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Measuring Heart Patients' Willingness to Pay for Changes in Angina Symptoms

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Willingness-to-pay (WTP) measures of the effects of changes in health on a person's welfare are more comprehensive than traditional cost-of-illness (COI) measures, but they are sometimes difficult to obtain. The authors investigated two approaches for measuring heart patients' WTP for changes in their angina symptoms. First, actual expenditures and perceived angina episodes avoided were used to infer an averting-behavior measurement of WTP. Second, a contingent-valuation approach was used to ask direct WTP questions regarding a hypothetical medical treatment that could be purchased to avoid additional angina episodes. The results indicated that although negligible COI changes were expected with small changes in angina frequency, the subjects had significant WTP to avoid increases in angina. The average WTP to avoid additional angina episodes revealed by the averting-behavior questions was comparable to the directly-elicited WTP, providing a test of the validity of the contingent-valuation approach. *Key words:* willingness to pay; contingent valuation; cost of illness; cost–benefit analysis; averting behavior; angina symptoms; welfare effects. (**Med Decis Making 1996;16:65–77**)

Many health care and government agencies must decide how to allocate their budgets for various programs that protect and improve public health. This may involve making judgments about the importance of preventing or reducing risks of various health problems. Monetary measures of the welfare benefits associated with preventing or reducing specific health problems are useful for determining such judgments and also for cost–benefit analyses of specific public health programs.

One type of monetary measure that has been widely used in examining the economic impact of health problems is the cost of illness (COI). The COI approach, described by Rice[1] and Hartunian et al.,[2] involves estimating the medical expenditures and productivity (income) losses associated with a specific health condition. But, it has long been recognized that COI measures do not reflect the full welfare effect of health problems because the financial impact of an illness is only part of the story. Health problems also typically involve discomfort, inconvenience, and restrictions on

activity that have effects on human welfare beyond what is reflected in medical expenditures and lost income.

A more complete economic valuation of the effect on welfare of a change in health is the amount the individual is willing to pay to prevent a health problem or to obtain an improvement in health. Willingness to pay (WTP) measures the change in an individual's income that would cause the same change in utility (well-being) for the individual as that caused by the change in health. WTP is more appropriate than COI for comparing the costs of public health policies, such as pollution-control regulations, because WTP is a monetary measure of the full effect on welfare of the potential change in health.* However, WTP, although theoretically more desirable for benefit–cost analysis, is more difficult to estimate than COI. This paper presents a new approach for estimating WTP for change in health and compares results of an application with heart patients using this and other approaches.

There are two general approaches for estimating WTP for changes in health: the averting-behavior method and the contingent-valuation method. The averting-behavior method involves inferring WTP from real-life situations where individuals are choosing a benefit or cost that has a monetary value as a tradeoff for a change in health.[3] The averting-behavior method rests on the economic presumption that averting expenditures will be made up to the point where the marginal cost c

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* It should be noted that there are situations where paid sick leave, insurance, and public health programs that transfer the cost of illness to others may result in underestimates of WTP if the burden of these transfers is not taken into account.

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additional averting efforts just equals the marginal benefit of avoiding one more unit of the health problem. At this point, the marginal averting expenditure is equal to the maximum WTP for the last unit of health problem avoided. Expenditures for previous units of health problem avoided may understate WTP because they lie on the marginal cost curve, not on the WTP curve.

Calculating WTP with the averting-behavior method using actual expenditure data can be difficult because instances of observable tradeoffs between money and health are rare. In addition, analysis is often difficult due to the complexities of most health-related behaviors and multiple motives for expenditures. A significant analytic difficulty in applying the averting-behavior method is in determining the specific health benefit obtained as a result of the behavior or expenditure. The novel approach developed in this study simplifies this task by asking subjects what they perceive the health benefit to be. Although this may not be the most accurate way to determine the actual benefit, it is an appropriate way to interpret the implied WTP, because WTP choices will be based on perceived benefit.

The contingent valuation method involves asking people to estimate the maximum amount they would be willing to pay to obtain or prevent a hypothetical specified change in health. Direct WTP questions used in contingent valuation must be carefully framed because participants often resist the idea of trading dollars for health. Also, a subject's budget constraint affects the WTP. Further, it is generally assumed for the subsequent analysis that a person's utility function over money is linear in the relevant range. In the arena of clinical treatment or public health care, willingness-to-pay studies are described and commented on by Donaldson,[4] Gafni,[5] Golan and Shechter,[6] Johannesson,[7] Johannesson and Jönsson,[8] Thompson,[9,10] and Thompson et al.[11]

A significant concern about the results of the contingent-valuation approach is whether subjects respond accurately to hypothetical payment questions. There is suspicion that what subjects say they would pay and what they actually would pay may be different. This study examined this issue by comparing the results of direct WTP questions with results obtained using a perceived-averting-behavior approach. This study also compares the results of two types of contingent-valuation questions: open-ended WTP questions and yes/no questions for specific dollar amounts.

We designed a survey instrument to obtain both COI and WTP information for evaluating the prevention of potential increases in the frequency of angina pectoris, the chest pain and complex of symptoms associated with myocardial ischemia. The instrument was designed to obtain information from patients with ischemic heart disease (IHD) who have experienced angina symptoms. Averting-behavior questions about actual tradeoffs subjects make between expenditures and perceived reductions in angina symptoms, direct WTP questions, and yes/no WTP questions were asked.

Methods for estimating WTP for changes in morbidity are in developmental stages, and our study contributes to this development effort. Our most important contributions include the development of a contingent-valuation instrument for obtaining WTP estimates from a previously unexamined but large patient group (500,000 Americans died from IHD[12] in 1989), and the development of a new averting-behavior procedure based on the subjects' perceptions of the health benefits of a given expenditure. The study also allowed the comparison of results using two different WTP estimation approaches, and illustrated some of the limitations of the COI approach.

