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THE WILLINGNESS TO PAY FOR THE DETECTION AND TREATMENT OF VULNERABLE PLAQUE RELATED TO HEART ATTACKS

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ABSTRACT OF DISSERTATION

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ABSTRACT OF DISSERTATION

A dissertation submitted in partial fulfillment of the
requirements for the degree of Doctor of Philosophy in the
College of Business and Economics
at the University of Kentucky

By
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Lexington, Kentucky

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Recent medical studies have led cardiologists to revise theories regarding the cause of heart attacks. Rather than a gradual clogging of the arteries, eruption of a "vulnerable plaque" is thought to be the cause of approximately 75% of all heart attacks. As a result, traditional risk factors are no longer sufficient indicators of who is at risk for a heart attack. Therefore, this research investigates the willingness to pay (WTP) for a new, hypothetical detection (screening) and treatment method for vulnerable plaque. For this study, two survey instruments were developed that take advantage of the visual and interactive aspects of the Internet. Individuals report their perception of heart attack risk both *prior to* and *after* receiving new information on who cardiologists currently believe to be at risk for a heart attack. In addition, respondents are provided with information about the effectiveness and risks associated with screening and treatment. Using web-based surveys, which follow a contingent valuation format, an iterative bidding process is used to elicit the respondent's WTP for either the screening or treatment method. Internet, on-line surveys are often prone to coverage bias; however, the survey valuing screening (a simple blood test) used a Knowledge Networks panel and resulted in a sample of 268 adults that is essentially representative of the general population. The survey valuing treatment (a more invasive heart catheterization procedure) was administered only to individuals with doctor-diagnosed heart problems, who are presumably more familiar with these types of medical decisions, and resulted in a sample of 295 adults. The mean for screening is $69 and the mean WTP for treatment that is

85% effective is $5,816. A two-part model is used to identify the factors that influence WTP, as well as the decision to receive the screening/treatment. The data suggests that these factors vary across genders. The data obtained for this study demonstrate construct validity; therefore, the results may provide useful information for policy analysis regarding the screening and treatment of heart attack.

Key words: Willingness to pay, iterative bidding, Internet, stated preference, health

Patricia L. Ryan

July 18, 2007

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Dedicated to the memory of
Professor Mark Berger

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Chapter I: Introduction

1.1 Motivation

This research was motivated by a recent development in the medical literature regarding the primary cause of heart attack. Many of us are familiar with the idea that "clogging of the arteries" typically associated with high cholesterol levels can lead to a heart attack. However, new medical evidence has shown that gradual plaque build up is not always the cause of heart attack – in fact, cardiologists now believe that 75% of all heart attacks are caused by pools of "vulnerable plaque" that lie hidden *within* the arterial walls. Stress or other extrinsic triggers cause these plaques to erupt, creating a blood clot to form almost instantaneously within the coronary arteries, resulting in a heart attack. The reason this new information is so important is because it implies that prior to a heart attack, the individual's vessels may be relatively free of plaque build-up, such that the individual never experiences chest pain or any other warning sign of a heart problem prior to the attack. In fact, evidence from the Framingham Heart Study[1] indicates that over half of those who die from a heart attack do so without ever experiencing any symptoms of heart disease (American Heart Association 2003). Therefore, this new theory of an erupting vulnerable plaque explains why individuals who appear in good health and have low cholesterol levels have been known to die suddenly from heart attacks.

Unfortunately, the factors that contribute to vulnerable plaque are not well understood; therefore, physicians still base heart attack risk on traditional factors that are associated with plaque build up, such as high cholesterol, smoking, and being overweight. Although these factors may provide some information on who is at risk for a heart attack due to vulnerable plaque, an important piece of the equation is still missing, such that many individuals who are at risk for a heart attack are not being identified as needing treatment until they actually experience a heart attack. Approximately 50% of the individuals who experience a heart attack die as a result. For those who survive, outcomes can vary greatly – from essentially no effect, to the individual being left

[1] The Framingham Heart Study is an ongoing study that is well-known and well-respected among cardiologists.

permanently disabled. In response to the need for an inexpensive and non-invasive screening method that could be used on the general population, researchers have discovered some simple blood tests that may prove useful in identifying those who are at risk for vulnerable plaque. With such a test available, treatment could be started on those identified as being at high risk to reduce the probability of a potentially fatal heart attack. Unfortunately, the only treatment currently available for treating vulnerable plaque is drug therapy, which is only about 30% effective. In addition, drug therapy requires a considerable amount of time to become effective, so the currently available method of treatment offers little immediate benefit in terms of risk reduction for heart attack. Therefore, in addition to a new screening method for identifying those who are at high risk for a heart attack due to vulnerable plaque, a more effective treatment method is also needed. Medical research is currently underway to develop both of these goods. In fact, early forerunners offering limited potential as screening methods are already becoming available. Therefore, it is expected that both screening and treatment for vulnerable plaque will be available in the near future.

1.2 Why is Screening and Treatment of Vulnerable Plaque an Economic Issue?

Although a growing number of heart attacks are occurring in younger individuals, heart attack risk is primarily an issue for those individuals 65 years of age or older, who are covered by Medicare. As such, a large percentage of the expenditures associated with treating these individuals is borne by the government and financed with tax revenues. Therefore, decisions regarding who receives this screening and treatment (when it becomes available) will largely be at the discretion of public policy decision makers.[2] However, little is currently known about the underlying consumer preferences for these goods, which should be directing public policy decisions. Even for those individuals not covered by Medicare, heart attacks and the symptoms associated with coronary heart disease (i.e. chest pain) are the "leading cause of premature, permanent disability in the U.S. labor force, accounting for 19 percent of disability allowances by the Social Security Administration" (American Heart Association 2003 p. 12) Therefore, understanding the

[2] In January 2002, Medicare started covering the cost of C - reactive protein (CRP), a simple blood test that indicates high levels of inflation (Comarow 2002), which may be associated with vulnerable plaque.

value individuals place on screening for preventing a heart attack and its associated treatment is necessary to ensure the efficient allocation of available health care resources.

1.3 Measuring Health Benefits

Benefit cost analysis (BCA) is often used as a means to measure the gain to society for various programs in order to determine which programs are potentially pareto-improving. BCA offers many advantages over other methods of valuation (i.e. cost-effectiveness analysis) because net benefit is measured in dollars, which allows for a direct comparison of programs. In addition, BCA is consistent with the assumption of consumer sovereignty, that is, that the individual is the best judge of his/her own utility (Mitchell and Carson 1989). As a result, BCA analysis has become the accepted standard for evaluating the societal gains of a program and is now required by Federal agencies and many state agencies as an integral part of the implementation process (List et al. 2004).

The requirement for a formal measure of benefits in public policy decision making has created a particular challenge for environmental and health policy because environmental goods are not typically exchanged in consumer markets, and many markets for health-related goods and services are influenced by the presence of insurance companies as third-party payers. Therefore, in valuing environmental and health-related goods, economists often utilize stated preferences obtained through a contingent valuation (CV) survey. CV is a stated preference method that uses a survey to elicit individual preferences by asking respondents directly about their willingness to pay for a particular good or service *contingent* upon a market for that good existing**.** A distinct advantage of stated preference is that this method has the potential to measure both direct values (those that are obtained through revealed preference methods), as well as passive use values. Therefore, stated preference methods have the potential to measure the *total value* of the good, and as a result, are important to BCA in estimating the *total* benefit associated with a good or program (Carson et al. 2001).

There has been some debate regarding the ability of CV to provide accurate measures of valuation for non-market goods (Hanemann 1994; Diamond and Hausman 1994). One of the current concerns regarding values obtained using CV is that several studies have indicated a tendency for stated preferences elicited through hypothetical markets to overestimate revealed preferences observed in actual markets (Cummings et al. 1995, List and Gallet 2001). However, many studies have demonstrated that hypothetical bias can successfully be eliminated *ex ante* using a cheap talk script or *ex post* using a certainty follow-up question, such that stated preferences obtained in contingent markets coincide with actual purchase decisions (Cummings and Taylor 1999, Blumenschein et al. forthcoming 2007)

Valuing health is important because, from a benefit-cost standpoint, it is necessary in order to ensure the combination of health services being offered is the one that will maximize the wellbeing of its citizenry. Therefore, valuing health-related goods and services is necessary in order to make efficient decisions regarding the number and types of health programs to offer, and CV offers a meaningful method to accomplish this objective. A review article by Diener et al. (1998) indicates that CV surveys have been utilized in valuing several health-related conditions and treatments, including (but not limited to) hypertension (Johannesson et al. 1993, Johannesson et al. 1991), screening for cystic fibrosis (Donaldson et al. 1995), anti-depression medication (O'Brien et al. 1995), and *in-vitro* fertilization (Neumann and Johannesson 1994).

Although some studies have looked at the macroeconomic benefits and costs associated with heart disease, as measured by the number of cases avoided (Long et al. 2006) or reduced medical expenditures (Cutler et al. 1998); few studies have asked individuals directly about *their* valuation for potential improvements in heart-related care. A Swedish study conducted by Johannesson et al. (1993) uses a CV survey to estimate the WTP of those with high cholesterol for participation in a program that would promote normal cholesterol levels. In addition, two studies (Kartman et al. 1996 and Chestnut et al. 1996) estimate the WTP to reduce chest pain, a potentially debilitating symptom associated with CHD. However, it does not appear from a review of the economic literature that any published studies have asked respondents to value a screening test that would better identify those at risk for a heart attack or treatment that would directly reduce the risk of heart attack by a specifically stated amount. Therefore, this study utilizes two CV surveys to value these two health-related goods (screening and treatment) related to the prevention of heart attacks.

1.4 Method

As part of the survey development process, decision trees (typically used in clinical decision analysis) were created to better understand the decision(s) that an individual would face both in the current state of the world (when screening and a more effective treatment are not available) and in the desired state of the world (when screening and a more effective treatment are available). Using the decision trees as guides, two surveys were developed - one to elicit the WTP for screening and the other to elicit the WTP for a more effective treatment. Both surveys were administered via the Internet. The survey for screening was administered to adults in the general population using a nationally representative panel. The survey on treatment was administered to adults who have a past medical history of heart-related problems, who are therefore more familiar with heart-related treatment options and, as a result, are expected to provide more reliable estimates of valuation. As part of the surveys, individuals were provided with information on vulnerable plaque (similar to the information presented in the opening section of this chapter). Respondents were asked to assess their perceived risk of having a heart attack both *prior to* and *after* receiving the new information. Respondents were then asked about their WTP using an iterative bidding process.

According to Alberini et al. (2003), "single-bounded dichotomous choice questions are notoriously imprecise as the only information revealed as whether WTP resides above or below the threshold provided by a single bid" (p. 42). Therefore, both surveys used for this study utilize an iterative bidding process to increase the efficiency of obtaining welfare estimates. The iterative bidding process used for this study was inspired by the interactive computer program used by Viscusi, Magat and Huber (VMH) (1991).[3] Respondents are assumed to have an underlying WTP that remains constant, such that the iterative bidding process (in conjunction with a series of follow-up questions) will elicit the maximum WTP (for either screening or treatment) for each respondent.

Valuations obtained using iterative bidding have been known to be subject to starting point bias (Whitehead 2002, Watson and Ryan 2007); therefore, some

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[3] VMH (1991) use an interactive computer program to generate a series of pair-wise comparisons (based on the respondent's pervious answers) to elicit risk-risk and risk-dollar tradeoffs related to chronic bronchitis.

economists advocate using a payment card as an alternative to iterative bidding as a means of obtaining stated WTP (Mitchell and Carson 1989, Alberini et al. 2003). In the economics literature, many bidding games that are referred to as "iterative" do not actually allow the bids to *both* increase and decrease to converge upon the respondent's WTP. Rather pre-set bids are offered starting with a randomly chosen initial bid that increases (decreases) monotonically until the respondent changes from a "yes" to "no" response (or vice-versa).[4]

The iterative bidding process used for this study is truly "iterative," offering bids that become *both* higher and lower depending on the individual's responses to each bid. In addition, subsequent bids are not pre-set, but rather created by a computer algorithm, that allows each survey to be tailored to the individual respondent. The computer program also allows the bids to cover a much wider range than would be feasible to offer on a payment card. For example, the algorithm used for the screening survey elicits WTP for screening to within a $5 margin and covers a range of $0 to $1600, which creates a number of possible bid options that would be impractical to include on a single payment card. Therefore, the iterative bidding used in this study allows the potential bids to increase (decrease) quickly when several sequential "yes" ("no") bids are indicated, while at the same time narrowing the range of WTP if the respondent changes their response frequently.

Results from this study are analyzed using a two-part model, which is often used for analyzing health care data. The hurdle model treats the decision to have the screening/treatment as one decision, and the WTP for screening/treatment as another, completely separate, decision. A probit was used to model the decision to have the screening/treatment, and an OLS regression on WTP for those who chose to have the screening/treatment was used to determine the factors that influence the WTP. The results suggest that the factors that influence the decision to have screening/treatment are not necessarily the same as those that determine the individual's WTP.

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[4] Bids are either increased or decreased according to a pre-set group of bids. For example, if the pre-set bids are $5, $10, $15, $20, $25 and $30, and the respondent answered "yes" to the initial bid of $15, the interviewer would ask if the respondent was willing to pay $20. The interviewer will continue to the next highest pre-set bid until the respondent answers "no"; thus, determining a narrow range in which the respondent's WTP lies. A similar process would occur if the respondent answered "no" to the initial bid. In that case, the interviewer would then proceed to go down to the next pre-set bid until the respondent switched their answer to "yes."

1.5 Contribution to the Literature

This study contributes to the literature in several ways. Primarily, this study provides a consumer-derived valuation for two health-related goods that are likely to become available in the near future, offering insights into specific demographics and risk factors that affect those valuations and provides potentially useful information in determining public policy. This study also provides additional information regarding the feasibility and accuracy of obtaining WTP valuations using a contingent valuation survey administered via the Internet. And finally, this study provides insights into how information influences medical decisions made by the consumer patient, and whether individuals place a value on information even when it does not affect medical outcomes.

1.5.1 Valuing Heart-Related Health

As discussed above, only a few studies have used contingent valuation to estimate consumer benefits associated with improvements in heart-related health. Kartman et al. (1996) and Chestnut et al. (1996) estimate the WTP to reduce chest pain. Although chest pain is a symptom of heart disease, which may be related to heart attack,[5] these studies only focus on the value of reducing this symptom, not a reduction in the risk of heart attack. A CV study by Johannesson et al. (1993) estimates the WTP for a cholesterol lowering program for individuals in Sweden with high cholesterol. In a self-administered survey, respondents are asked to value a program that reduces their cholesterol to a normal level. This study does include information which states: "the risk of heart attack is influenced by, for instance, high blood pressure, high cholesterol levels, and smoking" indicating that high cholesterol levels increase the risk of heart attack; however, as this is one of several factors listed, the specific reduction in heart attack risk offered by the program is not included as part of the survey. However, given the strong connection between cholesterol and heart attack risk at the time the Johannesson et al. (1993) survey was administered, it is likely that the results from this earlier study would be comparable to those obtained in this study; although it is certainly possible that cultural differences

[5] As Chapter 3: Medical Background will explain, an individual may experience chest pain from calcified (stable) plaques and not necessarily be at risk for a heart attack. However, due to the fact that chest pain can be debilitating, causing extreme discomfort which can cause the individual to limit work and other activities, it is not surprising that individuals express a significant WTP for the reduction of these symptoms.

between individuals in Sweden and the United States may account for some degree of variation in WTP.

1.5.2 Iterative Bidding with Cheap Talk and Follow-up Certainty Question

In the economics literature, the term "iterative bidding game" refers to the use of a multiple-bounded dichotomous choice (DC) question in which respondents are asked repeatedly if they are willing to pay $X for a good. Although this process is termed "iterative" in some ways it is misnomer because the process does not go back and forth to converge on a single value. Instead, the initial bid is monotonically raised *or* lowered (depending on the respondent's answer to the first bid) until the respondent's answer changes from "yes" to "no" (or "no" to yes").[6] Although bidding games increase the efficiency with which WTP values can be obtained, they are often prone to starting point bias (Whitehead 2002, Watson and Ryan 2007).

Typically bidding games are administered using trained interviewers using a set of pre-determined bids. Based on the initial bid, each subsequent bid is increased (decreased) in small increments until the respondent switches their initial response (Kartman et al. 1996, Desvousges et al. 1987, Randall et al. 1974). For example, in the study by Randall et al. which estimates the WTP for aesthetic environmental improvements, respondents who answer "yes" to the starting bid receive higher bids until the respondent answers "no." Those that answer "no" to the starting bid receive incrementally smaller bids until the respondent answers "yes." In this form of bidding game, the same objective could clearly be accomplished using a payment card, eliminating the potential for starting point bias. In fact, this is the reason several economists advocate the use of a payment card in place of this form of bidding game (Mitchell and Carson 1989, Alberini et al. 2003).

Instead of a single range of preset bids from which the starting bid is randomly chosen, some bidding games use multiple "sets" of preset bids, in which respondents are randomly assigned. Asgary et al. (2004) use three sets of four possible bids to estimate the WTP for health insurance in developing countries. Each respondent is randomly

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[6] Examples of studies employing some form of this type of monotonic bidding game include Whitehead 2002, Langford et al. 1996, Kartman et al. 1996, Desvouges et al. 1987, Randall et al. 1974, and Asgary et al. 2004.

assigned to one of the three possible "bidding games." As long as the respondent answers "yes," the next pre-selected bid for that game is offered. In this form of iterative bidding game, no option was available to reduce the bids; therefore, a "no" response to the first bid was simply recorded as a WTP=0 (Asgary et al. 2004).

Langford et al. (1996) employ a more sophisticated model in which 8 randomly assigned starting bids are either doubled or halved (for up to 3 subsequent bids). Again, the bids only increase or decrease based on the response to the first bid, and the bidding terminates when the respondent's answer is reversed. Therefore, the range of potential WTP values remains fairly wide if the respondent switches answers in the first follow-up question. If additional iterations are known to increase the efficiency of WTP estimates and up to 4 bids were potentially planned for each respondent, then why not take advantage of asking all 4 questions to narrow down the WTP even further? Most likely the reason is that performing the mathematical operations necessary to accomplish this task (quickly and accurately enough) does not lend itself well to surveys utilizing telephone or in-person interviewers. Therefore, in order to ensure consistency and accuracy in the interviewing process, the iterative process terminates once the respondent's answer changes.

