# Willingness to Pay for Reductions in Angina Pectoris Attacks

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To compare the costs of health care programs with the benefits, the values of changes in health status must be expressed in monetary terms. The development of methods to estimate willingness to pay for changes in health status is therefore of interest. This paper reports the results of a contingent valuation study measuring willingness to pay for reductions in angina pectoris attacks. An innovative study design allowed analysis of the data on wlllingness to pay using two approaches, a binary question and a bidding-game technique. Percentage reductions in anginal attacks were varied randomly in different subsamples, and data were collected about angina pectoris status, attack rate, and income to test the internal validity of the contingent valuation method. Willingness to pay for a 50% reduction In the attack rate for three months was estimated to be about SEK 2,500 ($345) with the binary approach, and about SEK 2,100 ($290) using the bidding-game technique. Regression analyses showed that income, angina pectoris status, attack rate, and percentage reduction in attack rate were all related to willingness to pay, in agreement with the authors' hypothesis. *Key words:* willingness to pay; contingent valuation; angina pectoris; cost-benefit analysis. (Med Decis Making 1996;16:246-263)

In recent years, there has been an increasing interest in using the contingent valuation method to measure willingness to pay for changes in health status.' By comparing the willingness to pay for a health care program with the social costs, it is possible to carry out -a cost-benefit analysis. The contingent valuation method was developed within the environmental field to measure values of environmental changes,' but studies of the values of changes in health status have also started to appear.[3-7] Many issues concerning the reliability and validity of the contingent valuation method are, however, still unresolved.*

Atherosclerosis is a widespread cardiovascular disease that often presents as chest pain (angina) caused by transient episodes of myocardial ischemia resulting from an imbalance between oxygen supply and tissue demand.' The frequency of angina1 attacks is frequently used as a clinical measure of the severity of the underlying disease.

The aim of the present study was to assess the internal validity of using the contingent valuation method to assess willingness to pay for reductions of angina pectoris attacks. Multiple regression analysis was used to test whether willingness to pay was related to percentage reductions in angina pectoris attacks, weekly angina pectoris attack rates, angina pectoris status (unstable vs stable angina), and income. An innovative survey design made it possible to analyze willingness to pay data both according to the currently recommended binary (yes/no) approach,[8,10] and using the open-ended bidding-game question technique?" A secondary aim of the current study was thus to compare the results obtained employing these two elicitation techniques.

The design of the contingent valuation study is outlined in detail in the Methods section below. The results are then presented, followed by concluding remarks.

## Methods

The data were collected through telephone interviews conducted by trained nurses at a medical marketing agency. The sample used comprised 402 Swedish angina pectoris patients* recruited in con-

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**Two other articles about assessing willingness to pay appear in this issue of MDM on pages 242 and 288.**

***The patients gave informed consent to participate in the study, which was approved by an independent ethics committee at Sahlgren's Hospital, Gothenburg.**

**secutive order** during the period December 1993 to April 1994 by 38 participating physicians (23 general practitioners and 15 doctors from departments of internal medicine). In all, 438 patients were asked to participate in the study (the non-response rate was thus only 8%). Since this was not a randomized clinical trial, and because we wanted to represent clinical practice, we defined the broad inclusion criteria to be "patients receiving drug treatment intended for angina pectoris." The inclusion of patients was then left to the discretion of the physicians.

Contingent valuation questions can be divided into open-ended questions and binary questions. In the open-ended format, each respondent is directly asked about his or her maximum willingness to pay for the good. Elicitation of the maximum willingness to pay, however, usually employs a bidding game in which an initial bid is raised or lowered until the maximum willingness to pay is reached." The main problem with the bidding-game approach is that the reported willingness to pay is likely to be affected by the size of the first bid offered, i.e., so-called starting-point bias.[12] In binary contingent valuation questions, each respondent accepts or rejects only one bid. The bid is varied in different subsamples to derive a measure of the mean willingness to pay for the good. The binary question is the approach currently recommended for contingent valuation,[8,10] but it has been used in only two studies in the health care field.[3,4]