We conducted this study as part of research funded by the U.S. Environmental Protection Agency on the effects of carbon monoxide in ambient air on heart patients with angina.[13] Inhaled carbon monoxide binds to hemoglobin, resulting in less oxygen being delivered to the heart muscle, which can exacerbate angina pectoris. Although carbon monoxide exposure has been associated with faster onset of angina symptoms in patients with IHD,[14] it has not been determined to be a cause of IHD itself.[15]

Methods

STUDY PARTICIPANTS

Fifty men with a history of chest pain and a physician's diagnosis of angina pectoris served as volunteer subjects. They were part of a pool of 127 angina patients who had been treated at the UC Irvine Medical Center or the Long Beach Veterans Administration Hospital. The 50 men participating in the study represented a wide range of angina experiences. Forty-three subjects were currently experiencing angina, and all subjects had experienced angina within the previous two years. Seven subjects no longer experienced angina and attributed the relief largely to bypass surgery. Twenty-three subjects had undergone coronary artery bypass surgery. Thirty-four subjects had experienced at least one heart attack, and the median time since their last attacks was two to three years.

Fifteen subjects were currently employed. Their household incomes (in 1985) ranged from less than $5,000 to more than $60,000, with a mean of $22,000. The ages of the subjects ranged from 44 to 83 years, with a mean of 61.5 years. Thirty-nine of the subjects were eligible for health services from the Veterans Administration. The majority of subjects supplemented their VA coverage with private insurance or Medicare. In general, subjects had complete coverage

for physician office charges, emergency room fees, and hospitalization expenses.

INSTRUMENT DESIGN

The survey instrument combined several types of questions to examine the welfare implications of potential changes in the frequency of angina symptoms for IHD patients. The questions were designed to elicit information about COI, lifestyle changes and attitudes, averting behaviors and expenditures related to avoiding angina symptoms, and contingent-valuation estimates of WTP.

Cost of illness. Information was obtained to estimate annual COI associated with all aspects of IHD and to estimate COI associated with incremental increases in the number of angina episodes, as might be expected to occur with worsening coronary atherosclerosis or with an increase in aggravating environmental factors. Since most of the subjects were Veterans Administration patients, they were unable to provide medical cost information, because they never receive the bills. Therefore, the costs of medical treatment were estimated using self-reports of treatment. Treatment scenarios were assembled under the guidance of a staff cardiologist from the University of California, Irvine, Medical Center. The costs of a typical emergency room visit, hospitalization for complaint of chest pain or myocardial infarction, and surgical procedures were estimated using accounting records furnished by UC Irvine Medical Center. The instrument also included questions about work loss due to angina and other IHD symptoms. Patients currently working were asked to estimate work loss days and paid sick leave due to all IHD symptoms. Subjects younger than retirement age who were not working were asked whether they had ceased work because of IHD and what they had previously earned. This allowed estimation of income lost due to IHD.

Because this analysis focused not on changes in the incidence of IHD but on changes in the frequency of angina symptoms for patients who already had IHD, it was necessary to estimate the change in COI that could be expected with small changes in angina frequency. The subjects were therefore asked to give estimates of expenditures, treatments, and work losses associated with their most recent angina episodes.

Averting activities and actual expenditures. The subjects were asked a series of questions regarding expenditures (other than medical expenses) taken to avoid or reduce angina symptoms. This line of questioning served two purposes: to help the subjects think about actual situations in which they might spend money to reduce angina, and to obtain information to estimate averting behavior based on actual expenditures and perceived angina avoided.

A series of questions probed whether an individual had hired help for chores, such as lawn mowing or housecleaning, which he would otherwise have done himself had he not been trying to avoid angina symptoms. The subject was asked to identify the most frequent type of help hired, if any, and to estimate the cost and the number of angina episodes he believed he avoided each year by making the expenditure. Expenditures were recorded only if the subject said that he would prefer to do the work himself if his health permitted. This tended to minimize, although not eliminate, the problem of joint benefits from the expenditure. In addition, the subjects were asked to list all expenditures made for services or goods to avoid angina, so a total averting expenditure estimate could be developed for each subject. Additional descriptive information was also obtained about changes made in activities due to the heart problem.

Lifestyle changes, attitudes, and descriptive information. Using open-ended questions, the subjects were asked to describe recent typical, mild, and severe angina episodes. Closed-ended questions, Likert scales and open-ended questions were used to assess the significances of various problems associated with a potential increase in angina, including pain, medical costs, lost income, activity restrictions, and worry about heart attacks. The subjects were asked whether they thought angina symptoms indicated actual damage to the heart. These questions provided a characterization of the perceived impact of angina symptoms on the patient, and also prompted the subject to think about how a change in these symptoms might affect him.

Direct WTP questions. Subjects were asked their WTP to avoid additional angina symptoms. This question is in an equivalent-variation format because it asks subjects how much they would pay to maintain their current health levels, avoiding a possible worsening of angina. Since some subjects were currently experiencing no angina, although they had experienced it in the past, we could not frame the question in a compensating-variation format, which would ask willingness to pay to bring about an improvement in health by reducing angina frequency. The format of the questions assumes the existence of a "contingent market" in which a medical treatment could be purchased to avoid additional angina. This hypothetical market mimics a market for a private good in which the purchaser reaps the full benefit of the purchase.