However, as VMH's (1991) study demonstrated, a computer program can quickly and accurately use the respondent's previous answers to determine the next question. Although VMH applied this to a series of risk-risk trade-offs, the same idea can be applied to a multiple-bounded DC question on risk-dollar tradeoffs that is truly "iterative" in nature – in which bids increase *and* decrease to converge on the respondent's true WTP. Given the fact that many multiple-bounded processes only move monotonically and often cover only a small range of bids, it is not surprising that economists have found iterative bidding to be subject to starting point bias. Therefore, this study will take advantage of the quick and accurate mathematical capabilities of the computer to explore whether using a truly iterative bidding process administered via the Internet can be used to efficiently elicit values of consumer WTP that are free from starting point bias.

Blumenschein et al. (forthcoming 2007) found that a cheap talk script was not as effective in removing hypothetical bias as a follow-up certainty question. In an effort to ensure that hypothetical bias did not enter consumer valuations, both a cheap talk script and certainty follow-up question were included in the surveys used for this study. Although actual WTP is unknown, collecting data on WTP both after the cheap talk script and after the certainty follow-up question does offer some potential for comparing these two methods. Many focus group participants indicated that they were "definitely sure" of their stated WTP values by the end of the elicitation process. Therefore, this study offers some potential to determine if an elicitation format that utilizes an iterative bidding process with a cheap talk and follow-up certainty question is a potential method for eliciting consumer WTP that are free from hypothetical bias.

1.5.3 The Role of Information on Consumer Demand for Health-related Goods

This study offers insight into the relationship between prior and new information regarding individual risk assessments and subsequent health decisions. Hoehn and Randall (2002) state that new information may have different affects on respondents' perception of risk, depending on the individual's priors, and thus affect WTP accordingly. Therefore, the surveys used for this study allow for this potential heterogeneity by collecting data on risk perceptions both *prior to* and *after* new information is presented to the respondent. In addition, a qualitative question regarding the change in the respondent's risk from the new information provides information on the strength of the individual's priors and is used in the data analysis. The empirical results suggest that the strength of priors plays an important role both on who chooses the treatment and on the individual's WTP.

1.5.4 Does Information have Value for its own Merit?

Finally, this study investigates the question of whether individuals are WTP for information, even when it offers no value in terms of medical decision making. A CV study by Berwick and Weinstein (1985) find that women with normal pregnancies place a value on information received from an ultrasound even when it offers no value in terms of medical decision making. Based on these finding Berwick and Weinstein conclude that information obtained from screening may have value simply "for its own sake." They explain that the decision to pay for information that has no relevance to medical decision making is analogous to people valuing being informed about world/local events, which is evidenced by individuals purchasing newspapers and taking the time to read them or watch the evening news. Clearly these behaviors reveal that people value being informed; therefore, Berwick and Weinstein surmise that individuals would be no less willing to expend some of their financial resources to have more information about their own health (Berwick and Weinstein 1985), especially if it has the potential to improve their expected level of utility.

In order to test whether information has value for its own sake, a small arm of the screening sample received a version of the survey in which respondents were asked to value the screening when no treatment was available. Although the sub-sample was relatively small in size, the results suggest that information does in fact have value to the patient consumer. Berwick and Weinstein's (1985) results indicated that 25% of the valuation for an ultrasound by women with normal pregnancies stemmed from information that had no bearing on medical decision making. The results from this study suggest that the informational value (not related to medical decisions of treatment) for heart attack screening is potentially even larger.

1.6 Study Objectives

Valuation of health-related goods and services is necessary in order to make public policy decisions that maximize social welfare. In the area of health, a large proportion of individual expenditures occur in the last few years of life, when many Americans are covered by Medicare. In particular, one of the main health concerns for those over 65 is heart disease and heart attack. In addition, a significant percentage of disability allowances paid by the Social Security Administration (and financed with tax revenues) are related to CHD and heart attacks. Therefore, a better understanding of the valuation individuals place on heart-related screening and treatment is necessary for sound public policy.

Thus, the primary objective of this research is to estimate the demand for (1) a new screening method that would better identify those at risk for a heart attack and (2) a new minimally-invasive procedure for the detection and treatment of vulnerable plaque. Willingness to pay (WTP) estimates for each of these "goods" will provide insight into the value individuals place on health, specifically the value they place on avoiding a heart attack. In addition, a better understanding of the marginal effects of factors that influence demand for these services can assist policy makers in determining who should receive these services to help ensure the efficient allocation of our scarce health care resources.

Chapter II: Review of the Literature

The purpose of this chapter is to provide a review of the literature relevant to the dissertation. As such, this chapter presents support for using benefit-cost analysis (BCA) as a tool to efficiently allocate scarce economic resources. In addition, the chapter includes a discussion of the possible methods for valuing changes in health, including willingness to pay (WTP) in contingent markets, which is used for this study. Due to the fact that there has been some debate regarding the validity of obtaining reliable valuations for non-market goods using stated preferences (Hanemann 1994; Diamond and Hausman 1994), a large section of this chapter is devoted to exploring this issue. As part of the basic understanding of what drives the demand for health, this chapter also includes an explanation of Grossman's (1972) household production model of health and the implications it has on the demand for health-related goods and services. Finally, this chapter concludes with an overview of how risk and uncertainty and the availability of information in markets for health-related goods and services may influence consumer decisions in regard to the health choices they make.

2.1 Welfare Economics and the Concept of Value

In his book entitled *The Measurement of Environmental and Resource Values*, Freeman (1993) states "The basic premises of welfare economics are that the purpose of economic activity is to increase the well-being of the individuals who make up society, and that each individual is the best judge of how well off he or she is in a given situation" (Freeman 1993 p. 6). If individuals are assumed to have well-defined preferences and can substitute between goods, the trade-offs that are made will reveal information about the value the individual places on that good (Freeman 1993). If individuals are further assumed to be rational economic agents, they will choose the bundle of goods that will maximize their utility given their budget constraint (Mitchell and Carson 1989). It therefore follows that as each individual maximizes his/her own utility, that society's welfare will also be maximized in the absence of a market failure.

The problem is that for many environmental goods, the non-rivalry and non-excludability of these public goods means that private markets would tend to under produce them as some individuals choose to be free-riders. In an attempt to correct this market failure, the government often chooses the amount[7] of these goods that will be provided and pays for them with tax revenues. In addition, the quantity of some health-related goods, especially those consumed by the elderly who are covered by Medicare, are also determined by the government. In these cases, it is still important for the government to choose the amount of the good that will maximize overall societal utility; however, a problem arises in identifying this optimal amount because individual preferences are unknown. As a result, several methods have emerged to assist policy makers in efficiently allocating scarce economic resources among competing public programs.

2.2 Methods for Evaluating Public Policy Programs

Methods that have been used to evaluate public programs include: Internal Rate of Return (IRR)[8], Benefit/Cost Ratio[9], Social Net Benefit, Cost Effectiveness Analysis (CEA)[10], and Payback Period[11]; however, many of these methods have significant shortcomings. For instance, IRR does not take into consideration the size of the project under consideration, nor the increase in consumer utility that will result from the project. CEA has an advantage over IRR in that it does take into account the size of the effect of the program; however, it is designed to find the least cost method of achieving a specific goal. As a result, CEA will not provide decision makers with information on how to efficiently allocated resources among programs with different goals. Therefore, using the Benefit/Cost Ratio is superior to CEA because it allows comparisons across programs and time; however, like the IRR, it does not indicate the size of the gain. In addition, the Benefit/Cost Ratio can be unduly influenced by whether an improvement is classified as

[7] Through direct provision of the goods or indirectly through regulation
[8] IRR compares the rate of return from the investment to the market interest rate. The decision rule suggests that those projects for which the IRR is higher than the market interest rate should be approved.
[9] The Benefit/Cost Ratio is calculated by dividing the benefits associated with a program by the costs associated with a program. The resulting ratio is then used as a measure to compare programs.
[10] Cost Effectiveness Analysis (CEA) allows decision makers to compare the costs of various programs in achieving a specific program goal. Therefore, this method will theoretically identify the least costly method of achieving a unit of effectiveness (such as a one point increase in test scores or incremental increase in health status).
[11] Payback period indicates how long it will take the benefits derived from a program to pay back the costs associated with the program.

a decrease in costs or an increase in benefits, creating some ambiguity in decisions made using this method. Finally, using Payback Period has the distinct disadvantage in that it does not allow decision makers to distinguish between programs for which most of the benefit occurs early versus programs in which the majority of the benefits accrue later; in particular, it does not consider the value of benefits accrued beyond the payback period (Zerbe and Dively 1994).

Unlike these other methods, Social Net Benefit does not suffer from any of these shortcomings and is clearly the preferred method for evaluating public programs and making policy decisions. Social Net Benefit is calculated by taking the total marginal benefits that accrue from a program and subtracting the total marginal costs associated with the program. Therefore, unlike the Benefit/Cost Ratio methodology, calculating the Social Net Benefit through benefit-cost analysis (BCA) will yield a consistent value regardless of whether improvements resulting from the program are classified as a decrease in costs (savings) or increase in benefits. In addition, Social Net Benefit allows programs to be compared across regions and time (using present value) and also allows for the comparison of programs with different goals. Another advantage of using Social Net Benefit is that this method naturally produces a measurement of the social gain derived from the program in monetary terms. This value can then be used to rank programs according to those offering the highest net benefit to society. The level of financial resources available will then allow decision makers to select the bundle of programs offering the highest collective social net benefit (Zerbe and Dively 1994).

From the above discussion, it is clear to see that BCA can be used to maximize utility for society because it will identify the programs that are potentially pareto-improving. The pareto-criterion suggests that if one person can be made better off without making another worse off, then it will increase society's welfare. Of course, improvements may accrue to certain members of society at the cost of others, but from the perspective of society as a whole, a positive social net benefit indicates an improvement to society. To account for the possibility that some individuals within society may have gained at the expense of others, the assumption can be made that the benefits accrued to the "winners" are more than enough to compensate the "losers" such that overall everyone will be *at least* as well off as they were before the change (Mitchell and Carson 1989). In fact, one of Harberger's (1971) three postulates for applied welfare economics states that for a given action "the costs and benefits…be added without regard to the individual(s) to whom they accrue" (Harberger 1971, p. 785).

Clearly, BCA offers many advantages over other options as a tool for assisting decision makers in making efficient allocations of our scarce economic resources. In addition, BCA is consistent with the assumption of consumer sovereignty, that is, that the individual is the best judge of his/her own utility (Mitchell and Carson 1989). Therefore, it is not surprising that BCA is the preferred method for valuing programs. In fact, Executive Order 12866 made during the Clinton Administration[12] "explicitly requires federal agencies to consider costs, benefits, and economic impacts of regulations prior to their implementation" (List et al. 2004 p. 742) and state agencies are increasingly employing BCA as a prerequisite for policy implementation (List et al. 2004).

2.3 Valuing Non-Market Goods through Revealed and Stated Preference

Unfortunately, determining the benefits of some environmental and health-related goods can prove challenging. Environmental goods pose a problem in that as public goods, individuals have an incentive to act as free riders and understate their true preferences. Although goods in the health care sector tend to be more private in nature, the presence of insurance companies as third-party payers distort the true preferences of consumers within the market. In fact, the extensive use of co-payments (where consumers only pay a portion of the actual cost) suggests that individuals will consume more than they would if they were bearing the full cost of these goods out of pocket (Phelps 1992).

In addition, many environmental and some health care goods simply do not have a market. For example, better air quality and increased safety can not be purchased directly in a consumer market; however, related purchase decisions may provide insight into the value individuals place on these "goods." When actual purchases (in either an explicit or implicit market) reveal how much an individual values a good, this method is referred to as *revealed preference*. When questions are asked such that the individual states how much they value a good or service, this is referred to as a *stated preference* method.

[12] This reaffirmed an earlier executive order made during the Reagan Administration (List et al. 2004)

2.3.1 Revealed Preference – Explicit Markets

Valuation can be made directly by observing preferences revealed explicitly in consumer markets. One of the three postulates made by Harberger (1971) in regards to applied welfare economics suggests that the market price of a good can be used as a measure of the value the consumer places on that good. This stems from the fact that if the individual does not buy the good, then the price is an upper bound on the individual's WTP; however, if the purchase is made, the price is clearly a lower bound on the individual's maximum WTP. Therefore, when a good can be purchased in an explicit market, the market price will provide information regarding the valuation of the good. As a result, for policies that involve marginal changes in the quantity of the good provided, market price can serve as a good starting point for valuation; however, for policies that involve larger changes in the provision of the good, a better measure of valuation is the area under the demand curve since this allows consumer WTP to vary with the quantity of the good provided (Blomquist and Whitehead 1995). Although preferences revealed through actual market transactions are an effective way of valuing goods and services, a problem arises when estimating the value of a good that is not traded explicitly, or what is referred to as a non-market good.

2.3.2 Revealed Preference – Implicit Markets

Implicit values for many non-market goods have been estimated by observing purchases made in markets for related goods (Blomquist and Whitehead 1995). For example, information on the value individuals place on their health and safety can be obtained by studying other markets in which these health-related goods are *implicitly* purchased, such as the market for housing or automobiles. Following Rosen's (1974) hedonic pricing model, the value of air quality has been derived by looking at median home values as a function of neighborhood characteristics, including air quality (Harrison and Rubinfeld 1978). A meta-analysis performed by Smith and Huang (1993) indicated that using hedonic equations to estimate implicit prices is effective; however, further research by Smith and Huang (1995) suggests that the equation specification (including the functional form and number of characteristics included) could affect the marginal WTP values (Zabel and Kiel 2000).

Likewise, hedonic models can be applied to labor market data to obtain information on the value individuals place on their health and safety. Compensating wage differentials are paid to induce workers into riskier positions. Therefore, since labor markets are well-defined, observed wages and known levels of occupational risk can be used to determine the dollar tradeoff that an individual requires to accept a job with additional risk to personal health and safety.[13]

Analyzing travel costs is another method that has been used to value public goods such as national parks. Calculating the "travel costs" associated with visiting the destination, including the opportunity cost of time traveled, provides an estimate of the value individuals place on the natural resource. However, this valuation method will only provide a lower bound on WTP because it does not include non-use or existence values[14] for individuals who *do not* travel to the park.

2.3.3 Stated Preference- Hypothetical Markets

Although revealed preference methodologies such as those described above have allowed economists to place a monetary value on some non-market goods, what happens when a good has no close market from which to collect data? In this case, economists have used surveys to create a hypothetical market in which the good is offered and asks individuals directly about the value they place on that good. This technique is referred to as contingent valuation and is a considered a stated preference technique because it relies on preferences stated by those surveyed rather than preferences that are revealed through actual observed behavior (Blomquist and Whitehead 1995). A distinct advantage of stated preference methods is that they have the potential to measure both direct values (those that are obtained through revealed preference methods), as well as passive use values.[15] In theory, stated preference methods have the ability to measure the *total value* of the good being valued, as either a willingness to pay (WTP) or willingness to accept

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[13] See Viscusi (1986, 1993) and Viscusi and Aldy (2003) for a review of the literature including risk-dollar trade-offs in consumer markets and risk-wage trade-offs in labor markets.

[14] Valuation associated with non-use or existence values may derive from the intrinsic value of the environmental resource, altruism, or a bequest motive (Blomquist and Whitehead 1995)

[15] Although the term "passive-use" was not coined until later, Krutilla (1967) introduce the concept in his article entitled "Conservation Reconsidered" in which he suggests that individuals may place value on the existence of a natural resource (such as the Grand Canyon), and thus, may be willing to pay to preserve it even if they never plan to utilize it themselves.

(WTA) amount.[16] Since revealed preference techniques may exclude important components of an individual's true WTP or WTA, stated preference methods have become increasingly important to BCA as a means of estimating the total valuation of a good (Carson et al . 2001).

2.4 Valuing Health

Just as individuals reveal their preferences for consumer goods and services through the purchases they make, the same basic approach can be applied to valuing health; however, instead of making financial outlays to purchase goods, "expenditures" for health and wellbeing are often revealed through the choices individuals make regarding their time and lifestyle choices (Tolley et al. 1994).

2.4.1 Grossman's Household Production Model of Health

Grossman's (1972) household production model of health demonstrates how individuals, as rational economic agents, make choices on a daily basis that affect their health and overall utility. According to the model, utility is defined as a function of the goods and services consumed, as well as the individual's level of health or "health stock." Individuals are endowed with a certain level of health stock, which gradually depreciates with age. In addition, an illness or accident can cause a decrease in the health stock. The model assumes no uncertainty, so when an individual's health stock falls below some minimum level, death will occur (Grossman 1972).

To counter decreases in the health stock caused by aging and illness, individuals can make investments in their health. Specifically, an individual can purchase market goods and services (i.e. doctor visits, prescription medication, tennis shoes, healthy foods, etc.) and combine them with their own time (i.e. time spend exercising, preparing healthy meals, etc.) as a means of "producing" health and adding to their health stock. Furthermore, market goods and own time are translated into a higher health stock according to the individual's own production process; thus, allowing for the possibility that some individuals may be more efficient than others at producing health. In

[16] WTP measures how much the individual is willing to pay to receive an improvement or increase in a good. WTA measures how much the individual requires to accept damages or a decreased level of the good. The decision to use WTP versus WTA depends on how property rights are assigned.

particular, Grossman suggests that those with more education may be better at combining market goods with own time to produce health, such that they will tend to be more efficient producers of health (Grossman 1972).

Because utility depends on the individual's level of health,[17] an illness can change the marginal rate of substitution between medical care and all other goods by increasing the marginal value of medical care. As a result, individuals will increase their consumption of medical care relative to other goods. However, if an illness reduces the individual's ability to earn income, then both medical services and other consumption may fall in response to a lower budget constraint. Acting as rational economic agents, individuals will continue to invest in their health as long as the present value of the marginal cost of gross investment is less than or equal to the present value of the marginal benefit (Grossman 1972).

2.4.2. The Demand for Health

Following Grossman's model, several conclusions can be made as to the demand for health. First, if the rate of depreciation in the health stock increases with age, then the demand for health will also increase with age because larger and larger amounts of investment will be required to maintain the individual's prior health stock. In addition, an increase in the individual's wage rate will have the effect of increasing the value of healthy time, thereby increasing the marginal product of health capital. This suggests that individuals with higher wages will choose a higher level of health stock and have a higher demand for health. Finally, those who have more education may be able to combine market goods and own time to produce health more efficiently (Grossman, 1972). Therefore, it is expected that education will increase the marginal efficiency of health, and thus result in more educated individuals choosing a higher optimal level of health (Grossman 1972).

Grossman's empirical findings support his theoretical predictions. Using data from the 1963 Health Interview Survey conducted by the National Opinion Research

[17] Empirical work by Viscusi and Evans (1990) supports Grossman's assumption that utility is dependent on the health state. Using data on chemical workers, Viscusi and Evans (1990) find that the marginal utility of income is higher when an individual is healthy (higher state of health) as compared to when the individual is injured (lower state of health).