In the present study, each respondent was randomly assigned to one of the following bid amounts (in Swedish kronor, or SEK; the exchange rate in June 1995 was $1 = SEK 7.251: 0; 120; 240; 360; 500; 1,000; 2,000; 5,000; ~10,000.' (A pilot study had been carried out to determine. what bid vector to use.1 The willingness-to-pay question described the following scenario (in Swedish):

> Imagine two drug treatments intended for angina pectoris. The first one is your current treatment, while **the second treatment is more effective. In fact, the more effective treatment has shown to reduce weekly anginal attacks by** 50%. However, for each three-month period of the more effective treatment you have to pay an amount **from your own income in addition to the usual prescription fee.?**

The respondent was then asked a binary question whether he or she would be willing to pay the assigned bid for three months' treatment with the more effective drug. Depending on the response, the bid was raised or lowered using the other bid amounts until the answer was reversed.

Each answer to the contingent valuation question was analyzed both as a binary response and as a bidding-game outcome. In the binary approach, the yes/no answer to the first bid given to the respondent was used. In the bidding-game approach, the midpoint of the interval bounded by a yes answer and a no answer was used as the willingness to pay for each individual. For those few in the bidding game who answered yes to. the highest bid (SEK 10,000), the amount they were willing to pay was considered to be SEK 10,000.

To test whether willingness to pay would increase with the magnitude of the reduction in the angina1 attack rate, the reduction level was varied in three different random subsamples[8,10] The percentage reductions used were 25%, 50%, and 75%. The reduction level was varied in only about a third of the sample (25%: $n = 47$; 75%: $n = 471$, with the reduction of 50% used for the rest of the respondents ($n = 308$).[13] This was because varying the extent of the health improvement was incorporated into the study after data collection had already been started, due to the publication of the proposed regulations by the National Oceanic and Atmospheric Administration (NOAA).' The regulations proposed by the NOAA stated that contingent valuation studies should demonstrate that willingness to pay increases with the size of the good by using different subsamples of respondents.

To derive mean willingness-to-pay quantities from the binary data, logistic regression analysis was used.[14] Separate regressions were carried out for the 25%, 50%, and 75% reductions in order to calculate the willingness 'to pay for each of the three levels. The calculations were based on both a linear and a log-linear specification of the regression equation.[14] A nonparametric method was also used to estimate mean willingness to pay from the binary question data.*' In both the nonparametric method and the calculations based on the log-linear regression specification, the highest amount respondents were willing to pay was assumed to equal the highest bid used in the study (SEK 10,000).[14-17]

Multiple regression analysis was employed in testing the internal validity of the contingent valuation method. The binary data were analyzed with logistic regression, and the bidding game data were analyzed using linear regression. To test whether the extent of the reduction in angina1 attacks had a statistically significant effect on the responses to the contingent valuation question, an "effect" variable taking on the value 25, 50, or 75 was included in the regressions. As a further test of the internal validity, the regressions also included a set of explanatory variables capturing angina pectoris status (unstable or stable‡), weekly attack rate, and income. It was

†The reduction level of 50% was based on a reduction achieved in a clinical trial.[13]

‡It was left to the discretion of the physicians to diagnose the patients' angina pectoris as stable or unstable.

**Table 1 • Characteristics of Individuals Included in the Multiple Regression Analyses (n = 341)***

| | |
|---|---|
| **Gender** | |
| **Men (coded 1)** | 63.9% |
| **Women (coded 0)** | **36.1%** |
| **Age (mean)** | **68.0 years (SD 10.2)** |
| **Income (mean)** | **15.7 thousand SEK/month (SD 8.7)** |
| **Angina pectoris status** | |
| **Stable angina (coded 0)** | **91.2%** |
| **Unstable angina (coded 1)** | **8.8%** |
| **Weekly attack rate (mean)** | **4.8 (4.4)** |