Two types of contingent-valuation questions were asked concerning a potential increase in angina symptoms. Closed-ended questions asked whether subjects would pay specific monetary amounts to prevent a specified increase in angina. If the subjects said that they would pay the first monetary amount, they were asked whether they would pay a specified higher amount, and if they responded "yes" again, they were asked whether they would pay a third higher amount These repeat dichotomous-choice questions were fol-

Table 1 • Attitudes and Responses to Angina

	Percent of Subjects ($n = 50$)
Factors triggering angina attacks	
Physical exertion	94
Stress or anxiety	84
Excitement	48
Cold air	44
Air pollution	38
Meals	30
Cigarette smoke	20
Changes in activities to avoid angina	
Avoid physical exertion	54
Sleep or rest more	46
Avoid emotional stress	44
Stay at home	40
Same activities, slower pace	34
Avoid active recreational activities	30
Avoid hot or cold weather	28
Avoid air pollution	26
Avoid cigarette smoke	18
Make no changes in activities	18
Take time off work	10
Beliefs about health significance of one angina episode	
Heart harmed a small amount and probably does not heal	**18**
Heart harmed a small amount and probably does heal	**18**
Heart probably not harmed; pain is a warning to slow down	60
Other	4

lowed by an open-ended question in which subjects were asked to give an estimate of the maximum amount they would be willing to pay to prevent the hypothesized increase in angina. The decision to use both types of questions was made after some preliminary interviews, in which the subjects found the open-ended WTP questions alone difficult to answer. It appeared to be easier to give a monetary amount after being asked to consider a few specific amounts suggested by the interviewer. Because it was possible that the amounts suggested in the closed-ended questions could bias the responses to the open-ended question, subjects were randomly assigned to receive different sets of three dollar amounts, ranging from $5–$50–$200 to $100–$400–$1,000.

To determine whether the WTP amount per episode would change if different numbers of episodes were anticipated, approximately half of the subjects were asked about a potential angina increase of four episodes per month and the other half were asked about a potential increase of eight episodes per month. The numbers of episodes were selected as small enough to be realistic, but large enough to be significant to the individual. The current average frequency of an-

gina episodes in the sample was four or five per month, although this ranged from none to three times a day or more. We anticipated that there might be decreasing marginal utility over number of episodes avoided.

Follow-up questions were used to probe refusals to respond, answers of zeros, responses of very large WTP amounts, and apparent inconsistencies. For large WTP amounts and other apparent problems, the interviewer simply asked for an explanation. Interviewers also recorded any comments made by the subjects.

Interview procedures. Telephone interviews that lasted an average of 45 minutes were conducted between February and July 1986. Prior to the telephone interviews, the subjects were sent a copy of the questionnaire so they could review the questions before the interview and refer to them during the interview. The complete questionnaire is available in Chestnut et al.[13]

Results

COST OF ILLNESS

Annual out-of-pocket medical expenditures by the subjects averaged $256, and were primarily for transportation and medication. (All costs are in 1986 dollars.) The estimated medical costs (based on reported treatment) paid by insurance (including the VA) for the past year averaged $4,523. Total medical costs for the previous year varied widely across the sample, depending largely on whether the individual had been hospitalized in the past year. Fifteen subjects had been hospitalized, and the average estimated costs of hospitalization for these subjects was $10,607.

Fifteen of the subjects were currently employed at an average annual wage of $19,400. Days lost from their normal work schedule due to angina and other IHD-related problems had an average wage value of $347, of which more than 95% was not covered by paid sick leave. Six of the employed subjects said that they were working an average of half-time, but would work full-time if they did not have a heart problem. Average annual income lost for these six was $3,973. Another 13 subjects said they had quit working within the past five years due to IHD; the mean annual income before they quit was $34,615. Assuming all 13 would work if they could, the average annual income lost due to sick days and partial and full loss of employment due to IHD was $9,581 for all 50 subjects. Combining total medical costs and income lost, the average COI for the sample in the previous year was $14,359.

We used two different procedures to determine how COI might change if angina frequency changed by a small amount, and we found in both cases that the expected change in COI would be negligible. First, we asked the subjects to estimate what their out-of-pocket

Table 2 • Responses to the Closed-ended Willingness-to-pay Questions

Dollar Amount	Total No. of Subjects Asked*	Total Response		Question Sequence					
				First		Second		Third	
		Yes	No	Yes	No	Yes	No	Yes	No
$5	4	4 (100%)	0 (0%)	4 (100%)	0 (0%)	—	—	—	—
$10	7	6 (86%)	1 (14%)	6 (86%)	1 (14%)	—	—	—	—
$25	18	16 (89%)	2 (11%)	13 (93%)	1 (7%)	3 (75%)	1 (25%)	—	—
$50	24	20 (83%)	4 (17%)	7 (78%)	2 (22%)	10 (91%)	1 (9%)	3 (75%)	1 (25%)
$100	29	22 (76%)	7 (24%)	12 (86%)	2 (14%)	8 (73%)	3 (27%)	2 (50%)	2 (50%)
$200	20	10 (50%)	10 (50%)	—	—	5 (42%)	7 (58%)	5 (63%)	3 (38%)
$300	10	2 (20%)	8 (80%)	—	—	—	—	2 (20%)	8 (80%)
$400	12	5 (42%)	7 (58%)	—	—	—	—	5 (42%)	7 (58%)
$500	10	5 (50%)	5 (50%)	—	—	5 (50%)	5 (50%)	—	—
$1000	10	3 (30%)	7 (70%)	—	—	—	—	3 (30%)	7 (70%)
TOTAL	144	93	51	42	6	31	17	20	28

*Each subject was asked three different dollar amounts. Two subjects refused to answer these WTP questions. Thus, 144 responses were obtained from 48 subjects.

expenses had been for a recent "typical" angina episode. Over 95% of the subjects said there had been none. Second, we did a regression analysis of the total COI for the past year for each subject on income, angina frequency, and whether the subject had had a heart attack or bypass surgery in the past year. The coefficients for heart attack and surgery were statistically significant, but the angina frequency coefficient was not.

