million. The observed differences in WTP between road safety measures versus HEMS are probably due to both differences in study design and differences in target populations (general population with low injury fatality risk versus severely injured patients with high injury fatality risk).

Conclusion

In spite of methodological considerations, the results of this study show positive preferences of the general public towards expansion of HEMS. Though possibly slightly overestimated, the willingness to pay derived from this study is by far exceeding the 1-1.5 Million-euro necessary per HEMS per year for the expansion from a daytime HEMS to a 24-h availability in the Netherlands. Respondents are willing to pay for lives saved by HEMS in spite of increases in flights and concurrent noise disturbances. Utilizing these results in the decision-making process for the extension of HEMS during nighttime would provide a positive argument for the expansion of HEMS towards a nationwide service that is available 24 hours a day.

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Table 1. Attributes and accompanying levels

Attributes	Levels			
Costs for HEMS per household each month (€)	1	5	15	30
Number of additional lives saved by HEMS each month	2	5	7	10
Number of noise disturbances caused by HEMS during daytime (between 07.00h and 19.00h) in one month	30	60	90	120
Number of noise disturbances caused by HEMS during nighttime (between 19.00h and 07.00h) in one month	0	10	20	30

Table 2. Demographic characteristics of the 136 respondents versus the Dutch population

Characteristics Respondent	DCEP	DP
Mean age (years)	42	39
Male (%)	46	49
Highest education (%)		
Elementary school	4	5
Junior secondary school	7	19
Senior secondary (vocational) education	42	44
Higher vocational education	31	19
University education	16	12
Unknown	0	1
Net income household (%)		
< € 2000	30	37
€ 2 000 - € 3000	35	51
> €3 000	31	12
Missing	4	0
Household composition (%)		
No partner, no children	21	34
Partner, no children	40	29
Partner, one or more children	37	28
No partner, one or more children	2	6
Other	0	3

DCEP=population in the discrete-choice experiment;DP=Dutch population (LibermanM,Mulder D, Sampalis J.Advancedor basic life support for trauma: meta-analysis and critical review of the literature. J Trauma. 2000;49:584–99).

Table 3. Conditional logit outcomes for the forced choice, used to determine preferences of respondents

Attributes	Coefficient	Stand. error	Significance	95% Confidence interval	
Costs per household each month	- 0.06	0.00	<0.001	-0.07	-0.06
Life saved per month	0.32	0.02	<0.001	0.29	0.35
Noise disturbance during daytime per month (07.00-19.00h)	0.01	0.00	<0.001	0.01	0.01
Noise disturbance during nighttime per month (19.00-07.00h)	0.02	0.00	<0.001	0.01	0.02
Pseudo R^2			0.33		

Pseudo R^2, percentage of explained variance

Table 4. Conditional logit outcomes for the unforced choice, used to calculate WTP

Attributes	Coefficient	Stand. Error	Significance	95% Confidence interval	
Costs per household each month	- 0.07	0.00	<0.001	-0.07	-0.06
Life saved per month	0.22	0.11	<0.001	0.20	0.25
Noise disturbance during daytime per month (07.00-19.00h)	0.001	0.00	<0.059	-0.00	0.00
Noise disturbance during nighttime per month (19.00-07.00h)	0.008	0.00	<0.002	0.00	0.01
Pseudo R^2			0.17		

Pseudo R^2, percentage of explained variance