Center (NORC) and the University of Chicago's Center for Health Administration Studies, data showed a positive correlation between medical care with restricted activity days and work-loss days, suggesting a positive relationship between medical care and the depreciation rate. Using health stock measures obtained through self-reported health status, depreciation rates were found to increase with age. Grossman estimated depreciation to be approximately 2.1%, implying that 70% of the initial health stock would have depreciated by age 58, 80% by age 77, and 90% by age 96. Education was found to have a positive and significant effect. In addition, the wage rate was found to be positively related to the stock of health and the number of healthy days, which supports the hypothesis that an increase in an individual's wages raises the return on an investment in health, thus resulting in the individual choosing a higher stock of health (Grossman 1972).

2.4.3 Tradeoffs Involving Health

Household production models of health, such as that developed by Grossman, imply that "individuals will make expenditures of money and time to improve their health and reduce risks to their health" (Berger et al. 1994 p. 25). For example, the decision to purchase a smoke detector is an averting behavior in consumption that requires an expenditure of income in order to reduce the risk of fatality by a marginal amount. Therefore, even though health is not explicitly traded in a well-defined market, the value that an individual places on their health, and ultimately their life, can be derived from observing the choices they make in markets for other goods and services that affect their health (Berger et al. 1994).

2.4.4 Risk and Uncertainty

Risk is an inherent part of our everyday lives. We face risks when we drive/ride in a car, fly on a plane, or take a bus. In addition, we face possible risks of injury at our place of employment from the use of heavy equipment or coming into contact with hazardous materials. In our recreation, whether it is downhill skiing or simply jogging, the risk of injury or death exists. We even face significant risks in our homes, where a surprisingly large number of individuals are injured/die every day. And finally, we are at risk from disease and other medical conditions, such as cancer and heart attack. Although the average risk of injury or death from any single cause may be relatively small, the consequences from an unfortunate event have the potential to be life altering. Therefore, it is not surprising that individuals acting as rational economic agents will chose to expend some of their limited resources to reduce the probability of one or more of these risks (Viscusi 1992).

Because risk can not be eliminated completely, some risk of injury and/or death will always exist for each of us; however, it is possible to reduce those risks. Individuals can purchase cars with added safety features, choose a job that is less risky (although it may pay less), use safety equipment (such as a helmet, goggles, etc.) while participating in recreational activities, invest in carbon monoxide detectors for the home, and choose to have medical screening, to name just a few examples. These purchases which represent averting behavior in consumption will help reduce the probability of injury, illness, and/or death; however these risk minimizing efforts often involve a cost, either in monetary terms, utility, or both. For example, choosing to wear a helmet while downhill skiing involves both the monetary cost required to purchase the helmet, as well as a potential utility cost in that the individual may not enjoy the experience of skiing as much due to wearing the helmet.

Because individuals make decisions every day regarding how much risk to accept, these tradeoffs have the power to implicitly tell us how much a person would pay to avoid a certain amount of risk (either monetarily or in terms of lost utility). Therefore, "these tradeoffs in effect set the price that people are willing to pay for greater safety"(Viscusi 1992, p. 4). Thus, by observing these tradeoffs, estimates can be made as to the value society places on saving a life, as well as the value individuals place on their own health and wellbeing.

2.4.5. Value of Life

Thaler and Rosen introduced a methodology for estimating the value of a *statistical* life by addressing the question "How much will a person pay to reduce the probability of his own death by a 'small' amount?" (Thaler and Rosen 1976, p. 265).

In calculating the value of a statistical life, the identity of the person at risk is unknown. This is appropriate since decisions regarding risks to health and safety are often made by society in this manner. In fact, people often behave much differently in situations where the person at risk is known (Blomquist 2001). For example, it is not uncommon to hear in the news a story of a small town that expended many of its available resources for a short time in order to save a child who became trapped in a well. In cases such as this, "society will often spend whatever is available or do whatever is possible to save the life" because "the situation involves a potentially large change in survival for a known individual" (Blomquist 2001). Therefore, it is important to note that behavior under these circumstances is much different than when the risk is significantly smaller and exists for an *unidentified* group of individuals within society.

Risk in our daily lives is unavoidable (Viscusi 1992). As discussed above, individuals make risk tradeoffs everyday, including the choice to accept a riskier job in return for a higher wage – what Adam Smith (1776, 1994) referred to as compensating wage differentials.[18] What is interesting to note is that these observed tradeoffs provide an implicit value of avoiding additional risk, which is illustrated by the following statement:

> Suppose a person is observed taking a known incremental risk that could be removed by spending one dollar. Then the implicit value of avoiding the additional risk must be something less than one dollar or else it would not have been observed (Thaler and Rosen 1976, p. 266).

[18] The theory of equalizing or compensating wage differentials was first described by Adam Smith in *The Wealth of Nations.* Smith explained how some workers could expect to earn higher wages than others because of differences in key job characteristics. For example, those individuals who worked in jobs that were generally considered harder, more dangerous or required special training would typically earn higher wages than those individuals with otherwise identical characteristics who were employed doing jobs that offered more favorable working conditions. The higher wages paid to these workers was considered a means of compensating them for withstanding the unpleasant aspects of their job. The amount of the wage differential paid for each type of job and its associated unpleasantness would be determined by the market. The wage would have to be high enough in order to induce the marginal worker to accept the unpleasant job rather than taking a more pleasant job offering a lower wage.

Using data from the 1967 Survey of Economic Opportunity (SEO)[19] and the 1967 Occupation Study of the Society of Actuaries,[20] Thaler and Rosen (1976) test Adam Smith's theory of compensating wage differentials. They do this by incorporating risk into a standard wage equation to estimate the dollar amount required to induce an individual worker to accept a job with a slightly higher degree of risk (fatality). This estimate is based on the assumption that if each worker is willing to pay $50 to avoid, say, a .001 chance of dying, it logically follows that 1,000 workers together would pay $50,000 to eliminate the probability of death and *statistical* save a life.

Using this methodology, Thaler and Rosen (1976) estimate the value of life to lie in the range of $140,000 to $260,000 (in 1976 dollars), which would amount to approximately $500,000 to $940,000 in today's dollars.[21] Although this range is lower[22] than many of the more recent studies, Thaler and Rosen's 1976 study contributed something incredibly significant - a meaningful way of "valuing" a human life in monetary terms. The meta analysis by Viscusi and Aldy (2003) find the most reliable estimates for prime-age workers to be in the range from 5 to 9 million in current dollars.

Tradeoffs involving risk are not unique to the labor market. In fact, there are countless such tradeoffs that occur each day in consumer markets. Consider for a moment the automobile and housing markets. Individuals purchase used cars offering fewer safety features than newer models, and families buy homes in areas abutting

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[19] This data set provided demographic information, as well as the individual's occupation and industry in which they work.

[20] This study used insurance company records between 1955 and 1964 to measure additional risks associated with extremely hazardous occupations. Because the data reported information using a combination of *both* industry and occupation, it could be directly matched to individuals in the SEO sample. In this regard, it provided a better measure of risk than data from the Bureau of Labor Statistics (BLS), which was the traditionally source for industry hazards data. The BLS only reported the average hazard for each industry, regardless of occupation. Since occupations within an industry could vary widely with regard to risk, use of this data could cause a large degree of measurement error. Therefore, Thaler and Rosen used the 1967 Occupational Study on Society of Actuaries to avoid the aggregation problem inherent in the BLS data.

[21] (CPI March 2007 – Ave. CPI 1976)/ Ave. CPI 1976 = (205.352-56.9)/56.9 = 2.608998
$140,000 * 3.608998 = $505,260 & $260,000 * 3.608998 = $938,340

[22] This is most likely a result of Thaler and Rosen's chosen data set. The Society of Actuaries data includes individuals in very high-risk occupations, and therefore would be expected to yield a lower value of life because of "the self-selection of individuals with low risk-dollar tradeoffs into the most hazardous pursuits" (Viscusi 1993). For a detailed discussion of this and other data and econometric issues, see Mrozek and Taylor (2002) and Viscusi and Aldy (2003). As Shogren and Stamland (2002) argue and Kniesner et al. (2005) find, self selection on unobserved productivity in dealing with risk in the labor market can produce estimates of value of life that are biased *upward*. The net effect depends upon the relative strength of the effects of the unobservable factors.

Superfund sites. Despite the fact that these purchases may pose a potentially higher health hazard, these goods are still consumed because they tend to be more affordable. Therefore, value of life estimates can be derived by observing purchasing behavior in certain private consumer goods markets that entail some amount of risk. In particular, the demand for automobile safety features, cigarettes, and housing locations all provide information on the underlying safety preferences of individuals; and hence, can be used to estimate society's willingness to pay to avoid higher levels of risk (Tolley et al. 1994, Blomquist 2004).

For example, Atkinson and Halvorsen (1990) estimate the value of a life based on the premise that individuals pay more for an automobile that offers a higher level of safety (or a lower probability of fatality risk). Using the risk-dollar trade-off framework initially proposed by Thaler and Rosen (1976), Atkinson and Halvorsen use data obtained in the automobile market to estimate the value of a statistical life. Since accident rates may be affected by the personal characteristics of the individuals who tend to buy that type of automobile, they use a hedonic equation to control for this possible effect. After adjusting for the average number of occupant fatalities per accident (dividing by 1.15), they estimate the value of a statistical life to be $3.4 million (in 1986 dollars), which is approximately $6.3 million in today's dollars.[23] This amount is consistent with the findings in Viscusi and Aldy's (2003) review article and therefore lends credibility to this method as a means of valuing a human life.

2.4.6 Methods for Valuing Health

Although placing a value on something as intangible as one's health may at first seem implausible, just as economists have found reliable means of valuing a life, they have used similar methods to value improvements in health. Valuing health is important because, from a benefit-cost standpoint, it is necessary in order to ensure that the combination of health services being offered is the one that will maximize the wellbeing of its citizenry. Therefore, finding a meaningful way to value health is necessary in order to make efficient decisions regarding the number and types of health programs to offer.

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[23] (CPI March 2007 – Ave. CPI 1986)/ Ave. CPI 1986 = (205.352-109.6)/109.6 = .873650
$3.357 million * 1.873650 = $6.29 million

As a result, economists have strived to improve the methodology employed to value health. The following describes several methods that economists have utilized in estimating the value of health.

Cost of Illness

One method that has been used to value health is the cost of illness (COI), or human capital, approach.[24] The theoretical basis for this method relies on the assumption that individuals within our society represent human resources that produce goods and services (Berger et al. 1994). Therefore, when individuals within our society become sick and are not able to work, there is a cost involved – specifically, the cost of medical services utilized, as well as the loss of productivity during the illness. These costs can be classified as either direct or indirect costs of illness. Costs such as health expenditures and the value of resources used for treatment (doctor's time, medical supplies, medications, etc.) are all considered direct costs; whereas the value of lost productivity and lost wages resulting from being sick (or dying prematurely) are considered indirect costs. Therefore, using this approach, the value of a health improvement is equal to the sum of the direct and indirect costs associated with the illness (Berger et al. 1994).

When an individual works in a clearly defined market and/or has a specified wage, the COI approach can be used to estimate a lower bound for the value of improvements to health. This method can only provide a lower bound for health valuations because it does not take into consideration the value an individual places on avoiding the pain and suffering associated with an illness (lost utility). In addition, significant problems arise when this approach is used in an attempt to estimate the value the general population places on a health improvement. This is because it completely disregards the value placed on health by those who are retired or who work in non-defined markets (i.e. full-time homemakers). Because these individuals do not have a market wage, their loss of productivity due to sick time is simply recorded as a zero in the calculation. Therefore, this method clearly has limitations in estimating reliable values on health improvements and at best can only yield a lower bound (Berger et al. 1994).

[24] For examples, see Weisbrod (1971) and Cooper and Rice (1976)

Cost-Effectiveness Analysis

The inherent shortcomings of the COI approach for valuing health - its lack of a theoretical foundation in utility theory, the fact that it does not account for the intrinsic value and quality of life, and that it discriminates against those not in the labor force - lead to the development of cost-effectiveness analysis (CEA). Cost-effectiveness analysis measures the effectiveness of an intervention in terms of health outcomes (such as life years gained) for each dollar spent and is most often used in the field of public policy (Johannesson 1996). In determining how to allocate financial resources between competing health programs, the decision rule is to maximize the effectiveness for a given budget. This methodology works best when comparing alternate treatments that have the same goal; however, as discussed earlier in this chapter, CEA falls short when comparing programs with different outcomes. The problem with this method is that it does not provide a basis for comparison between outcomes measured in different units. Therefore, although this method is useful in finding the least costly way to achieve a specific health-related outcome, it provides no systematic way to choose between programs designed to pursue unrelated health goals.

Cost-Utility Analysis

One of the concerns with cost-effectiveness analysis was that the utility associated with a single outcome measure of life years gained could vary considerably depending on the quality of life associated with those years. For example, consider two programs, both of which have an outcome of 5 additional life years gained. One program will grant individuals 5 additional years with relatively no side effects, whereas the other will grant an additional 5 years with significant side effects. Clearly, the outcome without side affects is preferable; however, cost-effectiveness analysis would rate these two programs equally. Therefore, cost-utility analysis was developed as a special form of cost-effectiveness analysis in which life years gained are adjusted for the quality of life obtained in those years. As a result, this method uses quality adjusted life years (or QALYs) as the measure of effectiveness. QALYs are often obtained by taking the gain in life years and multiplying by a utility index based on the quality of life achieved in those years. For example, if an individual has a quality of life equal to 80%, then 5 life years gained would equal 4 QALYs (5 life years *.8). Because cost-utility analysis is essentially an extension of cost-effectiveness analysis, the same problems that are prevalent in cost-effectiveness analysis also exist for cost-utility analysis. In addition, cost utility analysis faces the added challenge of measuring quality of life and transferring it into a valid utility index[25] (Johannesson 1996).

Household Production and Preventative Expenditures

Whereas the COI approach looks at the expenditures made after the onset of an illness, the household production and preventative expenditures approach looks at expenditures intended to prevent illness (Berger et al. 1994). From the earlier discussion of Grossman's (1972) model on health production, it is clear that individuals can make purchases that contribute to their overall health. Therefore, one way to value health is to calculate the sum of the additional income that can be earned plus the monetary value resulting from a higher level of utility associated with good health (Berger et al. 1994). Thus, the household production and preventative expenditures method not only includes the indirect cost of illness (lost wages), but unlike the COI approach, also includes a preference-based measure that stems from the individual's own consumption and resulting utility[26]

Willingness to pay – Implicit markets

Household production models can also utilize observations of self-protection to estimate the WTP for small changes in fatality risks (Blomquist 2004). Self protection refers to individual actions which avert risk, such as wearing a seatbelt, choosing not to smoke, or as discussed above, making purchases that improve the individual's level of safety (buying smoke detectors for the home, purchasing a car with added safety features) (Blomquist 2004). A study by Smith and Desvousges (1985) showed that households in the suburbs of Boston took varying preventative measures (including purchasing bottled

[25] methods used to measure utility include the standard gamble and time-trade off
[26] For examples, see Cropper (1981), Gerking and Stanley (1986), and Dickie and Gerking (1991)

water, installing water filters, and attending public meetings) as a means of reducing the health risks associated with toxins in the drinking water (Berger et al. 1994).[27]

Because people invest time and money in producing their own health, it is possible to observe the consumption of goods that are *indirectly* related to health (and purchased in well-defined markets) to derive the value people place on health improvements. As discussed earlier in this chapter, individuals chose jobs that reveal their preferences regarding risk (averting behavior in the labor market) and purchases in consumer markets (averting behavior in consumer markets) that involve dollar-risk trade-offs that can be used to estimate valuations for health in terms of the individual's WTP. WTP provides a more complete measure of valuation compared to COI and is preferable measure over cost-utility and cost-effectiveness measures because it is compatible with BCA. Therefore, WTP[28] is the preferred measure in valuing improvements in health.

Willingness to pay – Contingent markets

In valuing goods for which no market exists (i.e. lower health risk, reduced side effects), economists have used surveys to get respondents to reveal their willingness to pay (WTP) for a specific health commodity *contingent* on the existence of a market for that good. This is known as the contingent valuation method (CVM). The CVM is a stated preference method that uses surveys to elicit individual preferences by asking respondents directly about their willingness to pay for a particular good or service. As discussed earlier in this chapter, stated preference methods have an advantage over revealed preference methods in that they have the potential to determine the *total* valuation of a good, including passive-use values. Therefore, this method is incredibly useful for BCA. As a result, contingent valuation (CV) is widely used to estimate values of environmental resources and is growing in popularity as a means for valuing health-related goods and services.

[27] See Blomquist (2004) for a review of the literature on self-protection and averting behavior

[28] WTP is the maximum amount an individual is willing to pay for a given quantity of a good. Therefore, the benefit associated with a health improvement can be found by measuring the area under the aggregate demand curve (WTP plotted against quantity).

2.5 Contingent Valuation Methodology (CVM)

Contingent valuation (CV) is a stated preference methodology that utilizes a survey to elicit information regarding an individual's valuation for an improvement in a health, environmental, or other good for which a well-defined market does not exist. CV surveys have been conducted face-to-face using an interviewer, over the phone, and through self-administered surveys delivered through the mail and via the Internet.

2.5.1 Description of the Contingent Valuation Survey

Although no formal standard exists, most CV surveys contain a detailed description of the good to be valued, including the manner in which it would hypothetically be made available to the respondent; a mechanism by which the respondent reveals his/her willingness to pay for the good; demographic questions; and questions regarding the individual's attitudes that may influence his/her valuation of the good (Mitchell and Carson 1989).

Since the CVM has a variety of applications, the "good" described in the survey can take many forms. It can be a *public* good such as electric wind power (Champ and Bishop 2001), preserving rain forests acreage (Cummings and Taylor 1999), or reclaiming wilderness areas at the Grand Canyon (Champ et al. 1997); a *semi-private* good, such as a diabetes management program that may have positive externalities (Blumenschein et al . forthcoming 2007); or a *private* good, such as an electric juice maker (Cummings et al. 1995), sportscards (List 2001), sunglasses (Blumenschein et al. 1998), or a box of chocolates (Cummings et al. 1995). Regardless of the good being valued, it is important to fully and accurately describe the good, to help ensure the respondent has a clear understanding of the good they are being asked to value. This will help prevent unwanted scope effects or embedding problems.