LIFESTYLE CHANGES AND ATTITUDES

Knowledge, attitudes, and behaviors related to angina were assessed, and selected data are presented in table 1. Physical exertion and emotional stress were most often identified as triggers of angina; however, environmental factors, including cold temperature, air pollution, and cigarette smoke, were also identified as causing attacks of angina. Nine of the 50 subjects (18%) reported that they made no change in their activities on days when they felt that they were more likely to have an angina episode. A majority of subjects reported that they avoided physical exertion such as housework or yard work, slept or rested more, and avoided emotional stress. Thirty-four percent of subjects reported that they pursued the same activities, but at a slower pace, on the days when they perceived themselves to be at higher risk of angina. For individual angina episodes, the subjects were asked about their beliefs of the extent of harm caused by the episode. Most subjects believed that their heart was probably not harmed and instead the angina was a warning to slow down. Thirty-six percent of the subjects believed some small amount of harm to the heart was associated with each angina episode, and half of these subjects believed the small amount of damage associated with an individual episode did not heal.

AVERTING ACTIVITIES AND EXPENDITURES

Twenty-one of the subjects said they had hired services (e.g., yard work, plumbing, car maintenance) or purchased goods (e.g., lawnmowers, household appliances, and new automobiles) for the primary purpose of avoiding additional angina. These 21 subjects had paid an average annual cost of $2,151 for these purchases. Sixteen of these subjects estimated the number of angina episodes they perceive they avoid each year as a result of the service they hire most frequently (or their largest purchase) to avoid angina. In the past year, these subjects had spent an average of $603 for these services or goods. The average expenditure per perceived angina episode avoided was $38, ranging from $3.50 to $140 per perceived angina episode avoided.

CLOSED-ENDED WTP RESPONSES

The responses to the closed-ended WTP questions are summarized in table 2 and separated according to question sequence. As expected, the percentage of "yes" responses declined as the amount increased. For all amounts under $200, more than half of the responses were "yes." At $200, the split was 50/50, and for all amounts above $200, half or more of the responses were "no."†

Two subjects refused to answer the closed-ended WTP questions. One of these subjects also refused to answer all income and financial questions. Another subject said that he could not decide whether he would be willing to pay the amount asked. Six subjects said they would not pay the first amount asked. The same six subjects also answered the open-ended WTP ques-

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† For $500, five of the respondents said "yes" and five said "no."

tion by saying they would not pay any amount to prevent an increase in angina. The refusals and zero responses are further discussed in the next section.

OPEN-ENDED WTP RESPONSES

Responses to the open-ended WTP question are plotted in figure 1, with the horizontal axis compacted for the larger monetary amounts. These responses reflect adjustments made after evaluating the refusals and zero responses. One group of subjects was asked the maximum amount they were willing to pay to avoid four additional episodes each month. The other group was asked the same question for eight episodes per month. Two major patterns of response were observed. First, the two groups were willing to pay similar amounts to avoid additional angina. Among those who gave a specific dollar amount, the average WTP for avoiding eight additional episodes ($218) was only $15 more than the average WTP to avoid four additional episodes ($203). The median WTP was $100 for each group. Second, a sizable number of subjects (7 of 50 = 14%) said they would not pay to avoid the increased angina, while another group (7 of 50 = 14%) said they would give everything they had (an unspecified "very high" amount) to avoid additional angina episodes.

After considering the explanations given by the six subjects who said they would not pay to avoid increased angina, all the zero responses were retained as valid because the subjects said either that the specified change in angina would not matter to them or that they could not afford to pay. One of the subjects further explained, "I would mortgage my house and pay $100,000 to be rid of all my angina, but I would not pay anything to avoid eight episodes." An additional subject's response was changed from a refusal to a zero because he said "no" to the specific dollar amounts and also said that the change in angina would not be worth paying for. Most of these seven subjects reported having angina once a day or more, and apparently several felt that an increase of four or eight episodes a month would not be worth paying to prevent, although several of them added that a significant improvement in their overall condition would be worth a great deal.

Seven subjects said they would pay an unspecified "very high" amount to prevent the specified increase in angina. In open-ended probing of these responses, several of these subjects acknowledged that there would be a limit to the amount of money they could actually pay, but many of them explicitly said that they would sell or mortgage their houses. All of these subjects said "yes" to every specified dollar amount asked in the previous question. They emphasized in their explanations that they placed a very high value on preventing an increase in angina. In contrast to the subjects who said "zero," only one of these subjects currently had one or more angina episodes a day. Thus, an increase of four or eight episodes a month represented a substantial worsening of the angina condition for most of these subjects. All of the very high responses appeared to be sincere indications of a very large WTP to prevent additional angina, reflecting that such an increase would have a very large impact on these individuals.