*Of the 402 individuals in the sample, 41 were deleted due to protest answers, and 20 due to missing values for explanatory variables.

hypothesized that respondents diagnosed as having unstable angina (the more severe form of angina) would be willing to pay more for reductions in attack rates. It was further assumed that willingness to pay would increase with the weekly attack rate, since for a specific percentage reduction, a higher weekly attack rate will imply a larger absolute reduction in the attack rate. Finally, willingness to pay was hypothesized to increase with income. Age and gender were also included in the regression analysis to control for these variables, but no hypotheses were made with respect to these variables. In the logistic regression, a further test of internal validity of the contingent valuation method is whether the probability of accepting the bid decreases with a higher bid, as expected. In the linear regressions, the bid was included as an explanatory variable to test for starting-point bias." The presence of that bias was also tested for by comparing the mean willingness-to-pay amounts for the different starting bids using ANOVA.[12]

Characteristics of the individuals whose data were included in the multiple regression analyses are reported in table 1. All regressions were carried out with both a linear specification and a log-linear specification of the explanatory variables. In the logistic regressions, McFadden's $R^2$ and the percentage of correctly predicted responses were used as goodness-of-fit measures.[18] In the linear regressions, adjusted $R^2$ was used to assess the explanatory powers of the models.

In order to identify so-called protest answers to the contingent valuation question, a follow-up question was used, asking for the reasons for the specific response to the offered bid.' Forty-one such protest answers were identified (approximately 10% of the responses). The regressions were run both with and without these protest responses included. Since the goodness-of-fit of the regressions improved after excluding the protest answers, all the results below are reported excluding these responses. However, the pattern of the results was not much affected by whether protest responses were excluded or not (the results based on the inclusion of the protest answers are available from the authors upon request).

## Results

Table 2 shows the mean amounts the patients indicated they were willing to pay for the different reductions in angina pectoris attack rates, based on both the binary question data and the bidding-game data. For the binary data, these amounts were quite similar for the different approaches used. The percentage of individuals accepting the highest bid level in the binary data was 12.5%.

The mean willingness-to-pay amounts calculated using the bidding-game data are similar to those based on the binary data. Comparing the mean willingness-to-pay amount in the bidding game for the whole sample with the mean amount according to the nonparametric method, the mean is about SEK 400 higher with the nonparametric approach (i.e., about 20% higher). In figure 1, the proportions of individuals willing to pay as a function of the bid (survival functions1 are shown for both the binary data and the bidding-game data. As can be seen in the figure, the curves have similar shapes. Table 2 reports mean willingness-to-pay amounts that increased greatly between the reductions in the attack rates of 25% and 50% for all the estimates. Although the differences are smaller, the binary data also show increasing willingness to pay between the reduction levels of 50% and 75% for all the estimates except the one based on the linear-regression specification. Thus, the bidding-game approach yielded willingness-to-pay amounts that increase with the reduction in attacks. Whether the impact of the ex-

**Table 2 • Mean Willingness-to-pay Amounts for Three Percentage Reductions in Angina Pectoris Attacks**

| | Amount (SEK*) Willing to Pay for Attack-rate Reduction of | | |
|---|---|---|---|
| | **25%** | **50%** | **75%** |
| **Binary data** | | | |
| **Linear regression specification** | **1,145** | **2,780** | **2,621** |
| **Log-linear regression specification** | **1,540** | **2,542** | **2,900** |
| **Nonparametric method** | **1,873** | **2,499** | **2,692** |
| **Bidding-game data** | **1,388** | **2,079** | **3,350** |

*1994 prices; in June 1995, $1 = SEK 7.25.