2.5.2. Payment Mechanism for Eliciting WTP

Once the respondent has been provided with a description of the good, they are asked to value it in some way. For public goods, a common method of eliciting estimates of WTP is through the use a dichotomous choice (DC) referendum question. Respondents are asked to vote either in favor or against everyone contributing a certain dollar amount to a good (Brown et al. 2003, List et al. 2004, Cummings and Taylor 1999). Due to concerns that the referendum essentially "forces" everyone to contribute, information on individual WTP has been obtained by asking for voluntary donations for a public good, such that an individual's decision to contribute does not affect others. Voluntary contribution mechanisms (VCM), in which respondents are asked to make voluntary donations may also include a provisional point mechanism (PPM) (Murphy et al. 2005). In the context of the survey, respondents are informed of a minimum amount that is needed in order for the good to be provided (the provisional point). It is thought that inclusion of a PPM with a "one-shot" voluntary donation reduces the occurrence of free-riding, and therefore provides more accurate measures of WTP (Poe et al. 2002). It is not uncommon for CV studies that include a PPM to also tell respondents that if the total contributions do not reach the dollar amount needed to provide the good, individuals donations will be refunded (Murphy et al. 2005).

In valuing private goods, WTP can be elicited using a DC question in which respondents are asked if they would be willing to pay a certain amount for the good. Because this method will only yield a yes/no response from each individual, providing either an upper or lower bound on the respondent's WTP, econometric techniques are needed to estimate the mean WTP. Therefore, in an effort to obtain additional data from each respondent, DC choice questions are sometimes repeated with different price offerings. Depending on the number of times the question is asked, this is referred to as a single bounded, double bounded, or multiple bounded DC question ("bidding game").

In the economics literature, the term "iterative bidding game" refers to the use of a multiple bounded DC question in which respondents are asked repeatedly if they are willing to pay $X for a good. Bids are either increased or decreased according to a pre-set group of bids. For example, if the pre-set bids are $5, $10, $15, $20, $25 and $30, and the respondent answered "yes" to the initial bid of $15, the interviewer would ask if the respondent was willing to pay $20. The interviewer will continue to the next highest pre-set bid until the respondent answers "no"; thus, determining a narrow range in which the respondent's WTP lies. A similar process would occur if the respondent answered "no" to the initial bid. In that case, the interviewer would then proceed to go down to the next pre-set bid until the respondent switched their answer to "yes." Although this process is termed "iterative" in some ways it is misnomer because the process does not go back and forth to converge on a single value. Instead, bids are simply move in a single direction until the respondent's answer changes.

Bidding games are often subject to starting point bias (Mitchell and Carson 1989); therefore, Mitchell and Carson (1989) suggest the use of a payment card in which respondents are provided with all the bids and asked to circle the highest amount they would be willing to pay. Finally, another approach to eliciting respondent WTP is to simply let respondents state the maximum they would be willing to pay in an open-ended question.

Through the use of one of these elicitation methods, CV surveys can determine WTP for a good *contingent* upon a market for that good existing. This information can then be used to estimate the benefit of the good/program and subsequently be used to make recommendations regarding the efficient allocation of available resources.

2.5.3 The Growing Use of CVM

The use of contingent valuation (CV) first appeared in the environmental literature, see Carson (2001). Valuing environmental goods posed a somewhat unique difficulty in that market transactions reflecting consumer preferences are seldom observed since many environmental goods are public goods provided with tax revenues by the government. However, the development of the CV approach allowed economists to collect data on the demand for environmental goods by asking individuals "to give their willingness to pay for some outcome contingent on the assumed existence of a market in which it [could] be purchased" (Magat, Viscusi, and Huber 1988, p. 395). Although a market for health care does exist, economists face similar problems in valuing health-related goods because of the presence of insurance companies as third party payers, which tend to obscure the true preferences of consumers in these markets. Therefore, the CVM gradually started appearing in the health literature as a means of evaluating the value of health-related goods and services.

According to Portney (1994), the first mention of CVM occurred in 1947 in an article by Ciriacy-Wantrup about the benefits of preventing soil erosion; however, early applications of the method did not occur until years later. Perhaps the first to employ the

CVM was Davis (1963), who as part of his dissertation research, used a survey to estimate the demand hunters and wilderness lovers placed on a particular recreational area. In an effort to validate his results, Davis compared his estimates to those obtained using the "travel cost" approach, in which the quantity of visits is plotted against a range of "prices." In this case, the "price" is determined by the inferred cost required to travel the distance. Davis discovered that the estimates derived using the CVM were comparable to those estimated using the travel cost method (Portney 1994); thus lending credibility to the use of CV as a method for valuation.

In the early 1970's, economists began to recognize the importance of CVM as a valuation method for environmental and resource economics. In fact, Mishan (1971) encouraged economists to use this direct questioning approach to elicit willingness to pay values as opposed to methods that employed cost of illness measures (Berger et al. 1994). During the 1970's the CVM became increasingly important for its potential to fully value environmental resources, including existence values (Blomquist and Whitehead 1995). In addition, the use of the method was not limited to environmental goods. Coincidentally enough, one of the first applications of the CVM in health economics was a study by Acton (1973) who used a CV survey to value reductions in the risk of death from heart attack (Portney 1994).

One of the unique features of the CVM is that it has the potential to capture passive use values[29] that may not be obtained using other valuation methods (Carson et al. 2001). Therefore, CVM is highly useful for benefit-cost analysis. As a result, this method gained popularity as a means of valuing environmental goods and resources that were thought to have high passive use values.[30] However, the use of this method to value environmental resource damages in Alaska following the Exxon Valdez oil spill, which resulting in a highly public court case and large monetary award for damages (resulting primarily from high existence and non-use values) has brought a lot of attention to the CVM and fostered a debate as to whether CV can provide accurate measures of valuation

[29] "passive use value" was a term adopted by the courts intended to be a broad descriptor which included the following: non-use value, existence value, preservation value, bequest value, stewardship value, intrinsic value, and option value (Carson et al. 2001).

[30] In valuing environmental resources it is often the case that individuals place a value on a good even if they never plan to use it. These existence values are utility based and may arise from purely intrinsic values, altruism, or the fact that individuals would like to see the resource preserved for future generations (Blomquist and Whitehead 1995).

(Portney 1994). Unfortunately, opposition to the CVM may not be coming solely from individuals within the economic profession who are attempting to shed light on this issue for the sake of academic integrity. Industry groups outwardly opposed to the use of CVM have sponsored research investigating the reliability of the CVM (Carson et al. 2001). This means that sources of financing for CV validation studies may need to be considered when making broad assessments as to the reliability of the CVM in valuing non-market goods.

In response to the criticism over the validity of the CVM, a panel of well-respected economists was convened by the National Oceanic and Atmospheric Administration (NOAA). The purpose of the panel was to answer the question "Is contingent valuation capable of eliciting reliable estimates?" (Portney 1994, p 8). The panel concluded that "CV studies can produce estimates reliable enough to be the starting point for a judicial or administrative determination of natural resource damages including lost passive use values" (Arrow et al. 1993 p. 4610). In addition, the panel including a set of guidelines intended to help ensure the reliability of estimates obtained using this stated preference method (Arrow et al. 1993). The NOAA panel has periodically updated these rules in accordance with general findings derived from the growing contingent valuation literature to help ensure the credibility of CV as a valuation method (List and Gallet 2001, Little and Berrens 2004, NOAA 1994, 1996).

Although there are still some unanswered questions as to whether CV can accurately reflect consumer preferences in all cases, the CVM continues to be widely used in the environmental literature and a growing number of studies are using CV as a method to value health-related goods and services.[31] It is expected that this trend will continue due to the important role stated preference methodology (including the use of CV surveys) plays in providing valuations for benefit-cost analysis which is required by federal agencies and more and more by state and local government for the implementation of public policy programs (List et al. 2004).

[31] See Diener et al. (1998) for a review of the health care studies utilizing the CVM.

2.6 Potential Concerns with CVM

Some economists have expressed concerns regarding the validity and reliability of estimates obtained using CV (Diamond and Hausman 1994, Kahneman and Knetsch 1992). Therefore, the following section includes a discussion of each of these possible issues: Hypothetical bias and other potential biases, embedding, insensitivity to scope, familiarity, and warm glow.

2.6.1 Bias

There are several types of bias, or systematic error, that can occur when conducting a CV study including: hypothetical bias, strategic bias, starting point bias, vehicle bias, and information bias. Hypothetical and strategic bias are an inherent part of any CV study, whereas the other biases stem primarily from the design of the survey instrument (Kenkel et al. 1994). The bias that currently appears most often in the literature, and potentially poses the greatest concern for obtaining accurate valuations using CVM, is hypothetical bias. The following provides a more detailed explanation of each of these potential biases.

Hypothetical Bias

The term "hypothetical bias" is commonly used in the empirical literature to refer to the tendency of stated values in hypothetical markets to overestimate preferences revealed through actual behavior. Hypothetical bias has serious implications regarding the validity of utilizing CV valuations for policy decisions. According to Kenkel et al. (1994) hypothetical bias can occur when the respondent does not believe the credibility of the question being asked. If the respondent puts little or no faith in the validity of the question, then their response will also tend to be less than credible (Kenkel et al. 1994). Because decisions being made in contingent markets do not require a financial outlay, one of the challenges in designed a CV survey is to select a payment mechanism that is incentive-compatible; that is, one that will provide an incentive for respondents to reveal their true WTP.

One of the current concerns regarding values obtained using the CVM is that several studies have shown that stated preferences elicited through hypothetical markets tend to overestimate revealed preferences observed in actual markets (Cummings et al. 1995, List and Gallet 2001). Cummings et al. (1995) compared decisions to purchase three goods: an electric juicer, a box of chocolates, and a thin solar calculator, and found that respondents were more likely to say they would purchase the good when the decision was hypothetical versus when the decision was real. List and Gallet (2001) perform a review of the literature and find that for several studies, hypothetical values exceed actual values for both public and private goods. This finding indicates that hypothetical bias is a real concern for CV surveys that needs to be addressed in order to obtain valid benefit measures using this method.

Strategic Bias

Even if the respondent believes the question to be credible (to help address hypothetical bias), the potential for strategic bias still exists. According to Mitchell and Carson (1989), "strategic bias occurs when respondents deliberately shape their answers to influence the study's outcome in a way that serves their personal interest" (Mitchell and Carson 1989, p. 238). Therefore, the more credible the question is perceived to be by the respondent, the more likely he/she is to misrepresent a response in a strategic manner. In this case, the respondent's valuation for a good would not necessarily be a statement of their true preferences, but rather would reflect their strategy to accomplish another, possibly completely unrelated, pursuit (Kenkel et al. 1994).

Strategic bias is much more likely to occur in the valuation of a public good, because of the tendency for individuals to try and become "free-riders." When respondents believe that the valuation they give in a survey could ultimately affect how much they would have to pay for the good (perhaps through an increase in taxes), there is an incentive to act strategically and give a valuation that is below their true valuation. Or, if the individual expects that because of their limited income, there may be a maximum amount that would be required of them to receive the good, there could be an incentive for these individuals to overstate their preferences in an attempt to ensure that the good becomes available. In general, the overall expectation is that if strategic bias does exist in the sample, then a slight overestimation is likely to occur. (Mitchell and Carson 1989). However, even in this case, there is little evidence to support the theory that people act strategically in completing CV surveys and because this is much less likely to occur in valuing a private good, strategic bias does not appear to be a significant issue for this particular study.

Starting Point Bias

Starting point bias arises from the tendency of respondents to perceive the initial bid as reasonable, thus causing valuations to cluster around the starting point. This can potentially be avoiding in several ways. One way is to vary the starting points among the surveys. Another method is to use a dichotomous choice framework in which the respondent is simply asked to accept or reject a single, random bid. Based on the series of yes and no responses, the mean WTP can be calculated (Kenkel et al. 1994) using econometric techniques such as Kriström's (1990) non-parametric approach.

Vehicle Bias

Vehicle bias occurs when a response is influenced by the payment vehicle. For example, the questionnaire may state that the good will be financed by an increase in taxes. In this case, the respondent may state their maximum WTP is zero as a protest to any increase in taxes, even though they may actually place a significantly higher value on the good (Kenkel et al. 1994). Vehicle bias can potentially be avoided by wording the question in such a way that the payment method is vague; however, this could inadvertently increase the potential for hypothetical bias as it may reduce the credibility of the proposal as perceived by the respondent (Kenkel et al. 1994).

Information Bias

Finally, information bias can occur as a result of the information provided in the questionnaire. It is necessary for contingent valuation surveys to provide some information, as asking an individual to value a good with no understanding of that good would not provide accurate assessments of valuation (Fabian and Tolley 1994). However, it is not always the case that more information is better. As Mitchell and Carson (1989) point out, sometimes adding information to make the survey scenario more realistic can cause respondents to focus on unimportant details while losing sight of the good being valued. Therefore it is necessary to find a balance in which enough information is conveyed so the respondent understands and can credibly value the good, while avoiding too much detail that can will take excessive time and potentially lead to boredom on the part of the respondent (Fabian and Tolley 1994).

Mitchell and Carson (1989) caution that information bias can have a significant effect on WTP values if respondents misunderstand the good being valued. For example, if the researcher asks respondents to value a low-probability risk, but it is misperceived by respondents to be a high-probability risk, then it is likely to have an effect on stated WTP (Mitchell and Carson 1989). Therefore, care should be taken to clearly define the good and test respondents' understanding of the good, perhaps through the use of focus groups. In addition, the potential for information bias can be diminished by ensuring the CV survey focuses on two types of information – elements that are valuation *relevant* (which are intended to be taken into account in the valuation process) and elements that are valuation *neutral* (those that provide a credible market for the good, and are not intended to influence the valuation) (Mitchell and Carson 1989).

2.6.2 Embedding

Some economists, including Diamond and Hausman (1994), have argued that stated WTP obtained through the CVM can be subject to an embedding effect. Embedding occurs when respondents to a CV study value more than what the researcher intends (Schulze et al. 1998). For example, in an air quality study by Tolley at al. (1985), respondents were asked to provide a WTP amount for improved *visibility*. In stating their WTP for improved visibility, it is possible that respondents also included a dollar value associated with the improved health that would additionally result from better air quality (Schulze et al. 1998).[32]

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[32] Schulze et al. (1998) offer three possible reasons why embedding might occur: (1) Individuals gain "moral satisfaction" from giving to a good cause; however, marginal utility derived from increased giving diminishes rapidly. Therefore, giving to more than one cause or increasing the amount of the good has little effect on the individual's WTP; (2) If goods have high substitutability, then respondents may view giving to one program as having high value, but giving to a second program would have little value; (3) Individuals consider "joint products" when making their valuations. This occurs when respondents value more than they are asked to value. For example, a respondent may be asked how much they would be willing to pay to save an endangered species of butterfly in the Amazon. If the respondent feels that the only way to save the butterfly is to preserve its habitat, then the respondent may state their valuation for saving the forest, as opposed to just saving the butterfly (Schulze et al. 1998).

Hoehn and Randall (2002), two of the economists who worked on the Tolley et al. (1985) study, later utilize a procedure for valuing multi-dimensional goods that eliminates the embedding problem. Hoehn and Randall (2002) use a CV survey to value improvements to the Coeur d'Alene River Basin that had sustained environmental damages due to years of coal mining. Using an information booklet,[33] respondents are asked to assess the severity of individual environmental injuries (i.e. toxicity to the area, fish mortality, swan mortality) associated with the resource damage. After all of the information regarding resource injuries was made, respondents were then asked to state their preferences for improving the area by voting in favor or against a one-time tax (tax amounts ranged from \$60 to \$220). Marginal WTP for each individual benefit stemming from the overall treatment can then be obtained using a linear model (in a manner similar to hedonic regression) in order to decomposes WTP into the implicit prices associated with each specific improvement (Hoehn and Randall 2002). Although the authors agree that this method may still be susceptible to question order effects (Hoehn and Randall 2002) which could affect marginal WTP values, this method does address the issue of embedding, and as such, should result in reliable valuations for the *overall* improvement being valued.

2.6.3 Insensitivity to Scope

Problems associated with scope occur when economic theory dictates that people should be willing to pay more (for an increase in quality or quantity of the good) and yet WTP remains relatively constant. In an attempt to discredit the CVM, Diamond and Hausman (1991) cite a study by Desvousges et al. (1993) in which, according to Diamond and Hausman, the WTP valuations obtained were essentially the same for saving (a) 2,000, (b) 20,000, or (c) 200,000 birds. Although this seems like strong evidence to suggest a problem with scope, Carson et al. (2001) point out that this statement is misleading because in fact, the Desvousges et al. (1993) survey was worded such that respondents were valuing "saving (a) much less than 1%, (b) less than 1%, or (c) about 2% of a population of 8.5 million migratory waterfowl" (Carson et al. 2001).

[33] According to the authors, the booklet was organized following the hierarchical format suggested by Bettman et al. (1987) and Magat et al. (1988).

This is not to say that problems with scope are not possible; however, it does suggest that clearly defined goods (in terms that are easy for the respondent to understand), can help prevent scope from being an issue. One area in which scope is known to be a valid issue is "valuing small changes in small probabilities in health risk" (Carson et al. 2001). Beattie et al. (1998) find that individuals have difficulty understanding low-level changes in risk which can result in valuations that are insensitive to scope.

2.6.4 Level of Familiarity

When people choose to make a purchase in an actual market, they generally know something about the good they are planning to purchase. However, in asking about a good in a contingent market, respondents may not be familiar with the good they are being asked to value. This can lead to problems associated with embedding or scope, as mentioned above, and can also bring into question the accuracy of using stated preferences as a method of valuation. Regarding the degree of familiarity that is necessary to make valid estimations of value, some economists (Carson et al. 2001, Hanemann 1994) argue that numerous new products are introduced in consumer markets each year, such that individuals routinely make "purchase decisions involving goods for which they have no prior experience" (Carson et al. 2001 p. 178). Therefore, the information provided in contingent valuation surveys may actually provide more information about the good than consumers have in making purchases for "unfamiliar or infrequent commodities" (Hanemann 1994 p. 20).

Although this theoretical argument may appear to have merit, the empirical evidence suggests otherwise. Whitehead et al. (1995) find that in valuing improvements in the water quality and wildlife habitat for an environmental resource in North Carolina, on-site and off-site users provide estimates of WTP that meet tests of construct validity; whereas those provided by non-users did not (Whitehead et al. 1995). In addition, Boyle et al. (1993) find that experienced boaters provide more valid WTP responses than inexperienced boaters in valuing flow levels that can affect the quality of a white water rafting trip through the Grand Canyon. These findings suggest that those who are more familiar with the good may give more valid estimates of WTP. In addition, sampling respondents who are more familiar with the good being valued may also prevent other related CV issues. In a review of the CV literature, findings by Schulze et al. (1998) suggest that embedding may be less of an issue for respondents who are familiar with the good versus those who are unfamiliar. These studies provide evidence that sampling respondents who have some degree of familiarity with the good may improve the accuracy of WTP estimates; however, it does not preclude the possibility that individuals with lower degrees of familiarity can still provide accurate valuations for certain types of goods, provided the CV survey provides relevant information and precautions are taken to mitigate the effect of hypothetical bias.