Four subjects refused to give a dollar response to the open-ended question. After evaluation, one response was retained as a refusal and the other three
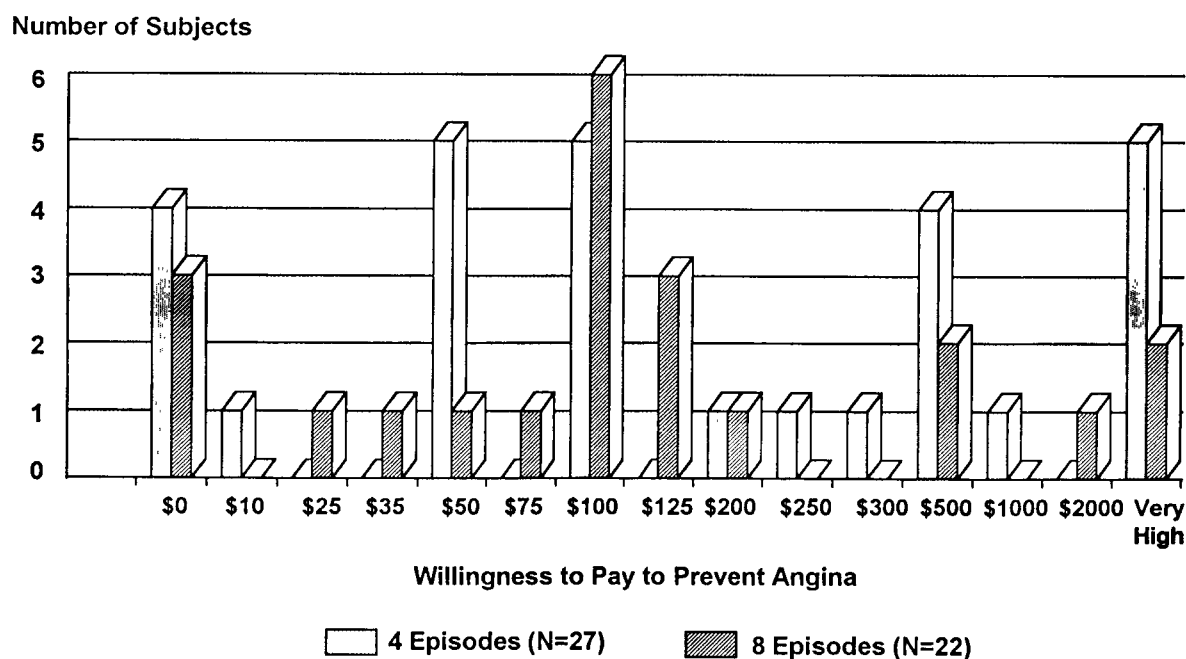
Number of Subjects

Willingness to Pay to Prevent Angina

☐ 4 Episodes (N=27)   ▨ 8 Episodes (N=22)

FIGURE 1.   Willingness to pay to prevent an additional four or eight episodes of angina. N = total number of subjects responding.

Table 3 ● Mean Responses* to the Open-ended Willingness-to-pay (WTP) Questions

	MEAN1	MEAN2	MEAN3
	Omitted Subjects with Very High Responses	Very High Responses Recoded to Highest Response in Closed-ended Question	Very High Responses Recoded to Equal Monthly Income
WTP to avoid 4 episodes	$203 (54)	$204 (45)	$590 (177)
	($n = 22$)	($n = 27$)	($n = 27$)
WTP to avoid 8 episodes	$218 (99)	$246 (97)	$387 (163)
	($n = 20$)	($n = 22$)	($n = 22$)
WTP to avoid 4 or 8 episodes, all subjects	$210 (54)	$223 (49)	$499 (121)
	($n = 42$)	($n = 49$)	($n = 49$)
WTP/episode, all subjects	$40 (9)	$42 (8)	$103 (27)
	($n = 42$)	($n = 49$)	($n = 49$)

*Standard error of the mean in parentheses to the right of the mean.

were recorded as some dollar amount.‡

A comparison between responses to the open-ended and closed-ended WTP questions revealed five subjects who gave lower responses to the open-ended question than the highest amount they had said "yes" to in the closed-ended question. Four of these subjects offered the explanation that they really could not afford the higher amount. The other said he would pay the higher amount if he really had to and the treatment worked. It appeared there might be a tendency for some subjects to go along with a higher amount when the question was asked in a yes/no format. In the subsequent analysis of the open-ended responses, the lower amount given was used. This appears to be a more accurate estimate of the maximum WTP for these subjects.

Mean WTP responses to the open-ended question were calculated with three different treatments (table 3) for the unspecified very high responses:

MEAN1: The unspecified very high responses were treated as missing.

MEAN2: The highest value the subject had agreed to pay in the previous closed-ended question was used for the unspecified very high responses.

MEAN3: The subject's reported monthly household income was used for the unspecified very high responses.

MEAN2 incorporates the very high responses in a conservative way, and the result of $42 per episode is very close to the $40 per episode from MEAN1, which left

the very high responses out of the calculation. MEAN3 is about twice as large as the other two and gives an upper bound to the extent that potential payments are limited by current household income. MEAN3 suggests that if the subjects who said they would pay an unspecified very high amount are taken into account, an average WTP value per episode is likely to be well in excess of $40. Illustrating the skewed distribution of responses, a person giving the median WTP response of $100 would have a WTP per episode of $25 if he responded for four episodes or $12.50 if he responded for eight episodes. So, half the participants had relatively low WTP amounts, but the average WTP was pulled upwards by the other half of the responders.

REGRESSION ANALYSIS OF OPEN-ENDED RESPONSES

Regression analysis was used to identify and quantify relationships between the open-ended WTP responses and potential explanatory factors, including personal characteristics and survey instrument factors (table 4). The dependent variable is the amount per month the respondent said he would be willing to pay to prevent an additional four or eight angina episodes per month. Respondents who said they would pay an unspecified very high amount are not included. The sample for the WTP regression analysis is reduced from 42 to 35 subjects due to non-response to some questions, primarily income or perceived angina benefits of averting expenditures.

The R-squared statistic indicates that the explanatory variables account for about half of the variation in the open-ended WTP responses, which is reasonably good for a small sample. The strongest relationships ($p < 0.05$) are seen with:

● *Household income.* The estimated income elasticity is 1.25, meaning a 1% higher income is associated with a 1.25% higher WTP response.