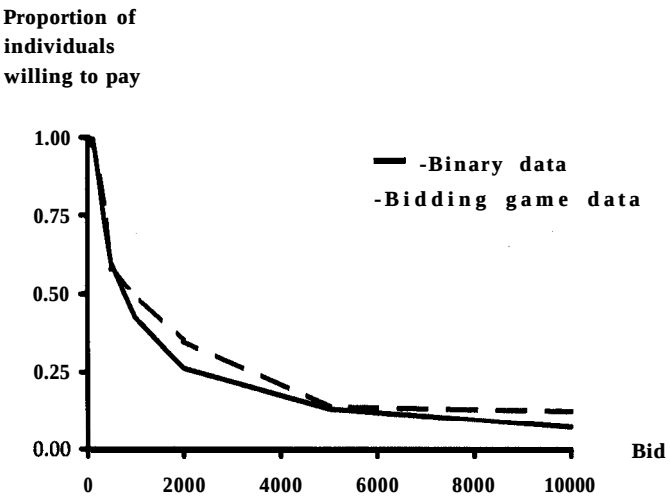


FIGURE 1. **Survival functions derived from binary data and bidding-game data.**

tent of the reduction was statistically significant was tested in the regression analyses.

In table 3, the results of the logistic regression analysis of the binary question data are given. Based on both McFadden's $R^2$ and the percentage of correctly predicted responses, the log-linear specification fits the data best. All explanatory variables have the hypothesized signs in both specifications. In the log-linear specification, income, bid, and angina pectoris status are statistically significant at the 1% level, age is significant at the 5% level, and the weekly attack rate is significant at the 10% level. In neither of the two specifications does the percentage reduction in the attack rate reach statistical significance.

**Table 3** • Results of Logistic Regression Analysis of the Binary-question Data

| Variable | Linear Specification (t Ratio) | Log-linear Specification (t Ratio) |
|---|---|---|
| Intercept | 0.42 (0.28) | **14.24 (2.41†)** |
| Gender | 0.41 (1.33) | **0.49 (1.37)** |
| Age | -0.018 (1.01) | **-2.80 (2.19†)** |
| Income | 0.074 **(3.17‡)** | **1.13 (3.19‡)** |
| Bid | -0.00084 **(7.53‡)** | **-1.50 (8.73‡)** |
| Angina pectoris status | 1.81 **(2.16†)** | **2.23 (2.84‡)** |
| Weekly attack rate | 0.088 **(2.34†)** | **0.084 (1.87*)** |
| Reduction level | 0.0088 (0.74) | **0.98 (1.83)** |
| *n* | 341 | **341** |
| Log-likelihood | -152.99 | **-121.44** |
| $\chi^2$ | 152.70 | **215.79** |
| Correct prediction | 79.5% | **87.2%** |
| McFadden $R^2$ | 0.33 | **0.47** |

*p < 0.10; †p < 0.05; ‡p < 0.01.

The linear regression results of the bidding game data are shown in table 4. The adjusted $R^2$ value is higher employing the linear model specification. In both specifications, all variables have the hypothesized signs. In the linear specification, income and reduction level are significant at the 1% level, while age, angina pectoris status, and weekly attack rate are significant at the 5% level. The bid is significant at the 1% level, indicating problems with starting-point bias in the data. The presence of that bias is also supported by ANOVA, thus refuting the hypothesis of equal mean willingness to pay, grouped by starting bids ($p < 0.0002$). The mean amounts the patients were willing to pay in the lowest and the highest starting-bid groups were SEK 2,025 and SEK 4,000, respectively.

**Table 4** • Results of Linear Regression Analysis of Willingness to Pay

| Variable | Linear Specification (t Ratio) | Log-linear Specification (t Ratio) |
|---|---|---|
| Intercept | 308.20 (0.22) | 8.22 **(2.14†)** |
| Gender | 135.49 (0.44) | 0.42 **(1.80*)** |
| Age | -35.77 **(−2.32†)** | -1.80 (-2.44'0 |
| Income | 97.77 **(5.38‡)** | 0.59 **(2.70‡)** |
| Bid | 0.19 **(4.13‡)** | 0.018 (1.03) |
| Angina pectoris status | **1,300.41 (2.52†)** | 0.87 **(2.37†)** |
| Weekly attack rate | 77.91 **(2.32†)** | 0.030 (1.10) |
| Reduction level | 35.51 **(2.92‡)** | 1.078 **(2.70‡)** |
| | 341 | 341 |
| a | 0.25 | 0.14 |
| Adjusted $R^2$ | 0.24 | 0.12 |
| F-value | 18.25 | 7.47 |

*p < 0.10; †p < 0.05; ‡p < 0.01.