2.6.5 Question Order and Context Effects

Question order effects arise when the valuation of multiple goods presented in a single CV survey is influenced by the order in which the goods are presented. The following example illustrates a common occurrence for CV studies in which two or more goods are valued as part of the same survey. If respondents are asked about their WTP to save whales in a certain natural resource area, and then asked about their WTP to save dolphins in the same area, respondents' WTP for saving whales tends to be higher; however, when the order of the questions is reversed, respondents' WTP for dolphins is higher. Another related problem is when two different surveys are used to value whales and dolphins separately. In this case, the sum of the WTP valuations when the two goods are valued independently tends to be larger compared to the sum of the WTP valuations for the two goods when they are valued together as part of the same survey. Carson et al. (2001) asserts that these outcomes can largely be explained by income and substitution effects. When two goods are valued together, the household income available to spend for the second is diminished by the respondent's stated WTP for the first. In addition, if these goods are viewed as substitutes, then it is not surprising that WTP for the first would diminish WTP for the second. However, income and substitution effects would *not* be observed when the goods are valued independently. Therefore, Carson et al. (2001) caution that summing up CV estimates obtained independently does not take into account substitution and income effects, and this is necessary in order to derive valuations that do not overstate true WTP.[34]

Evidence regarding question order effects in CV studies includes a study by Boyle et al (1993). In this study related to the quality of a white water rafting trip along the Colorado River in the Grand Canyon, 8 different levels of river flow were valued in the same CV survey (Half the sample received a survey in which the flows ranged from low to high, and the other half received surveys in which the flows ranged from high to low). Since the goods being valued were completely independent of each other, resulting valuations should also have been unaffected by question order. Boyle et al. (2003) found that those with more familiarity of the good (i.e. experienced boaters) did not demonstrate question order effects; however, those with less experience did have variances in their valuations that could be attributed to question order. This finding suggests that those with a higher level of familiarity may be less susceptible to question order in valuing goods through CV.

2.6.6 Warm Glow

Warm glow[35] is a concept that suggests that individuals can be motivated because they "derive utility from the act of giving through the associated social approbation, prestige, or moral satisfaction" (Carson et al. 2001 p. 177). Empirical evidence from the CV literature suggests that the warm glow effect may be an issue when respondents make their preferences known in such a way that the information may be made public.

A CV study by Leggett et al. (2003) in which visitors to Fort Sumter National Monument in South Carolina were asked about their WTP for a fort visit, suggested that conducting the survey using an interviewer resulted in "social-desirability bias" as compared to WTP estimates obtained using a self-administered mail survey. However, a study by Carson et al. (1994) found that using a standard CV format with an interviewer versus a secret ballot box resulted in no statistically significant difference in WTP estimates. In addition, in a comparison of mail versus telephone surveys, Ethier et al.

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[34] In as much as it does not take into account income and substitution effects, Carson et al. (2001) do not agree that the "adding-up test" proposed by Diamond and Hausman (1994) should be used to validate CV valuations.

[35] According to Carson et al. (2001), Becker (1974) used the term "warm glow" to describe the concept of impure altruism which was first introduced by Olsen (1965).

(2000) found that hypothetical decisions to participate in an environmentally-friendly energy program were not statistically different between survey modes, suggesting that social desirability bias did not occur when a respondent was interviewed over the telephone.

Like Leggett et al. (2003), List et al. (2004) also found evidence of the warm glow or social-desirability bias when stated preferences were obtained using an in-person interviewer and, in addition, when there was a possibility that the respondent would have to make his/her preference known to a group. List et al. use a referendum format to ask respondents whether or not they would support contributing $20 to the start-up of a new Center for Environmental Policy Analysis (CEPA) at the University of Florida. Respondents included a total of 268 undergraduate students recruited from the College of Business. The students were divided into three groups representing different degrees of anonymity under which they would state their preferences for the good. A split-sample format was used, such that half the students in each group received the hypothetical questions and the other half participated in the actual referendum. Study results indicated that those in the peer group (in which 10 members of each group were required to share their response) were more likely to vote "yes" compared to those surveyed using the other two methods. In addition, there was a statistically significant difference between those in the baseline group (for which only the surveyor would know the respondent's stated preferences) as compared to the percentage of "yes" responses given by the group for which respondent answers were completely anonymous (List et al. 2004).

The List et al. study suggests that when individuals are asked to state their WTP in a manner in which they feel their answers may be made public, there is a tendency for individuals to be influenced by an external source of utility -namely, that of "advertising one's own goodwill" (List et al. 2001 p. 749) and including that as part of their stated WTP. Since this value should not be included in assessing the WTP for the good itself, this study provides evidence that suggests confidentiality when stating preferences is important to elicit WTP values that are free from bias.[36]

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[36] This result also brings into question that assumption that is often made in validity tests – that "real" responses in laboratory and field experiments reflect true WTP. If, in fact, these "real" values are inflated due to warm glow, then that implies the degree of hypothetical bias may not be as large as previous

2.7 Evaluating the Validity and Reliability of CVM

The *validity* of CVM refers to how well stated preferences match actual valuations, and the *reliability* of CVM refers the consistency of stated preferences over time or across different samples of the population (Carson et al. 2001). Meeting one of these criteria does not necessarily imply that a contingent value measure will meet the other (Whitehead et al. 1995).

2.7.1 Validity

Ideally, validity would be confirmed by comparing results to a known standard (such as validating the weight of an object by comparing it to a known weight at the National Bureau of Standards); however, true underlying consumer preferences are unknown, such that no standard is available for comparing valuations obtained through CVM. Therefore, researchers typically rely on two tests to determine validity: construct validity and convergent validity (Carson et al. 2001).

Construct Validity

Construct validity is determined by how well stated preferences are explained by factors that economic theory would predict. For example, economic theory would predict that the percentage of individuals willing to pay for a good will decrease as the price increases (Carson et al. 2001). According to a review of the literature by Carson et al. (2001), this result is widely confirmed. In addition, construct validity implies that individual WTP can be explained by characteristics of the good and individual, in ways that economic theory would predict.[37] In particular, one would expect WTP for a good to increase with higher levels of income (for a normal good), and for WTP to also rise for increases in the quantity (or quality) of the good being provided (Carson et al. 2001). The later is often referred to as a scope test.

According to Carson et al. (2001), "a scope test looks at whether respondents are willing to pay more for a good that is larger in scope, whether in a quality or quantity sense" (Carson et al. 2001 p. 181). Carson et al. further state that failure to pass a scope

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thought. However, the fact that hypothetical bias has been observed for private goods, suggests that even if this theory is true, it cannot account for the entire difference between revealed and stated preferences.

[37] Testing this assumption is referred to as a theoretical validity test (Blomquist and Whitehead 1998).

test may be due to (1) insufficient statistical power as described by Arrow and Leamer (1994); (2) poor survey design or administration as explained by Carson and Mitchell (1995); or (3) CV results that are inconsistent with economic theory as discussed by Hausman (1993).

Two types of scope tests exist. An internal scope test uses stated preferences from the same individuals at *different levels* of the good to see if the results are consistent with economic theory (i.e. a higher WTP is observed when larger amounts, or a higher quality, of the good is offered). An external scope test examines the same assumption, but by comparing stated preferences from statistically equivalent subsamples, each of which value a different level of the good (Carson et al. 2001). A study by Blomquist and Whitehead (1998) uses a CV survey to estimate the WTP to preserve wetlands offering various levels of quality. Blomquist and Whitehead find that individual WTP does respond to differences in wetland quality as described in the CV survey; thereby suggesting that individuals do respond to variations in scope in CV surveys.

Although some critics of the CVM, contend that scope is a serious problem, Carson et al. (2001) argue that these claims are based on a small subsample of the literature that is not representative. In a review of the CV literature, Carson et al. (2001) find that 31 CV studies passed a scope test, while only 4 did not. Based on these studies, Carson et al. conclude that "poorly executed survey design and administration procedures appear to be a primary cause of problems in studies not exhibiting sensitivity to scope" (Carson et al. 2001 p. 183). Thus, suggesting that many issues related to scope insensitivity can be prevented with careful survey design and implementation.

Convergent Validity

Convergent validity is the degree to which stated preferences obtained through CVM match preferences revealed in implicit markets. Therefore, convergent valuation can be tested by looking at either (1) the degree of correlation or (2) the ratio between valuations derived using CV surveys to estimates of value for the same good obtained using implicit market methods (namely, travel cost or hedonic pricing).[38] Another potential way to test for convergent validity is to compare results of a CV survey

[38] For examples, see Loomis et al. (1991) and Blomquist (1988).

involving an upcoming referendum and then comparing the results predicted by the CV method to the actual voting results (Carson et al. 2001). According to Carson et al. (2001), CV studies using a referendum format that are conducted relatively close to the actual vote have been quite successful at predicting actual voting outcomes.[39]

2.7.2 Reliability

Reliability is a measure of the consistency of CV results over time or across different samples. Two tests of reliability include testing the consistency of CV responses by (1) surveying the same respondents at two different points in time, and (2) surveying two different samples at two different points in time (Carson et al. 2001). Carson et al. (2001) cite several studies[40] that found valuations remained consistent over time,[41] suggesting that the CVM has the potential to produce results that are reliable over time, both for across sample and same sample designs.

2.8 Addressing Hypothetical Bias: Evidence Supporting the Validity of the CVM

As mentioned previously, hypothetical bias appears to currently pose the greatest problem for the CVM. A meta-analysis conducted by List and Gallet (2001) compare hypothetical values to real values for 29 CV experiments and find the calibration factor[42] for many of these studies exceeds 1.2; thus, supporting the conclusion that valuations obtained through stated preferences (utilizing a CV survey) are, indeed, prone to hypothetical bias. Hypothetical bias has been observed for both private (Blumenschein et al. 2007, Cummings et al. 1995, List 2001) and public goods (Champ and Bishop 2001, Champ et al. 1997, Cummings and Taylor 1999) and across a wide range of payment mechanisms; therefore it is unlikely that this phenomenon is dependent on these factors[43]

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[39] Carson et al.'s (2001) conclusion is drawn from studies by Carson, Hanemann, and Mitchell (1987) and Polasky, Gainutdinova, and Kerkvliet (1996)

[40] Studies include Carson and Mitchell (1993), Carson et al. (1997), Whitehead and Hoban (1999) (independent samples) and McConnell, Strand, and Valdes (1998) (same sample).

[41] For some studies, including Whitehead and Hoban (1997) and McConnell, Strand, and Valdes (1998), WTP changed (which could potentially be explained by changes in the household's income or other relevant factors overtime), but the valuation function was unchanged (Carson et al. 2001).

[42] The calibration factor is found by dividing the mean hypothetical value by the mean real value and is used as a measure of the degree of hypothetical bias present in the valuation (List and Gallet 2001).

[43] Results from List and Gallet's (2001) meta-analysis suggest that hypothetical bias will be less pronounced when private (versus public) goods are valued using WTP (versus other mechanisms);

As a result of the presence of hypothetical bias in stated preference valuations, several methods have been employed to remove hypothetical bias from the data *ex post* using various calibration methods. Many of these methods involve assessing the degree of certainty with which the respondent states their preferences using a certainty scale or in answering a polychotomous choice question regarding how sure they are about their decision. Another, completely different, approach focuses on encouraging respondents to address the potential for hypothetical bias *before* stating their preferences. The idea being that if respondents are aware of the potential for hypothetical bias, they will then be able to correct for it before making a statement regarding their preferences for the good being valued. This *ex ante* method was introduced by Cummings and Taylor (1999) and is often referred to as the "cheap talk"[44] approach.

2.8.1 Cheap Talk

Cummings and Taylor (1999) introduce a potential method of eliminating hypothetical bias in which they use a "cheap talk" script to inform respondents directly about the possibility of hypothetical bias *prior* to stating their preferences for the good being valued. Cummings and Taylor find that for decisions regarding donations toward several public goods, there is no statistically significant difference between actual referendum voting and hypothetical referendum voting when a cheap talk script is utilized. Furthermore, additional testing on these public goods revealed that this result was robust for modifications of the cheap talk script and across variations in experimental design (Cummings and Taylor 1999). The results of this study are supported by Ajzen et al. (2004) who found that hypothetical student donations toward a scholarship fund under a referendum model exceeded real donations; however, inclusion of a corrective entreaty, which followed the cheap talk script proposed by Cummings and Taylor, effectively removed the difference between real and stated preferences.

Although the results of the Cummings and Taylor (1999) and Ajzen et al. (2004) studies suggest that utilizing a "cheap talk" script within a contingent valuation

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however, these findings were not supported in a meta-analysis performed by Little and Berrens (2004), which expanded on the work done by List and Gallet (2001).

[44] The name "cheap talk" is a reference to the term used in bargaining for the costless transmission of information or signals (Cumming and Taylor 1999).

framework has the potential to effectively eliminate the difference between decisions made in real markets versus those made in contingent markets, other studies reveal that cheap talk may be limited in its effectiveness at removing hypothetical bias, at least in certain cases (Blumenschein et al. forthcoming 2007, Brown et al. 2003, Murphy et al. 2005, List 2001).

Brown et al. (2003) and Murphy et al. (2005) found that utilizing a cheap talk script reflective of the one used by Cummings and Taylor (1999) was effective at removing hypothetical bias for higher dollar amounts, but was not as effective at lower dollar amounts. Brown et al. (2003) use a split-sample design to test whether the cheap talk script is effective at eliminating hypothetical bias for students making donations to a scholarship fund through a referendum mechanism. The amount of the donation was varied between $1, $3, $5, and $8. As economic theory would predict, the results indicate that the percentage of students voting "yes" decreased as the price increased when the referendum was real. However, when the decision was hypothetical, the percentage of "yes" votes remained fairly constant across price levels. This result implies that hypothetical bias may be larger for higher payment amounts; however, including a cheap talk script that mimicked the one used by Cummings and Taylor was very effective in eliminating the hypothetical bias for the higher bid amounts of $5 and $8. The cheap talk method; however, did not sufficiently remove the hypothetical bias at the $3 level (Brown et al. 2003).

A similar study conducted by Murphy et al. (2005) supports the finding that the cheap talk script may not be effective at lower price levels. Murphy et al. investigated the use of a provisional point mechanism in making donations to a public good. The purpose of the study was to use a wider range of values ($3 to $30) to further test the results of the Brown et al. study. Murphy et al. found that the cheap talk script was not effective at lower amounts ($3 and $6), but for higher dollar amounts ($9 and greater) the percentage of hypothetical donations converged with real donations (Murphy et al. 2005).

Interestingly enough, if you consider the prices used by Cummings and Taylor (1999) and Ajzen et al. (2004) in their referenda, then the conclusion drawn by Brown et al. (2003) and Murphy et al. (2005) - that the cheap talk script is only effective at higher dollar amounts - is not necessarily inconsistent across these four studies. Cummings and

Taylor used a price of $10 for all of its public good referenda and Ajzen et al. used a price of $8. The results of Brown et al. and Murphy et al. suggest that a price of $8 and $10 are high enough to fall within the range of prices for which the cheap talk was effective at eliminating hypothetical bias. Therefore, Brown et al. and Murphy et al. seem to have discovered a limitation of the cheap talk method that was not observed by Cummings and Taylor and Ajzen et al. due to the fact that all the goods used in these experiments had relatively high prices for which the cheap talk method appears to work well.

Another possible limitation of the cheap talk method is suggested by List (2001) who found differences in effectiveness based on familiarity with the good being valued. Using a Vickery second-price auction to value sportscards, List found that the cheap talk script proposed by Cummings and Taylor (1999) was effective at eliminating hypothetical bias for non-dealers, but not for dealers. Although this finding may suggest that a cheap talk script is more effective for those less familiar with a good due to the fact that those who are more familiar with the good may "rely on few, if any, external signals when formulating their value" (List 2001 p. 1498); it is also possible that a difference in recruiting methods between dealers and non-dealers may have contributed, at least in part, to this result.[45]

Although several laboratory experiments and field tests indicate that cheap talk is effective at eliminating hypothetical bias for higher dollar amounts, a recent field test by Blumenschein et al. (forthcoming 2007) and meta-analysis by Little and Berrens (2004) suggests that the cheap talk script is not effective in eliminating hypothetical bias in

[45] The study includes both dealers and non-dealers of sportscards and was conducted at a sportscard show. Non-dealers were recruited for the study when interested parties stopped and inquired about the specific sportscard being valued (which was displayed on a table). Dealers, on the other hand, were approached by the researchers *at their own booths* prior to the start of the show (between 7AM and 12 PM on Saturday and Sunday). Therefore, there was a distinct difference in the recruitment method between these two groups that may account for the difference in effectiveness of the cheap talk script for this study. The non-dealers recruited for the study expressed a specific interest in the card being auctioned, and as such, had a vested interest in performing well in the auction (in order to win the card). Dealers, on the other hand, may have been preoccupied with setting up their own booth when approached by the interviewer. If the dealers included in the study were, in fact, pressed for time, they may not have taken the time and effort necessary to adequately read the lengthy cheap talk script and learn about the Vickery auction through the information sheet that was included as part of the study. If dealers were less motivated to read the cheap talk script and auction procedure due to the circumstances in which they were recruited versus non-dealers, then the results of this study may be more a reflection of the study design as opposed to a true difference in the effectiveness of the cheap talk scheme across those with varying degrees of familiarity with the good.

stated preference studies that use the contingent valuation methodology. Blumenschein et al. use face-to face interviews to value a pharmacy-provided diabetes management program. The field test includes 260 diabetics recruited from nine pharmacies in the state of Kentucky. Prices for the program varied between $15, $40, and $80. Respondents at three of the pharmacies actually received the program, respondents at three different were given an opportunity to express their intentions of participating in the program by answering a dichotomous choice contingent valuation question, and respondents at the remaining three pharmacies were also asked whether they would participate in the program *if* it were offered, but prior to making their decision were read a cheap talk script similar to the one used by Cummings and Taylor (1999) in which hypothetical bias is described. Blumenschein et al. find a significant difference between real and hypothetical stated preferences, indicating the presence of hypothetical bias in the data. Based on their study, the cheap talk script is ineffective at removing the hypothetical bias; however, when the follow-up certainty question is used to calibrate hypothetical responses there is no statistical difference between real and hypothetical responses for those who were "definitely sure" of their response (Blumenschein et al. forthcoming 2007).

The results of the Blumenschein et al. (forthcoming 2007) study suggest that the cheap talk approach is not an effective tool at removing hypothetical bias in stated preference valuations. Since the prices used in the Blumenschein et al. study were clearly in the range of "high prices" for which the cheap talk methodology worked in earlier studies (Brown et al. 2003, Murphy et al. 2005), these latest results certainly bring into question the reliability of stated preferences obtained using *only* a cheap talk script. In addition, a meta-analysis by Little and Berrens (2004) also indicate that the cheap talk approach is not necessarily effective, but that using a certainty correction does effectively eliminate hypothetical bias.