● *Bypass surgery history.* Having had bypass surgery

‡As discussed above, one refusal was recorded as zero based on the subject's explanatory comments. Two of the remaining subjects answered the closed-ended question and said they would be willing to pay something but they did not know how much. One said "yes" to $25, $100, and $300, but when asked the open-ended WTP question he said that $300 was too much. His response was therefore recorded as $100. The second subject said "yes" to $25 and $100, but "no" to $300. His response was also recorded as $100.

Table 4 • Willingness-to-pay (WTP) Results for Dependent Variable of Open-Ended WTP/Month to Avoid Angina Episodes ($n = 35$ Participants)*

Independent Variable	Estimated Coefficient (t-Statistic)	Variable Mean (SE Mean)	Notes
Angina change	42.50 (1.49)	5.8 (0.28)	4 or 8 episodes per month
Household income	1.25 (3.09)	210.0 (22.2)	In $100's (1986)
Angina frequency	5.89 (1.85)	15.4 (3.5)	Current episodes per month
Bypass surgery	246.5 (2.08)	0.46 (0.07)	= 1 if ever had bypass surgery
Surgery angina	−12.23 (2.62)	6.6 (2.0)	Angina frequency for those who've had surgery
Averting expense	6.18 (3.89)	13.5 (4.5)	Averting expense per episode avoided
Starting dollars	3.67 (2.55)	47.0 (5.1)	First $ in closed-ended question
Ischemic heart disease expense	−0.001 (0.34)	9,833 (2,583)	Out-of-pocket medical and income loss last year
Heart attack concern	31.26 (1.58)	7.1 (0.4)	On a 1-to-10 scale

*$R^2 = 0.55$; $F = 3.54$.

is associated with a significantly higher WTP response; but the response is less for subjects who have had surgery and now have frequent angina, and negative for those who have had surgery and now have more than 20 angina episodes per month.

• *Averting expenditures.* Respondents who report spending more to prevent angina episodes also give higher WTP responses to prevent potential additional episodes. The coefficient suggests nearly a one-to-one relationship between averting expenditures per past episode avoided and WTP responses per new episode avoided.

• *WTP starting point.* If a higher amount was asked in the first closed-ended question then a higher WTP response was given to the open-ended question.

Current frequency of angina episodes shows a positive, but less significant ($p < 0.10$) relationship with the WTP responses. Combined with the bypass surgery coefficients, this suggests that for subjects who have not had surgery, greater current frequency is associated with a higher WTP. For subjects who have had bypass surgery, lower current angina frequency is associated with higher WTP.

Coefficients for the number of additional angina episodes (four or eight) that would be avoided and the subjects' level of concern about heart attack or bypass surgery if angina were to increase show the expected

signs, but are not statistically significant. Normalizing four or eight episodes as a percentage of current angina frequency also showed no statistically significant relationship with WTP responses.

Out-of-pocket medical expenses and income loss (due to all heart disease related problems) in the past year were not related to the WTP responses; this is consistent with the finding that COI estimates are not significantly related to angina frequency.

Discussion and Conclusions

Our analyses indicate that very small changes in total COI related to IHD are to be expected with relatively small changes in angina frequency.§ Such changes in angina frequency, however, are not insig-

§ Regression analyses of the COI associated with angina for the prior year were most strongly influenced by the costs associated with heart attack and bypass surgery. Typically, both events require extensive time in hospital and physician follow-up. On the other hand, angina frequency was not found to be predictive of COI in the prior year. This may be attributed to the small cost of medications and the ability of patients to control their angina through lifestyle changes. Indeed, over 95% of the subjects reported no out-of-pocket expenses associated with a recent typical angina episode. To assign a near-zero cost-of-illness value to incremental episodes of angina, in our opinion, is incorrect. Instead, the probability of infrequent yet costly treatments (e.g., bypass surgery) must be considered in the valuation of the incremental costs of angina episodes. It is beyond the scope of the study to estimate such a probability.

nificant to patients with IHD, and they are willing to pay to avoid additional angina episodes. Estimates of WTP to avoid angina from contingent valuation questions were of the same general magnitude as estimates calculated from patient reports of actual expenditures and the perceived episodes avoided. This suggests that carefully framed contingent valuation questions can elicit accurate estimates of WTP, consistent with actual behavior. Note, however, that the alternative measures for valuing angina effects varied in their frame of reference. The COI data generally reflect expenditures to improve health, but can include expenditures to avert worsening health. The averting behavior expenditures are generally to avoid to reduce angina episodes (a compensating variation measure), and our willingness-to-pay questions were framed as amounts to pay to avoid additional angina episodes (an equivalent variation measure).

The relation of episodes of angina pectoris to IHD is not unlike the acute phases of other chronic disease conditions such as asthma or multiple sclerosis. Like angina, asthma attacks or exacerbations of MS have severe impacts on the quality of life and raise anxieties about future health states, and many decisions of everyday life may include considerations for avoidance of these episodes. While conventional COI approaches are good at providing estimates of the major financial impacts of medical expenditures and lost income, WTP measures are well suited to assessing more subtle welfare effects related to day-to-day activities such as pain and discomfort, inconvenience, activity restrictions, and a patient's concern about the worry or inconvenience caused for family and friends. The angina patients in this study were less concerned about decreased ability to work at a job or medical expenses than they were about such day-to-day welfare effects. This ordering of concerns is consistent with those reported for asthmatics.[19] The promising results from this application to IHD patients suggest further methodologic development is warranted.