## Discussion

To assess the economic attractiveness of health care programs, it is necessary to express their values in monetary terms so that the benefits can be compared with the costs. This is so even if cost-effectiveness analysis is used, since to determine whether, for instance, a cost per QALY is high or low, a price per QALY is needed. The developments of methods to measure willingness to pay for health care programs is thus of great general interest. Before methods such as the contingent valuation method can be routinely applied in economic evaluations of health care programs, however, the validity of the approach must be carefully examined. This study is a contribution towards assessing the validity of the contingent valuation method.

For the contingent valuation method to provide

valid estimates of willingness to pay, it is necessary that the amount the respondents are willing to pay increase with the size of the health gain, This was tested by varying the reduction in the attack rate in different subsamples. In interpreting the results of this test, it is important to keep in mind the small sample sizes that were used for the reductions of 25% and 75% (37 and 33 respondents, respectively, after the exclusion of protest answers). The results still generally indicate that willingness to pay increases with the size of the reduction in angina attacks. The effect is highly statistically significant in regressions on the bidding-game data. In the logistic regression, the effect does not reach statistical significance, but this may be due to the fact that less information is received from each respondent with the binary question format.

In the regressions on both the bidding-game data and the binary data, willingness to pay was shown to increase with the weekly attack rate and the angina pectoris status, indicating that willingness to pay increased with the size of the health improvement. Furthermore, income was highly significant in all the regressions. The regression results thus support the internal validity of, the contingent valuation method in valuing reductions in angina pectoris attacks.

The absolute willingness-to-pay figures obtained in this study should, however, be interpreted with great caution.' Even if willingness to pay is related to the explanatory variables examined in the hypothesized ways, 'it is still possible that the estimated willingness to pay systematically under- or overestimates true willingness to pay. To compare hypothetical and true willingness to pay for health changes is one of the most important issues for future research involving contingent valuation. Only such external validation studies can ultimately determine the validity of the contingent valuation method.

Recently, the National Oceanic and Atmospheric Administration (NOAA) appointed a panel of economic experts to evaluate the use of the contingent valuation method in determining existence values of environmental resources (i.e., values not directly related to any use of the resource). The panel (cochaired by Kenneth Arrow and Robert Solow) published a report that contained a number of recommendations about the use of the contingent valuation method.' Subsequently, the NOAA issued proposed regulations concerning the use of contingent valuation studies as a basis for assessment of damage to natural resources.[10] Our study is largely in agreement with the NOAA guidelines. For instance, binary questions were used, and our study tested whether the respondents' willingness to pay increased with the size of the health gain using separate subsamples (a between-subjects design).

It has been argued that the willingness to pay for health care programs should be assessed from an insurance perspective using a general-population sample." Given that individuals are risk-averse with respect to income and that the marginal utility of income is not affected by health status, assessing the willingness to pay from an insurance perspective will increase the willingness to pay for a health care program." An advantage of using a general-population sample is that altruistic values can be included, which would further increase the aggregate societal willingness to pay for a health care program. The measuring of such altruistic values for health status changes is an interesting topic for future research.

The design used in this study, which makes it possible to analyze the data both according to the binary format and using the bidding-game approach, seems to be very useful. The two approaches yielded similar patterns of estimated willingness to pay, in that higher values were obtained for greater reductions in angina pectoris attacks. The regression results were also similar for the two approaches. The main problem with the bidding-game technique is the danger of starting-point bias, which also was detected in the present study. Whether it is possible to develop techniques to correct for starting-point bias is an issue for future research. The binary question format avoids the risk of starting-point bias, and therefore, at the moment, may be the preferable approach.

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