2.8.2 Using Certainty to Eliminate Hypothetical Bias

One possible explanation of the cause of hypothetical bias is based on the "discrepancy between intentions and behavior" (Ajzen et al. 2004 p. 1109). This theory implies that individuals with *strong* dispositions in favor of (against) the provision of a good, will vote in favor of (against) it *regardless* of whether the decision is real or hypothetical. However, for individuals for whose disposition is not as strong, inconsistencies between real and hypothetical decisions will be more likely to occur (Ajzen et al 2004). Although the results of the study by Ajzen et al., whose main purpose was to explore the formation of intentions and their relationship to actual behavior, suggest that those who vote consistently and those who vote inconsistently may express equally strong beliefs, they may do so with different degrees of *confidence* (Ajzen et al. 2004). This finding explains the difficulty economists have encountered in trying to develop a calibration function based on attitudes and beliefs, and lends support to pursuing the possibility of addressing hypothetical bias by looking at the *certainty* with which stated preferences are made. In particular, this finding is not inconsistent with the hypothesis that individuals who have a lower degree of certainty in their stated preferences are more likely to be the source of hypothetical bias.

There are two basic approaches to using certainty to "calibrate" hypothetical choices: (1) the use of a certainty scale first used by Champ et al. (1997), and (2) the use of a follow-up certainty question. Since the heart of the debate is the accuracy with which "hypothetical choices in the contingent valuation method correspond to real economic choices" (Johannesson et al. 1999), numerous studies have specifically tested this as a hypothesis by comparing stated preferences obtained in a hypothetical market with actual purchase decisions.

Follow-up Certainty Scale

Champ et al. (1997) included a certainty scale in their CV study that explored the difference between stated donations and actual donations to an environmental public good. Using a mail survey, respondents were asked to make a donation to remove roads along the North rim of the Grand Canyon and return the area to wilderness. The amount of the public good provided was continuous in that total donations would determine the amount of road that would be removed. For some respondents, the decision was real and for others, the decision was hypothetical. Following the voluntary donation question, respondents were asked to rate the level of certainty associated with their decision using a scale of 1 to 10 (where 1 was "very uncertain" and 10 was "very certain"). Champ et al.

found that hypothetical donations exceeded actual donations; however, when a hypothetical "yes" was recoded to a "no" for all the respondents except those who were "very certain" (indicated a 10 on the certainty scale); hypothetical donations were not statistically different from actual donations. Thus, these findings provide evidence to suggest that using a certainty scale to calibrate stated responses has the potential to effectively remove hypothetical bias, such that actual preferences can be obtained using a CV survey.

Since the Champ et al. (1997) study, several other studies have successfully used certainty scales to calibrate hypothetical responses, such that they correspond with real decisions; however, the degree of certainty used to recalibrate the responses varied to some extent across studies. For example, in a study by Ethier at al. (2000) on consumer participation in Green Choice (an environmentally-friendly electricity program), stated participation rates converged with actual participation rates at certainty level of 7 (hypothetical participation rates at a certainty level of 8 were also not statistically different from actual participation rates). Similarly, in a follow-up mail study that utilized a split-sample design, Champ and Bishop (2001) found that hypothetical donations toward the purchase of wind-generated energy corresponded to actual donations when a certainty level of 8 was used for calibration. Like, Ethier et al. (2000), a study by Poe et al. (2002) also used the Green Choice program as their good to be valued, but in addition to evaluating participation rates, this study also used a voluntary contribution mechanism with a PPM. Results were similar to those of Champ and Bishop and Ethier et al. in that hypothetical contributions most closely corresponded to actual donations when respondents indicated a certainty level of 7 or 8.

Collectively these studies suggest that hypothetical bias can be eliminated such that stated preferences obtained using a CV will reflect revealed preferences for public goods. However, the potential difficulty with the certainty scale method is that it is not entirely clear which level of certainty is the appropriate level to use for calibration. Although these studies suggest that a value of 7 or higher is appropriate, the exact value to be used for calibration may be dependent on the good being valued.

Follow-up Certainty Question (Definitely/ Probably)

Another approach that has proved very successful as a means of calibrating hypothetical responses, such that they correspond with real decisions, is the use of a follow-up certainty question in which respondents indicate if they are "definitely sure" or "probably sure" of their stated intensions. Like the certainty scale, this question is presented immediately after the respondent indicates their hypothetical decision regarding the provision of the good. To test the validity of using this type of certainty question as a means of calibration, several laboratory and field experiments have been conducted using private goods. Overall, this method shows excellent potential as a means of eliminating hypothetical bias, such that hypothetical responses reflect actual behavior. The following provides details on several related studies that trace the development of this technique.

An experiment conducted by Johannesson et al. (1998) asked business and economics students at Lund University in Sweden about their WTP for a box of Belgian chocolates. Following the hypothetical decision to purchase the box of chocolates, respondents were asked to assess how certain they were of their purchase decisions. Certainty could be expressed as "fairly sure" or "absolutely sure." The results showed that hypothetical "yes" responses overestimated real "yes" responses, indicating hypothetical bias. However, only counting those who were "absolutely sure" as a true "yes" response underestimated real "yes" responses, providing a conservative estimate of WTP.

In another laboratory experiment by Blumenschein et al. (1998), the certainty categories were modified to "probably sure" and "definitely sure." In this experiment, 133 college students were asked about their willingness to purchase a pair of sunglasses, either in a hypothetical or real context. Students who responded "yes" to the hypothetical question to purchase the sunglasses were then asked to indicate if they were "definitely sure" or "probably sure" about their decision. Using a nonparametric contingency table chi-squared test, the results revealed that simply using "yes" responses did tend to overestimate the true willingness to make the purchase; however, when only "definitely sure" responses were counted as a true "yes" there was no statistically significant difference between the two groups (Blumenschein et al. 1998). Therefore, this study suggested that hypothetical bias could be eliminated from CV estimates by simply adding a certainty follow-up question, and then calibrating the results using those who were "definitely sure" as a signal of a true intention to purchase the good.[46]

Given the success of this laboratory experiment, Blumenschein et al. (2001, forthcoming 2007) then applied this methodology to in two field tests valuing health-related goods. In the Blumenschein et al. (2001) study, patients taking asthma medication were asked about their willingness to participate and pay for a pharmacist provided asthma management program. Although 30% of the patients in the hypothetical group stated they would participate in the program at the stated price, compared to only 12% who actually participated in the program, when hypothetical responses were adjusted to only include those who were "definitely sure" as true "yes" responses, there was no statistically significant difference in participation rates between the real and hypothetical groups.

As discussed earlier, the Blumenschein et al. (forthcoming 2007) study which compared hypothetical and real decisions to participate in a pharmacy-provided diabetes management program, provides additional evidence to suggest that including only "definitely sure" respondents as a measure of true intentions to participate, can be an effective method to mitigate the effect of hypothetical bias often observed in CV studies.

Clearly hypothetical bias is an issue for the CVM; therefore, several studies have focused on validating calibration methods such that preferences state in contingent markets correspond to actual behavior. One of Diamond and Hausman's arguments against CV is that calibrations in prior studies have been arbitrary, however, Mitchell and Carson (1989) correctly point out that quantifying the difference between actual behavior and that stated on CV surveys is the *key* to accurate calibration.

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[46] Johannesson et al. (1999) further explore the data collected in the experiments conducted by Johannesson et al. (1998) and Blumenschein et al. (1998), both of which included a certainty scale similar to the one used by Champ et al. (1997). Using the respondent's self-reported value on the certainty scale, a variable representing the price level, and socio-economic variables including age and gender as explanatory variables, Johannesson et al. estimate a probit function to determine the probability of a "yes" response being a "true yes" response. After calibration, there was no statistically significant difference between the hypothetical "yes" responses and the actual "yes" responses in either study (Johannesson et al. 1999).

The results of several studies by Blumenschein et al. (forthcoming 2007, 2001, 1998) suggest that using a simple follow-up certainty question in which respondents indicate whether they are "probably sure" or "definitely sure" of their stated preference holds vast potential for eliminating hypothetical bias in CV surveys. Therefore, the results of these studies provide additional evidence to support that CV can accurately elicit individual WTP and provide valid valuations in deriving the benefits associated with health-related and other non-market goods.

2.9 Information and Risk

When making decisions regarding risk and uncertainty, individuals often do not have perfect information. However, According to Viscusi "if individuals were fully informed of the consequences of their decisions and made rational choices, then in a democratic society we should respect these choices" (Viscusi 1992, p. 4). This could imply that if individuals chose to skydive or ride in a car without a seatbelt, then society should allow them to do so. However, Viscusi (1992) goes on to state that it is often the case that consumers are not fully informed about risks, and therefore often make decisions with imperfect information. Therefore, if individuals are not fully informed of the risks they face, then there is a potential for market failure which could potentially justify government intervention (Viscusi 1992). So this suggests the question, "Do individual risk perceptions tend to correspond with actual measures of statistical risk?"

2.9.1 Perceived versus Actual Risk

If individuals do not fully understand the risks they face, then their perceived risk may be different from their actual risk. Viscusi and O'Connor (1984) test whether chemical workers update their risk assessment when the current chemical they are working with is replaced. Viscusi and O'Connor find that workers update their risk assessments in the correct direction, suggesting that individuals may, in fact, be good judges of actual risk. A study by Lichtenstein et al. (1978); however, finds a general tendency for individuals to overestimate small risks, while underestimating larger ones; thereby suggesting that an individual's perception of risk may not always correspond with actual risk.

2.9.2 The Effect of New Information on Risk Assessment

Although Viscusi's findings suggest that workers may be good judges of occupational risk, the result by Lichtenstein et al. (1978) demonstrate that individuals may not be good assessors of risk in all cases. If this is true, then does providing additional information help? What is the relationship between prior and new information regarding individual risk assessments? Viscusi's (1992) prospective reference theory (PRT) provides one explanation of how new information is incorporated into forming new risk assessments that are closer to the true value of statistical risk. PRT is based on an expected utility model in which information is processed in a Bayesian manner, such that prior and new risk assessments carry a "weight" that is dependent on the perceived credibility of the new information being presented and the strength of the individual's prior assessment of risk (Viscusi 1992). This theory suggests that the higher the degree of credibility that is placed on prior information, the less "weight" will be given to the new information. Findings by Tkac (1998) support this theory. Tkac finds that although respondents with higher levels of prior information have a higher WTP for treatment, valuations by knowledgeable individuals were not influenced by the information presented (Hoehn and Randall 2002). This finding supports the hypothesis that those with strong priors will place less weight on new information.

Hoehn and Randall (2002) modify the Bayesian updating model used by Viscusi and O'Connor (1984) by making it more general. In particular, Hoehn and Randall relax the "assumption that prior information is necessarily proportional to objectively true information" and "allow prior knowledge to differ across individuals" (Hoehn and Randall 2002 p 16). Poe (1998) and Carson et al. (1996) suggest that heterogeneity exists in the prior information held by individuals; therefore, dropping these assumptions allows Hoehn and Randall to account for this difference across individuals in valuing the quality of an environmental resource. Allowing for heterogeneity in prior knowledge implies that the new information may increase or decrease the individual's perception of resource quality, depending on their prior perception. In particular, if the new information suggests that the quality of the resource is higher (lower) than the individual previously thought, then they will have a positive (negative) change in their perception. Therefore, Hoehn and Randall allow for the possibility that the *same* information can have *different* effects for each individual.[47] This, in turn, is expected to affect individual WTP (Hoehn and Randall 2002).

Smith and Desvousges (1990) study the effect of various information presentations on the formation of risk perceptions of households relating to the presence of radon in their homes and discover that individuals systematically update risk perceptions when presented with new information regarding that risk. They also find that providing only minimal information regarding risk can, in fact, cause individuals to overestimate the actual risk. Therefore, from a public policy standpoint, the results of Smith and Desvousges (1990) suggest that providing *more complete* information regarding risk will lead to more accurate risk perceptions.

In addition, a study conducted by Magat, Viscusi, and Huber (1988) also revealed the importance of information on the validity of respondents' valuations. This study focused on consumers' willingness to pay for an increase in product safety for two common household items- bleach and drain cleaner. Based on the responses, the value of avoiding a "statistical" injury from bleach gas poisoning was \$1.38 million, child poisoning was \$0.5 million, drain cleaner burn was \$1.24 million, and \$.82 million for drain cleaner poisoning. These valuations are much higher than comparable morbidity valuations obtained through hedonic studies. One possible explanation posed by the authors is that the respondents looked primarily at the percentage decrease in risk posed in the question, without giving careful consideration to the base number of households subject to the risk. If this were indeed the case, the responses would have essentially have been unaltered if the study had been based on 2 million, 200,000 or perhaps even 20,000, which would have lowered the resulting valuations by a power of 10 to 100. Therefore, the authors caution that individuals must fully understand the risks if their responses are to be used to estimate benefits for the purpose of policy decisions (Magat et al. 1988).

[47] This is different from past studies which assumed that the new information would have the same effect across individuals.

2.10 Applications to this Study

2.10.1 Addressing the Potential for Hypothetical Bias

This study utilizes two CV surveys to value two health goods related to the prevention of heart attacks.[48] Because hypothetical bias was a concern, several measures were included as part of the survey to prevent the possibility of hypothetical bias from entering the data. First, a modified version of the cheap talk script originally used by Cummings and Taylor (1999) was used. Although recent literature (conducted after the fielding of this study) suggests that the cheap talk methodology may not be effective (Blumenschein et al. forthcoming 2007), some studies have shown that cheap talk is very effective at eliminating hypothetical bias for higher prices (when hypothetical bias is thought to be the greatest issue). Therefore, the inclusion of the cheap talk script is still an important component of the CV surveys used for this study, especially since the goods being valued are expected to have relatively high valuations.

A second measure to prevent hypothetical bias was the inclusion of a certainty scale. The meta-analysis by Little and Berrens (2004) indicates that use of certainty calibration within a CV survey is an effective method for eliminating hypothetical bias. In addition, Blumenschein et al. (forthcoming 2007) find that there is essentially no difference in hypothetical decisions to utilize a diabetes managements program once adjusting for individuals who are "definitely sure" as compared to real decisions. Therefore, these studies suggest that asking respondents to assess the certainty of their stated preferences is an important step in mitigating hypothetical bias.

2.10.2 Information and Perceived Risk

The concepts proposed by Hoehn and Randall (2002) are particularly relevant to this study. Presumably "new" information on who is at risk for a heart attack is presented and measures of individual risk perception are obtained both before and after respondents are made aware of this new information. As Hoehn and Randall suggest, new information may have different affects on respondents' perception of risk, depending on their priors. The CV surveys used for this study allow for this heterogeneity. In addition, data was collected in order to determine the direction and magnitude of the

[48] See Chapter 5: Development of the Web-based Surveys for details related to the survey instruments.

change in each respondent's perception of their own risk of heart attack. Data was collected both as a quantitative variable in which each unit increase (decrease) of risk corresponded to a 1/100,000 increase (decrease) in fatality risk. In addition, respondents were asked to qualify their change in risk by indicating whether they felt their risk of a heart attack after reading the new information was much higher (lower), somewhat higher (lower), or the same. Although it was expected that the information presented was truly "new" and would increase individual's perceived risk of a heart attack, both risk assessment methods allowed respondents to indicate that the new information did not change their risk perceptions. In addition, risk perceptions were also allowed to decrease. Therefore, this data can be used to assess how risk perceptions changed in response to the new information, and how that in turn influenced individual WTP.

2.10.3 Iterative Bidding

Starting point bias has been known to be a problem in iterative bidding as a result of respondents "anchoring" their WTP on the first bid presented; however, Fabian and Tolley (1994) find evidence from focus groups to suggest this becomes less of a problem "as questionnaires are enriched in their information and preference review" (Fabian and Tolley 1994 p. 143). Therefore, the CV surveys used in this study contain detailed information that is relevant to the formation of the individual's valuation and several opportunities are given for the respondent to reflect on their true valuation before stated their WTP. In doing so, this study utilizes a form of iterative bidding inspired by the interactive computer program used by Viscusi, Magat, and Huber (1990), which was used to elicit risk-risk and risk-dollar valuations of chronic bronchitis. The interactive computer program in the Viscusi et al. (1990) study offers paired-comparisons for which the attributes differ (based on the respondent's previous responses) until indifference between the two is reached (Viscusi et al. 1990). The iterative bidding program used for this study is similar in that subsequent bids are determined by the respondent's answers to previous bids, such that each survey is tailored to the individual respondent. In addition, unlike other iterative bidding processes that simply increase or decrease using a pre-determined set of bids, the computer program in this study follows a specially designed algorithm that allows the series of bids to vary considerably across respondents dependent on their responses. Through the use of this well-designed algorithm, respondent's WTP is obtained by asking only a minimum number of questions.

2.11 Summary

Federal agencies, as well as an increasing number of state agencies, require a comparison of benefits and costs before implementing public policy. Therefore, benefit-cost analysis has become the "gold standard" for valuing improvements in economic goods, including those related to health. For goods exchanged explicitly in well-defined markets, the market price offers a reasonable measure of value; however, for non-market goods such as environmental resources, market prices are not observed and therefore are not available for making valuations. However, placing a monetary value on these goods is "essential for sound policy" (Hanemann 1994 p. 19). This point became increasingly clear immediately following the Exxon Valdez accident, which spilled 11 million gallons of crude oil into Prince Edward Sound off the coast of Alaska. In the wake of this unfortunate accident, the courts were left wondering how to assess damages. Contingent valuation, a method that asks respondents to state what they would pay for a good contingent on the fact that it was available in a market, provided one possible answer.

Contingent valuation not only offered a viable means in which to value goods that are not explicitly traded, but it also had the added advantage of including passive use values, which are often a significant component of the total benefit derived from environmental resources. As a result, the use of CV grew rapidly in the environmental literature and its use is now growing in the health literature as well.

Although markets for health-related goods and services exist, prices do not accurately reflect consumer preferences due to the large presence of insurance companies as third-party payers. Therefore CV offers a method of eliciting underlying consumer WTP for health-related goods and services that would otherwise be unknown. In addition, the CVM is utility-based and derives a measure of benefit in terms of monetary value (WTP), which is preferable to other measures (i.e. COI) that have been used to value improvements in health.

There has been some debate as to the reliability and validity of the CVM method, in particular the tendency of stated preferences to be subject to hypothetical bias.

However, several studies suggest that calibration mechanisms, specifically those involving the degree of certainty with which the preference is stated, have the potential to correct for hypothetical bias and provide accurate reflections of observed consumer behavior. Although refinements to the CVM are certainly likely to occur as the further studies suggest additional improvements, several existing studies have already demonstrated that CV surveys can produce reliable and valid results. In addition, using stated preference offers a methodology for valuing non-market goods that could otherwise not be valued. Therefore, due to its importance to BCA, especially for valuing environmental resources, it is likely that the CVM will continue to be used as it provides the potential to obtain valuable information that is necessary to make efficient use of our scarce economic resources, including those related to health.