THE PERCEIVED-AVERTING-BEHAVIOR METHOD

The novel averting-behavior procedure applied in this study, based on the subjects' *perceptions* of health benefits obtained for a given expenditure, appears to be a useful approach for estimating WTP. This approach has two advantages over the use of an objective measure of the health benefits of an averting expenditure. One is that an individual's behavior is based on his perceived benefit of a given action, even if this differs from the actual benefit. Second, by avoiding the need for estimating the relationship between the averting action and the health outcome based on secondary data, the averting behavior analysis is much simpler and the situations to which the procedure can be applied are more varied.

The results of the averting behavior approach and

the contingent valuation results corroborate one another. The mean estimated averting expenditure per angina episode avoided was $38 for the 16 subjects who provided sufficient information to derive such an estimate. For the same group of subjects, the mean direct WTP response was $28 per additional episode avoided, using a contingent valuation scenario of paying for medical treatment to avoid additional angina. Both of these mean estimates are based on incremental changes in angina frequency for subjects with IHD, and can be reasonably interpreted as approximations of marginal value for an angina episode avoided.¶ The regression analysis of the direct WTP responses also suggests an approximately one-to-one relationship between averting expenditures and WTP responses per episode. These findings are based on a relatively small sample and need to be further verified in future research.

We are optimistic about the novel perceived-averting-behavior procedure presented here because it has some important strengths relative to the contingent-valuation approach. Because the averting-behavior procedure is based on the respondents' actual behaviors, the answers are potentially more credible than those obtained using the contingent valuation approach. Important limitations remain, however. One of these is the problem of how to treat joint benefits. Most expenditures of this nature are likely to provide more than one perceived benefit to the individual, and this needs to be addressed further, since it can lead to overestimation of true willingness to pay. Second, the interview listed manual chores for which people typically would hire help or purchase goods, so some subjects might have had expenditures they did not recall. Since this analysis used an individual subject's expenditure per each perceived episode avoided for the chore most often avoided, the potential problem of missing some expenditures was muted. Another important problem is simply the limited circumstances in which this type of expense occurs. It is not possible to identify such averting expenses for every type of health condition.

THE CONTINGENT-VALUATION METHOD

Although the consistency of results for both WTP estimation methods is reassuring with regard to the credibility of the contingent-valuation estimates, several concerns remain. These concerns about contin-

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¶The mean averting expenditure does not precisely match the marginal cost of the last angina episode avoided; it represents the average cost of the last few episodes avoided and not the maximum WTP for the last episode avoided. It is important to recognize that this average averting expenditure is made in addition to the purchase of medical care. However, the average averting expenditure may approximate the marginal cost of worsening angina (or the last episode avoided), because most persons probably seek medical treatment as their first option to reduce angina.

gent-valuation estimates fall into three categories: 1) WTP starting point influences, 2) similar WTP responses for different numbers of episodes, and 3) a tendency to give WTP responses at the extremes of $0 or "very high." These concerns are not unique to this study; similar concerns have arisen in prior contingent valuation studies.

Starting bid and yea-saying influences. The regression analysis of the WTP responses to the open-ended contingent valuation questions reveals a significant starting point bias. This is consistent with previous findings of starting point bias in iterative bidding procedures.[16] A similar tendency is found in the closed-ended results; respondents appear more likely to say "yes" to a given dollar amount if it is the first amount asked. Perhaps due to the small sample size of the study, this result is not statistically significant in a simple comparison of responses. With larger sample sizes, the probability of responding "yes" to each dollar amount could be evaluated in terms of the order in which the amount was asked (e.g., first, second, third) and characteristics of the individual, such as income level and angina frequency. This raises an important issue in the selection of WTP elicitation procedures in contingent valuation studies. Open-ended valuation questions will avoid a starting point bias, but, as noted in the pretesting of the instrument, open-ended questions are sometimes difficult to answer. This is a problem in some contingent-valuation surveys that can result in a high rate of non-response.[17]

Closed-ended (yes/no) procedures have been recommended by some,[17] but it appears from this evidence that these procedures may suffer a "yea-saying" problem similar to a starting bid bias in the older iterative bidding approaches. This occurs even if the first dollar amount is varied, possibly due to a greater propensity to respond positively to the first amount asked. One anonymous reviewer made the good suggestion of dividing the sample and giving half of the subjects questions in the usual ascending order, with the rest getting questions in descending order. Further, these closed-ended approaches require either repeated questions to a single person with varying amounts (similar to iterative bidding approaches) or single questions to different people requiring much larger sample sizes for the same estimator efficiency.[7,18] An alternative may be to use a payment card with a range of values listed from which the respondent can choose, with values ranging from very small to very large to minimize influences on the responses.

The value per angina incident. The mean WTP responses for the varying amounts of angina prevention were not statistically significantly different, suggesting that an additional four or eight episodes were not viewed as significantly different by the subjects in this between-subjects design. Similar results have been found in other contingent valuation studies, such as

when subjects would pay the same to have one lake cleaned up or ten lakes cleaned up. This needs to be further explored in future applications. In this study, it is possible that relative to the wide range of angina frequency experienced by the subjects, the difference between an additional four or eight episodes per month may have been lost in the WTP measurement error. For subjects currently having angina twice a day, the difference between four or eight episodes a month may seem insignificant. However, for subjects having angina once a month, four or eight added episodes would be a significant increase. Restructuring the question for two or twenty additional added monthly episodes may have altered this finding. Possibly, some of the respondents are given WTP responses that indicate how bad they think additional angina would be, but the level of uncertainty in the response does not allow a clear differentiation between four and eight additional episodes. Some subjects also implied that they may have been focusing more on what they could afford to pay than on the additional angina episodes being hypothesized. This needs to be further explored in studies where each subject is asked WTP questions for several different levels while the thought process behind the WTP responses is elicited. Interviews asking participants to "think aloud" as they respond should shed more light on how they construct their willingness to pay responses. This would provide another route to determine whether a person would exhibit decreasing marginal utility over the number of angina episodes avoided. Schkade and Payne[20] used this verbal protocol analysis approach in asking willingness to pay to save migratory waterfowl.