Chapter III: Medical Background

The purpose of this chapter is to provide the medical information necessary to understand a recent change in theory regarding the primary cause of heart attacks and to also explain why traditional risk factors currently used by physicians fail to identify a large percentage of the population who are at risk for a heart attack. This chapter will also describe how medical technology is changing in response to this new information and will provide the basis for the hypothetical screening and treatment that respondents are asked to value in the two surveys used for this study. In addition, this chapter will explain the current standard of care for a patient who presents with symptoms of heart disease, subsequent decisions that would typically be made regarding the course of treatment; and finally, how anticipated future developments in medical technology will affect these decisions. Thus, the information in this chapter will explain the medical advances that motivated this study as well as provide the medical background necessary to fully understand the decisions trees that are presented as part of the theoretical model in the next chapter.

3.1 Changing Theory Regarding the Primary Cause of Heart Attacks

It has long been thought that the primary cause of heart attacks is coronary stenosis – the buildup of plaque within the small arteries of the heart (Gazelle 2000). Doctors diagnose this condition as atherosclerosis, but many of us have heard it commonly referred to as "hardening of the arteries." For decades, it was presumed that as the degree of stenosis progressed and decreased the size of the lumen (vessel opening through which blood passes), it would restrict the flow of oxygenated blood to the heart. Then, when the heart muscle did not receive a sufficient amount of oxygen (for example, during times of exertion), the individual would experience chest pain, or angina. As the individual's medical condition worsened, the symptoms would persist and become more frequent until eventually the build up of plaque within the vessel was severe enough to cause a heart attack (Gazelle 2000).

Although this medical theory still correctly explains why individuals experience chest pain associated with heart disease, it does not explain why numerous heart attacks occur in individuals who, prior to having the attack, never experienced chest pain or *any* other symptoms of heart disease (Ryan 2000). In fact, according to the American Heart Association, at least 50% of the individuals who experience a heart attack have no symptoms prior to the attack (American Heart Association 2003). In addition, autopsy data from several studies have revealed that heart attacks and stenosis are often NOT correlated (Shah 1996)**;** thereby, directly contradicting the theory that plaque build-up is the primary cause of heart attacks. Further evidence to refute this theory includes studies that have found lipid-lowering medication to significantly reduce the mortality and morbidity risk due to heart attack, *while having little improvement on the size of the lumen* (Gazelle 2000). In other words, the risk of heart attack for individuals who take cholesterol lowering medication has been shown to decrease significantly, *without* diminishing the amount of plaque within the coronary arteries.

Findings such as these led cardiologists to revisit an earlier study on plaque composition (Davies and Thomas 1984) published in the *New England Journal of Medicine* in the mid-1980's. In fact, the work by Davies and Thomas (1984) is now considered a landmark study in linking plaque composition to heart attacks (Ryan 2000). Looking at histology from patients who had experienced heart attacks, Davies and Thomas (1984) found that approximately 75% of the patients who had experienced a heart attack died from a blood clot (or thrombosis) in the vessel. Interestingly enough, the clot that caused the heart attack was not necessarily located in an area of the coronary vessel that contained stenosis. Instead, these clots were located at a point in the vessel where lipid-rich lesions (fatty plaques) were present (Davies and Thomas 1984). Therefore, this study strongly suggested that the cause of heart attacks was not due to the *amount* of plaque within the vessel, but rather to the *composition* of that plaque.

Unfortunately, numerous other studies indicated that *plaque burden* was a more powerful predictor of a patient's prognosis (Yock 2001); therefore, advances in medical technology continued to focus on opening the restricted vessels, specifically by placing coronary stents and performing angioplasty (Ryan 2000). During the late 80's and early 90's significant advancements in cardiac inpatient care took place and the number of procedures performed increased dramatically. These procedures clearly reduced the occurrence of chest pain and improved the quality of life for these patients (Ryan 2000);

however, what continued to puzzle cardiologists was that despite these great advances in the type and number of procedures performed to treat patients, national heart attack mortality rates remained high (Muller 1999).

This prompted cardiologists to return to the idea that plaque *composition* rather than plaque *burden* was the primary cause of heart attacks. After further investigation, it is now the general consensus among cardiologists that it is not the *volume* of plaque in the coronary arteries, but rather the *composition* of that plaque that presents the greatest risk for a potentially fatal heart attack (Falk et al. 1995**,** Ravn and Falk 1999). Therefore, cardiologists and medical researchers in this field now believe that correctly determining the *type* of plaque is an important key in accurately identifying those at risk for a heart attack, or what physicians commonly refer to as myocardial infarction.

3.2 What is a Myocardial Infarction?

Myocardial Infarction, or "MI" as it is often called, is the medical term used to describe a heart attack. A MI occurs when cells within the heart muscle do not receive a sufficient supply of oxygenated blood, resulting in cell death and *permanent* damage to the heart muscle. If the depletion of oxygen to the heart is great enough, it can cause the heart to stop (cardiac arrest) and result in death. Even if a heart attack is not fatal, it causes irreversible damage which weakens the heart muscle; therefore, individuals who experience a MI are at much greater risk for a future heart attack (American Heart Association 2003).

3.3 Social Costs Associated with Heart Attack

An individual who experiences a heart attack is typically diagnosed with coronary heart disease (CHD). CHD includes both MI and angina pectoris[49] (a medical term for chest pain). According to the *Heart and Stroke Statistical Update* published by the American Heart Association, "CHD is the single largest single killer of American males

[49] CHD includes International Classification of Disease (ICD/9) codes 410-414, and 429.2 Note: Every 10-20 years the ICD codes are revised. These revisions reflect changes in medical technology, diagnosis and terminology. Starting in 1999, the tenth revision of these codes was used. Therefore, according to ICD/10 the codes for CHD include I20-I25.

and females" (p. 12) and is responsible for more than 1 out of every 5 deaths in the U.S. (American Heart Association 2003). In the year 2000, an estimated 681,000 individuals died from CHD, of which 239,000 were due to MI (American Heart Association 2003). Each year, more than 500,000 Americans experience a heart attack, and approximately 47% of those individuals die as a result (American Heart Association 2003). Of those who do survive, only about one-third will make a complete recovery. In fact, "CHD is the leading cause of premature, permanent disability in the U.S. labor force, accounting for 19 percent of disability allowances by the Social Security Administration" (American Heart Association 2003, p. 12).

Since the risk of heart attack increases with age, the elderly population is typically thought to be at greatest risk for a heart attack. Although it is true that 84% of the people who die of CHD are over the age of 65, there has recently been an increase in the number of heart attack related deaths in young people, especially women. In addition, almost 50% of the men and women under age 65 who experience a MI die within 8 years of the attack (American Heart Association 2003). Furthermore, what is possibly even more concerning is that evidence from the Framingham Heart Study indicates that over half of those who died suddenly of CHD *had no previous symptoms of this disease* (American Heart Association 2003). Therefore, thousands of people who are at risk for a heart attack are not even identified as needing treatment until it is too late.

3.4 Plaque Rupture: The Primary Cause of Heart Attacks

So, how could current medical technology fail to identify so many individuals who are at risk for a heart attack? The answer lies in the fact that for years, physicians have been looking at only part of the problem. As discussed in the opening section of this chapter, physicians thought that the long-term build up of plaque was the primary cause of heart attacks; however, medical research now suggests that most heart attacks (as many as 75%) are actually caused by plaque *rupture* (Falk et al. 1995, Davies and Thomas 1984). This rupture can almost instantaneously create a blood clot (thrombosis) that can completely or partially block the vessel, thereby preventing oxygenated blood from traveling to the heart and causing a heart attack (Falk et al. 1995). Prior to the plaque rupture, the blood vessel may be relatively clear and the individual may not experience any symptoms (such as chest pain) typically associated with heart disease (Shah 1996). Therefore, because plaque rupture is not necessarily correlated with a substantial build-up of plaque within the vessel, the individual may be completely symptom free and unaware that they are at risk for a sudden and possibly fatal heart attack.

3.4.1 Plaque Composition

There are different types of plaque that exist within the coronary vessels and medical research has shown that not all plaques are equally dangerous (Falk et al. 1995). In fact, some plaques are more prone to rupture than others; therefore, correctly identifying the composition of a plaque has become an important key in determining who is at risk for a heart attack.

Plaques are generally comprised of different types of materials. In fact, the term "atherosclerosis" is derived from the two main components of a mature plaque: (1) the soft, lipid-rich *athero*matous gruel and (2) the hard, collagen-rich *sclero*tic tissue. Although the sclerotic component makes up about 70% of the plaque, it is the smaller atheromatous component that is by far more concerning (Ravn and Falk 1999). This is because the soft atheromatous gruel tends to "destabilize" the plaque, making it more prone to rupture (Falk et al. 1995). Plaques that are primarily composed of the hard, collagen-rich sclerotic tissue tend to be mature plaques that are considered more stable – that is, less prone to rupture. There are different types of stable plaques, including calcified plaques, which are so named because they contain calcium that forms deposits when present in large amounts. These are the plaques typically associated with long-term plaque build-up that results in chest pain (Ryan 2000). Fatty plaques, on the other hand, are plaques that are comprised primarily of the soft, lipid rich atheromatous gruel. These plaques are more prone to rupture (Falk et al. 1995). In fact, it is a specific type of fatty plaque that researchers believe is most vulnerable to rupture; hence it has been given the name "vulnerable plaque" (Ryan 2000).

3.4.2 What is Vulnerable Plaque?

Vulnerable plaque is so named because its soft atheromatous component tends to "destabilize" the plaque, making it vulnerable, or prone, to rupture (Schroeder and Falk 1996). A vulnerable plaque is comprised of a lipid pool that lies hidden beneath the wall of the artery, much like lava within a volcano. The only thing that separates the lipid pool from the blood flow in the vessel is a very thin cap (Ryan 2000). This cap is extremely important because the gruel of the vulnerable plaque is highly thrombogenic, meaning that when it comes into contact with blood, it will cause the blood to clot almost instantaneously (Schroeder and Falk 1996). As long as the vulnerable plaque stays within the arterial wall, there is no problem; however, once it ruptures and enters the bloodstream, the resulting clot (thrombosis) can restrict the flow of blood to the heart, resulting in an almost instantaneous and possibly fatal heart attack. Therefore, plaques that are comprised primarily of the lipid-rich (fatty) atheromatous gruel pose a greater risk because they are more likely to rupture and cause a clot that will lead to a heart attack. Although some heart attacks are the result of arrhythmias (irregular beating of the heart) and stenosis (narrowing of the arteries), cardiologists now believe that 75% of all heart attacks are caused by the eruption of a "vulnerable" plaque (Falk et al. 1995).

3.4.3 Vulnerable vs. Stable Plaques

In addition to being more prone to rupture, vulnerable plaques also differ from stable plaques in that they tend to be smaller in size and appear in much greater frequency within the vessel, which can make detection and treatment difficult. Since the likelihood of having vulnerable plaque increases with plaque burden, it is not coincidental that patients with atherosclerosis often suffer heart attacks – it is just that the cause of the heart attack is different than previously thought (Ryan 2005). What is interesting to note is that it is not simply the presence of plaque or even the size of the plaque, but rather the likelihood of plaque rupture that places an individual at risk (Falk et al. 1995). In fact, someone who has been diagnosed with atherosclerosis, and has a significantly large amount of plaque which is predominantly stable could actually be at lower risk for a heart attack than an individual with a small amount of vulnerable plaque. This means that individuals with large deposits of calcified (stable) plaques who periodically experience chest pain and shortness of breath could actually be at lower risk for a heart attack than an individual with vulnerable plaque who is completely asymptomatic. In addition, traditional risk factors only give us one piece of information in determining an individual's actual risk. Therefore, the key to early detection is finding a screening method that can distinguish between those individuals who have stable, calcified plaques versus those who have fatty, vulnerable plaques.

3.5 Who is at Risk for a Heart Attack?

According to Falk et al. (1995) "age, male sex, hypercholesterolemia, hypertension, smoking, and diabetes correlate with the coronary plaque burden" meaning that the degree of atherosclerosis is associated with these risk factors; however "apart from…age and possibly male sex, a relation of specific risk factors to composition of plaque burden remains to be identified" (Falk et al. 1995). This suggests that traditional risk factors (age, sex, cholesterol level, etc.) may be good indicators of stenosis and identifying those individuals who are likely to experience chest pain and other symptoms of heart disease, but these risk factors provide very little information regarding who has vulnerable plaque and is actually at risk for a heart attack. Therefore, simply using traditional risk factors for heart disease (as is often done today) will fail to identify many individuals at risk for a heart attack (Gazelle 2000). This is why apparently "healthy" individuals who are asymptomatic suddenly die from heart attacks (Falk et al. 1995). Currently, a definitive set of risk factors is not known – that is why it is so important to find a way to determine who has vulnerable plaque in order to correctly identify those at risk so treatment can be started.

3.6 Limitations in Detecting Vulnerable Plaque

There are several potential treatments for vulnerable plaque once it is detected. The main problem lies in consistently and correctly detecting its presence within the coronary vessel. Unfortunately, the medical community does not currently have a method for doing so, although numerous research efforts are pursuing this goal (Muller 2001). In light of the potential risks posed by the presence of vulnerable plaque, a growing number of people, especially male physicians over the age of 50, have opted to take lipid-lowering medications, even though they have no other indication that they are at risk for vulnerable plaque (Ryan 2000). Although statin (cholesterol lowering) drugs, such as Lipitor, Pravachol, and Zocor, have been somewhat successful in lowering cholesterol levels, at best, they lower the individual's risk of heart attack by only about 30% (Waters 2000). Not to mention that prolonged usage of these drugs can have serious side effects, including liver failure (Ryan 2000). Therefore, medical researchers are working on developing a more effective way to detect and treat vulnerable plaque.

Many companies are funding these research efforts, including Pfizer, a Fortune 500 company, and other well-known medical device firms including Guidant and Boston Scientific (Muller 2001). Current research in this area involves a wide range of imaging technologies including ultrasound, MRI, laser, and spectroscopy (Ryan 2000). Although it is not entirely clear which technology will ultimately prove successful, it is highly likely that a method for detecting and treating vulnerable plaque will be developed in the near future.

3.6.1 Screening for Vulnerable Plaque

However, simply detecting vulnerable plaque is not enough. In order to be used as a screening method, it must also be inexpensive and non-invasive enough to use routinely on the general population (Muller 2001). In addition, the test should be very sensitive – that is give few to no "false-negatives." Sensitivity refers to how well a test finds everyone within the population that has a disease. Typically, highly sensitive tests have a tendency to pick up individuals who *do not* have the disease as well; thereby resulting in false-positives. On the other hand, a highly specific test is more specific to what the test is looking for, but it is also more likely to miss someone – resulting in a false-negative (Ryan 2000). Ideally, you would want a test that has both a high sensitivity and a high specificity; however, due to the nature of laboratory tests, there is often a tradeoff between the two. In practice, the goal for many health care professionals is for the screening method not to miss *anyone* who is at risk.[50] Therefore, tests with a

[50] Economists would recognize that false positives (stemming from higher sensitivity) will result in disutility for the patient/consumer. Therefore, from an economic standpoint, the goal of a screening method would be to balance the value derived from high sensitivity against the social costs associated with false positives.

high sensitivity are generally used for screening. This reduces the chances of missing someone who has the disease, but as discussed above, will result in false-negatives. Therefore, for those testing positive to the screening, a follow-up test or procedure that is more specific (and typically more invasive) would be necessary to identify those individuals who are actually at risk.

3.6.2 Using Technology to Detect Vulnerable Plaque

There are several technologies that are currently being explored as methods for detecting vulnerable plaque and identify those at risk for a heart attack. However, as described below, each technology still has limitations in either its ability to correctly and consistently identify those individuals with vulnerable plaque or to do it in a timely and cost effective manner.

CT scan

Coronary CT (computed tomography) scanning, specifically electron beam (EBCT) and multi-detector CT, which cost about $500 to $700, has proven to be an effective way of identifying plaque build up (Yorke 2005). This non-invasive method takes only about 10 minutes and clearly shows calcium in the arteries. Because calcium is drawn to inflammation in the plaque, calcium is known to be correlated with plaque burden. Therefore, CT scans can provide physicians with good information on the amount of calcified plaques in the arteries; however, the technology can not (as of yet) detect the fatty vulnerable plaques (Yorke 2005) that are now thought to be the most dangerous (Falk et al. 1995). Although this test is non-invasive, it is too expensive to be used as a screening method. In addition, with false negatives in the 5-10% range (Yorke 2005), the results of CT scans are not yet reliable enough to use this method, even as a secondary test that would follow the initial general screening.

Ultrasound

Unlike CT scans, high-resolution ultrasound uses no radiation, costs much less, and can be performed by a physician after receiving only minimal training. Like the CT scan, ultrasound is non-invasive and is relatively fast, taking only about 12 minutes to perform (Yorke 2005). Ultrasound allows the physician to see plaque in the six major arteries in the body. This is done by placing a high-frequency probe on the neck and groin, which allows the physician to see the arteries from the outside in. Performing this procedure on a routine basis allows the physician to track plaque build up over time and treat the patient accordingly. However, the primary drawback of high-resolution ultrasound is that it can not be used to see the arteries within the heart (Yorke 2005). Since the coronary arteries are where the vulnerable plaque that causes heart attacks is located, this technology is currently not useful as a screening method for vulnerable plaque.

MRI

MRI can provide limited images of the arteries as well as plaque; however, it does not yet have sufficient resolution to distinguish between different types of plaques (Ryan 2005). Therefore, the inability of this technology in being able to identify those who have vulnerable plaque and well as the fact that this is very costly procedure, preclude MRI as an means of screening. Although this technology may prove useful as a secondary, confirming method as the resolution produced by this technology improves, more studies will still be needed to determine the efficacy of using this as a definitive means of identifying those at risk for a heart attack.

From these descriptors, it is clear to see that none of these technologies currently meet the criteria needed for an effective, cost-efficient, and relatively non-invasive screening technique. Yet, another completely different approach which utilizes the correlation between inflammation and plaque, may allow researchers to develop a simple blood test that may prove useful as a screening method (Comarow 2002, Falk et al. 1995). In order to understand the correlation between inflammation and plaque rupture, it is necessary to understand in more detail the process by which a plaque ruptures.

3.7 Factors that Lead to Plaque Rupture and MI

There are two factors that increase the risk of plaque disruption, or rupture. As discussed above, the first is the composition of the plaque. A plaque that contains more of the soft atheromatous gruel is more unstable and therefore considered “vulnerable” to rupture. Plaques that are comprised almost entirely of the harder collagen-like sclerotic material are considered more "stable" (Falk et al. 1995). This is why some studies utilizing autopsy data have revealed individuals with substantial stenosis who never experienced a MI, and who are now believed to have been at lower risk for a heart attack than someone with a much smaller amount of vulnerable plaque (Ryan 2000).