Answers at the extremes of the distribution. It may seem paradoxical that some angina patients indicated they would pay nothing to avoid additional angina attacks, while others said they would pay everything they have, implying a very high amount. However, legitimate differences in perspectives among respondents about how detrimental the hypothesized increase in angina would be may account for the differences in responses. The fact that respondents with few current episodes often cited high WTP while respondents with frequent episodes often cited low WTP to avoid a few episodes is consistent with marginal damages of one additional episode increasing at a decreasing rate as the number of episodes increases. This is also consistent with a finding of WTP to avert eight episodes only slightly larger than WTP to avert four episodes.

Both the tendency to answer at the extremes of the distribution and the similarity of the responses regarding four or eight additional episodes may have been aggravated by the complexity of angina. Because angina is one symptom of a very serious health problem (IHD), it may have been difficult for some subjects to focus on an incremental change in angina frequency

in isolation from their overall conditions. A subject's response includes his willingness to pay to avoid all aspects of some additional angina episodes, including pain, discomfort, anxiety about risk of heart attack or death, limitation of activity, etc. If the underlying concern with regard to an increase in angina is the associated risk of heart attack and death, then some subjects may have been focusing on the small probability of death associated with each angina episode and editing the problem structure by considering this probability to be virtually zero. Other subjects may have been anchoring on the possible loss (severe pain, total incapacitation, or death) and on how much they would be willing to pay to avoid this loss, then adjusting downward (but not all the way) to account for the low probability of this loss in association with a small increase in angina. Future research might reveal more about this phenomenon by further examining the relationship between the individual's personal health history and attitudes and the tendency to give very low or very high responses. Although personal health histories were available for these subjects, the sample size was too small to draw any concrete conclusions regarding health history and attitudes and the tendency to answer at the extremes of the distribution. Future studies should include structured questions to follow up both extremely low and high responses. They should also elicit household wealth as well as income.

Another aspect of the disease that might be important to consider is that over time patients may adjust to the restrictions their disease imposes, thereby reducing the bothersomeness of the restrictions. For example, some subjects who no longer work indicated this was no longer troubling, though it did bother them in the past. The framing of the WTP questions, however, assumes the benefit of preventing additional angina is constant. Keller and Lambert[21] discuss the problem of measuring habitual behaviors via decision-based questions, such as WTP questions. Future applications might be able to consider where the subject is in this adjustment process and how that influences responses. Whether the pre-adjustment or post-adjustment effect on the individual is more appropriate for evaluating health policies is a question that needs further consideration.

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APPENDIX

Averting Behavior Questions

20. In the past 12 months, have you hired any help for yard work, home or auto maintenance, or housework to reduce or prevent angina or other problems related to your heart condition?

1 NO ➡ | 2 YES ➡ (INTERVIEWER: SKIP TO ALT-20, INTERVIEWER PAGE 12. SUBJECT DOES NOT HAVE ALT-20, BUT SEQUENCE AND RESPONSE CHOICES ARE VERY SIMILAR TO QUESTION 20)

20a. Please give an example of the type of help you hire most often. Consider only work that you would prefer to do yourself rather than have someone else do.

_____

20b. How often do you hire help for this purpose?

_____ times per year

20c. On average how much does this cost you?

$_____ per year

20d. If you did this work for yourself for a year, do you believe you would probably have more frequent angina?

1 NO
2 YES ➡ If you did this work for yourself, how many *additional* angina episodes per year do you think you would get, over what you now get?

_____ additional episodes per year

20e. If you did this work for yourself for a year, do you think the severity of your angina episodes after doing this work would be worse or about the same as your current other angina episodes?

1 ABOUT THE SAME
2 WORSE ➡

Using our 1 to 7 scale, how severe do you think your angina episodes after doing this work would be?

1 NO DISCOMFORT
2 VERY MILD DISCOMFORT
3 MILD DISCOMFORT
4 MODERATE DISCOMFORT
5 MODERATELY SEVERE DISCOMFORT
6 SEVERE DISCOMFORT
7 VERY SEVERE DISCOMFORT

20f. If you did this work yourself for a year, do you believe this might increase your chances of having a heart attack?

1 NO
2 YES ➡

If you did this work for a year, how much do you think this would add to your chances of having a heart attack during the year?

1 ADD A SMALL AMOUNT (ADD LESS THAN 5%)
2 ADD A MODERATE AMOUNT (ADD 5 – 10%)
3 ADD A MODERATELY LARGE AMOUNT (ADD 11 – 25%)
4 ADD A LARGE AMOUNT (ADD MORE THAN 25%)
5 OTHER (please explain) _____

20g. Do you hire this help for any other reasons, in addition to possible concern about angina and heart attack risks?

1 NO
2 YES ➡

Please explain:

_____

(INTERVIEWER: CHECK HERE TO MAKE SURE THEY WOULD PREFER TO DO THE WORK THEMSELVES)

Contingent Valuation Questions

32. Suppose your heart condition were to become worse so that with your current medical treatment and lifestyle your angina episodes would occur more often. Suppose also that a new medical treatment were available that could prevent the additional angina without causing undesirable side effects or requiring lifestyle changes.

If the treatment would prevent ____ additional angina episodes per month and if you had to pay the entire cost yourself, would you take the treatment if it cost $_____ each month?

1 NO
2 YES ➡

Would you take the treatment if it cost $_____each month?

1 NO
2 YES ➡

Would you take the treatment if it cost $_____ each month?

1 NO
2 YES