The second factor that increases the likelihood of plaque rupture is the presence of an extrinsic force or "trigger" acting on the plaque (Falk et al. 1995). This can be caused by strenuous exercise, emotional stress, or in some cases, simply getting out of bed in the morning (Schroeder and Falk 1996, Muller 1999). In short, the presence of vulnerable plaque predisposes the individual to an acute coronary event, whereas the trigger or acute risk factors can precipitate the rupture (Falk et al. 1995). Although it is beyond the scope of this dissertation, it is interesting to note that a similar process occurring in the carotid arteries of the neck is now believed to be a major cause of stroke (Ryan 2000).

3.7.1 How does Plaque Rupture Occur?

The lipid-rich soft atheromatous gruel typically makes up the "core" of the plaque and is surrounded by the collagen-rich sclerotic tissue. For the most part, this is located *within* the vessel wall, with the exception of a "cap" which is created where the sclerotic tissue is exposed to the lumen (or vessel opening). Therefore, the only thing separating the highly thrombogenic lipid pool from the blood stream is this very thin cap. Triggers that increase blood pressure and tensile forces can then cause the cap to rupture at a weak point. This typically occurs at the shoulder region of the plaque, where the cap is thinnest (Falk et al. 1995).

From this discussion, it is clear to see that the risk of plaque rupture is dependent on (1) the size and consistency of the atheromatous core, (2) the thickness and collagen content of the fibrous cap covering the core, and (3) the amount of cap "fatigue" (Falk et al. 1995). In addition, researchers now typically list "inflammation within the cap" as a fourth risk factor (Falk et al. 1995). The following provides an explanation of the role inflammatory cells are thought to play in vulnerable plaque rupture.

3.7.2 Inflammation

Autopsy data has revealed that a higher number of inflammatory cells (such as macrophages that are associated with fighting infection) are often present at cites of plaque rupture (Falk et al. 1995). Researchers theorize that the inflammatory cells help create the lipid pool and eat away at the surface of the vessel, leaving only a "thin cap" (Ryan 2002, Falk et al. 1995). Because of the high correlation between inflammatory cells and the occurrence of plaque rupture, it is thought that inflammation itself may provide the key to finding a screening test for those potentially at risk for a heart attack due to vulnerable plaque (Falk et al. 1995, Comarow 2002).

One possible method of screening is a blood test that detects inflammatory cells that form the lipid pool of the vulnerable plaque (Comarow 2002). This potential screening method would consist of a simple blood test similar to existing tests that detect high density lipoprotein (HDL) and low density lipoprotein (LDL), commonly referred to as "good" and "bad" cholesterol.

3.8 Potential Screening and Treatment Methods

3.8.1 CRP: A Possible Screening Test for Vulnerable Plaque

The November 25, 2002 issue of *U.S. News and World Report* describes a test that measures levels of C - reactive protein (CRP), an indicator for inflammation, which could potentially be used in the near future to screen for those at risk for a heart attack. This article describes the results of an eight-year study of nearly 28,000 individuals in which it was found that CRP was a better indicator of MI and stroke than high levels of LDL ("bad" cholesterol) (Comarow 2002). The CRP test is similar in nature to any simple blood test, such as cholesterol, HDL, or LDL, and is conducted by many laboratories across the country. The test generally costs between $10 and $25 but is not yet covered by most insurance companies; however, Medicare did start covering the cost of this test starting in January 2002 (Comarow 2002).

Since "half of all heart attacks strike people who don't have a cholesterol problem…and at least 25 percent of heart attacks happen to individuals with no major risk factors" (Comarow 2002), at the very least CRP could provide an additional piece of information in assessing a patient's risk of having a heart attack. However, as of yet, there is no standard regarding the use of CRP testing. In fact, several different CRP tests exist, each with varying degrees of sensitivity. Therefore, according to a top researcher in the field, the first step is to establish a uniform test, with agreed upon guidelines regarding the interpretation of the results (i.e. high, moderate, and low levels of risk) (Comarow 2002).

After establishing a uniform test, studies would then need to be done to verify that there is a statistical correlation between high levels of CRP and a higher risk of heart attack (Comarow 2002). Unfortunately, the current CRP test can not distinguish between inflammation associated with lipid pools versus inflammation due to injury or infection Ryan 2002). This means that someone who has a common cold virus (and has a large number of macrophages present in their blood stream) would likely have an abnormally high CRP test result, yet it would be a result of the infection and not necessarily an indicator of the presence of lipid pools and possible risk of heart attack. Therefore, the CRP test may not be specific enough to serve as an effective screening method for identifying those at risk for heart attack. For now, physicians may choose to use this test on a limited basis – specifically, as a source of additional information to help assess the risk of marginal patients (Comarow 2002). Although it is still unclear whether the CRP test will ultimately prove effective as a general screening method to detect those at risk for heart attack, it is clear that the potential of a simple blood test being used in this fashion is certainly feasible.

3.8.2 Inflammation as an Indicator for Treatment

If inflammation is an indicator for lipid pools and could potentially be used as a screening method, then could it not also be used as an indicator in developing a detection/treatment method for vulnerable plaque as well? Unfortunately, the answer to this question is "probably not." Although the presence of a large number of inflammatory cells may be an indicator of a higher risk of heart attack and offer a potential method for screening, it is unlikely that locating inflammatory cells could be used in the detection/treatment of the lipid pools. This is because the inflammatory cells can be located in many places within the coronary vessels, including many places where lipid pools are *not* present. Therefore, using inflammation as an indicator would lead to treating numerous areas unnecessarily (Ryan 2002).

3.8.3 Potential Treatments for Vulnerable Plaque

Currently, drug therapy (taking a cholesterol-lowering drug such as Lipitor, Pravachol, or Zocor) is the only treatment for vulnerable plaque. Unfortunately, as mentioned previously, this treatment method is only about 30% effective (Waters 2000). In addition, these drugs work slowly and therefore require a considerable length of time to reduce the individual's risk of having a heart attack (Ryan 2000). Therefore, this is not a very effective treatment for the immediate threat posed by the presence of vulnerable plaque within the coronary vessels. This has led medical researchers to explore several potential treatment techniques in an attempt to develop a more effective detection and treatment method for vulnerable plaque. Several of these methods utilize a heart catheter, a device that can be threaded through the coronary arteries so that the physician may either "see" or treat a specific area of the vessel. The following describes drug therapy, as well as some other potential methods that may ultimately prove successful in the development of a detection and treatment method for vulnerable plaque.

Systemic drug therapy

"Systemic" means to put in the blood stream, typically by mouth or intravenously (IV). Drug therapy is the current "standard of care" and requires the patient to take a statin (cholesterol lowering) drug like Lipitor, Pravachol, or Zocor on a daily basis, often for the remainder of the patient's life. Although these drugs have been shown to lower cholesterol (and CRP), they are only about 30% effective at reducing the individual's risk of heart attack. In addition, individuals taking these drugs have a higher risk of liver failure. However, to reduce this risk, patients taking statin drugs typically have liver function tests periodically (about every three months for the first year) to monitor for potential liver damage (Ryan 2000).

Localized drug treatment

This is a catheter directed treatment, meaning that a heart catheter is used to apply a drug at the point of interest. One possible procedure for treating vulnerable plaque would be similar to catheter-directed TPA (tissue plasminogen activator), a procedure in which a clot dissolving drug is given at the site of an acute thrombosis (clot). However, the treatment of vulnerable plaque would require a catheter that could deliver the drug *into* the coronary wall. Such a device does not currently exist (Ryan 2000).

Photo-activated drug therapies

For this therapy a patient is given a systemic "inactive" drug treatment. A fiber optic heart catheter is then used to emit a certain frequency of light at the point of interest. The light causes the systemic drug to become active, *but only at the point of interest.* This allows the drug to take effect *only* at designated points within the body, as opposed to the entire body. Therefore there is less risk of an adverse side effect from the drug being administered. Although some photoactive drugs currently exist, none are commercially available at this time for the treatment of vulnerable plaque (Ryan 2000).

Angioplasty

Balloon angioplasty is traditionally performed to expand a vessel; however, the same treatment could potentially be used for treating vulnerable plaque. For this treatment, a patient is given a dose of heparin through an IV. This drug acts instantaneously to prevent the patient's blood from clotting; however, this is only a short term effect. A heart catheter is then used to expand a balloon within the coronary vessel at the point of interest. The balloon will cause the plaque to rupture; however, due to the effect of the heparin, a clot will not result. Therefore, this method reduces the risk of heart attack by allowing for a controlled rupture. This is analogous to how controlled fires are used to reduce the risk of forest fires (Ryan 2000).

Stent

This is similar to angioplasty, except that the balloon has a wire mesh around it, resembling a Chinese finger puzzle. As the balloon inflates the wire mesh expands and once in place remains in the coronary vessel to help stabilize the point of interest. This method is designed to force the cap up and prevent it from rupturing. In fact, the use of a stent will often cause the cap to thicken, making it more stable. It is possible for the placement of the stent to rupture the plaque; however, just as in angioplasty, the use of heparin prior to the procedure will allow for a controlled rupture with little to no resulting clot. Therefore, this procedure will have one of two outcomes: stabilization or a controlled rupture (Ryan 2000).

As indicated by these descriptions, a method tailored to the detection and treatment of vulnerable plaque does not yet exist; however, almost all of the potential therapies do have one thing in common – localized treatment. This is a strong indication that the detection/treatment method that is ultimately developed will utilize a heart catheterization procedure, such as those described above (Yock 2001, Ryan 2000). Therefore, for the purpose of this dissertation, a heart catheterization procedure will be utilized as the hypothetical detection/treatment method that is more effective than drug therapy.

3.9 Standard of Care

3.9.1 Current Standard of Care for Symptomatic Individuals

When a patient presents with symptoms of heart disease, such as chest pain or shortness of breath, the physician will typically order a stress test. If the results of the stress test indicate a possible blockage of the coronary vessels, then the patient will undergo an angiogram in the catheterization lab (Ryan 2000). This procedure cost around $4,000 (Yorke 2005) and requires making a small incision in the upper thigh and placing a “guide” wire. A heart catheter is then threaded through the artery up to the coronary vessels. This procedure allows the physician to determine if a blockage exists and identify its location (Ryan 2000).

Depending on the degree of stenosis found, the physician may choose to place a stent in specific locations where the stenosis could potentially create a blockage. Placing a stent typically reduces angina (chest pain) because it expands the lumen, thereby increasing the flow of oxygenated blood to the heart. In the past, it was also believed that this procedure would reduce the patient’s risk of a heart attack; however, in light of new evidence involving vulnerable plaque as the primary cause of heart attacks, this is no longer believed to be the case. Although placing a stent may allow a controlled rupture or stabilize a single lipid pool located directly beneath the stent as described above, vulnerable plaques tend to be small and appear in multiple locations within the coronary arteries. Since a stent only treats an area up to 30 mm in length, this procedure does little, if anything, to prevent the occurrence of a heart attack if vulnerable plaque is present in the individual's vessel walls. Following the stent procedure, patients are placed on a statin drug, which is typically taken for the remainder of the patient's life. Although placing a stent may alleviate the patient's chest pain, any reduction in the occurrence of heart attacks for these patients can most likely be attributed to the drug therapy, and not from the placement of the stent (Ryan 2000).

3.9.2 Current Standard of Care for Asymptomatic Individuals

For asymptomatic individuals, a stress test may be ordered if the patient has a family history of heart problems or a large number of risk factors. However, an estimated 25 million Americans who do not have traditional risk factors or exhibit symptoms of heart disease are also at risk for a heart attack, and are not receiving treatment (Yorke 2005). Since it is not feasible (or affordable) to perform a heart catheter procedure on everyone to determine who is at risk (Yock 2001), there is a need for an inexpensive, non-invasive screening method to begin the process of better identifying those at risk. This will get potential "at risk" individuals "into the system" such that additional (and often more invasive) procedures can be performed to determine if they are truly at risk (Muller 2001).

However, even if the individual is found to be at high risk for a heart attack, the current treatment of drug therapy is only about 30% effective, and because it takes time for the drugs to become effective, it offers very little in terms of immediate risk reduction (Ryan 2000). Therefore, a new treatment method that is more effective at reducing the occurrence of a heart attack is also needed.

3.9.3 What change is needed?

To effectively identify and treat those at risk for a heart attack due to vulnerable plaque, there are two things that would need to occur. First, an inexpensive and relatively non-invasive screening method would need to be developed that could be administered to the general public. Second, a more effective detection and treatment method would need to exist (Muller 2001).

In this particular case, detection and treatment go hand-in hand. Since potential treatment methods already exist, the key is being able to accurately locate the pockets of vulnerable plaque within the coronary vessels so they can be treated. According to doctors conducting research in this field, the most likely candidate for a detection/treatment method is one that is localized, meaning that it utilizes a heart catheter (Yock 2001, Ryan 2000). Although such a device would look similar to a heart catheter used to place a stent, it would need to be specifically designed for the sole purpose of detecting and treating vulnerable plaque (Ryan 2000). Because this device would be able to discern between stable and vulnerable plaque, it would allow the physician to assess with greater accuracy the patient's risk of a future heart attack. If the physician detects a significant amount of vulnerable plaque, he/she would also be able to treat the patient as part of the same procedure; thereby eliminating the risks (primarily resulting from anesthesia and the possibility of infection) associated with an entirely separate surgical procedure[51].

Since stress tests, angiograms, and stents are primarily used to treat blockages and chest pain, these procedures would most likely no longer be part of the treatment regimen for the detection and treatment of vulnerable plaque. Therefore, for the patient found to be at high risk for vulnerable plaque, the only real alternatives would either be drug therapy or a new detection/treatment procedure.

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[51] It is important to note that when the patient agrees to undergo the catheterization procedure to detect vulnerable plaque, he/she will be sedated during the procedure such that the individual would not be able to give informed consent for subsequent treatment. Therefore, by consenting to the procedure, he/she is also giving consent for treatment should the physician determine that it is warranted.

3.10 Summary

Although there are many factors that may play into who is at risk for a heart attack (age, gender, stress), and several tests (CRP, LDL) can provide *some* additional information, the bottom line is: *there is currently no method to correctly and consistently identify who is at risk for a heart attack*. In fact, current risk factors and tests miss a large percentage of the "at risk" population, such that 50% of those individuals who currently die from a heart attack do so without ever having been diagnosed with CHD or experiencing a warning sign prior to the attack (American Heart Association 2003).

Recently the idea of plaque burden as the primary cause of heart attacks has been replaced by a newer theory that indicates that it is not the *amount* of plaque, but rather the *type* of plaque that places an individual at risk for a heart attack. Specifically, the existence of vulnerable plaques, which are prone to rupture, are now thought to be the primary cause of heart attacks. Therefore, efforts are underway to develop a new screening method, such as the CRP blood test, which is inexpensive and non-invasive enough to use routinely on the general population that will better identify those at risk for a heart attack due to vulnerable plaque. Since this is clearly the direction medical technology is taking, it was logical to choose a simple blood test as the hypothetical screening method that respondents would be asked to value in *Survey 1: Screening*.

As discussed in this chapter, highly sensitive screening methods have a tendency to result in false-positives. Therefore, it is often necessary to further test those who have positive screenings using a more specific procedure in order to gain additional information and more accurately assess the individual's true risk. A more specific procedure for identifying those at risk for a heart attack currently does not exist, but in the near future it may involve having a MRI or heart catheterization procedure.

Once a patient is correctly identified as being at risk for a heart attack, the only treatment that currently exists is drug therapy. However, because drug therapy requires a significant time to take effect, and even then is only about 30% effective at reducing the occurrence of a heart attack, this treatment method does not really address the immediate threat of a vulnerable plaque rupture. Therefore, a new, more effective treatment method is also needed. Since the potential treatments currently being explored all involve localized procedures in which a heart catheter is utilized, it followed that the detection and treatment procedures would most likely be combined to reduce the risks associated with anesthesia and infection stemming from having an additional procedure. Furthermore, because a slight modification to the heart catheter procedure that is commonly used today was a likely candidate for eventually being able to detect and treat vulnerable plaque, this was the logical choice for the hypothetical treatment that respondents were asked to value in *Survey 2: Treatment*.

Chapter IV: Theory

The purpose of this chapter is to develop a theoretical framework to identify the factors that will influence willingness to pay (WTP) for both a screening and detection/treatment method for vulnerable plaque. This is accomplished by using a set of decision trees that represent decisions faced by individuals in the current state of the world, as well as potential decisions that are likely to occur if a new screening and detection/treatment method for vulnerable plaque were made available. Using the decision trees, equations representing expected utility are derived for various treatment alternatives in both the current and desired states of the world. Then, using a model which closely resembles that of Michael Jones-Lee (1974), expected utility is held constant under different conditions in order to define the consumer's maximum WTP for a change in his/her risk of having a heart attack, or for additional information regarding that risk. In addition, the factors affecting the marginal WTP for treatment are also identified since payment for a new treatment method reduces the individual's risk of a heart attack. Finally, this chapter concludes with a discussion of how these models influenced the development of the surveys, such that the theoretical expectations regarding WTP for screening and treatment could be tested empirically.

4.1 Fundamentals of Clinical Decision Analysis using Decision Trees

In treating patients, physicians are continually faced with having to make decisions involving risk and uncertainty. Since decision analysis provides a "systematic approach to decision making under conditions of uncertainty" (Weinstein and Fineberg 1980 p. 3) it is appropriate to utilize this method when making clinical decisions. In fact, because decision analysis allows the physician to determine the treatment option that would maximize a desired outcome (such as the highest probability of survival), decision analysis provides a valuable tool in determining the best treatment for an individual patient as well as for an entire population. Therefore, decision analysis can be used to identify what physicians often refer to as the "best practice" or "standard of care"[52] and can also be applied in decisions regarding social policy (Weinstein and Fineberg 1980).

[52] The usual course of treatment when a patient presents with a certain set of symptoms.

Decision analysis often utilizes decision trees as a means of visualizing the problem being addressed. The decision trees presented in the figures at the end of this chapter were developed in accordance with the information presented in Weinstein and Fineberg's (1980) book *Clinical Decision Analysis.* Each branch of the decision tree represents actions or consequences that occur over time. A square represents a decision node, or a point at which a decision is made (it should be noted that for this type of analysis, doing "nothing" is considered a decision). Branching points that do not involve a decision (but are merely a function of chance) are referred to as chance nodes and are indicated by a circle.

When the decision tree is completed, it visually illustrates all of the possible courses of action (paths) and their resulting outcomes. For example, consider the decision tree presented in Figure 4-4. This tree illustrates the treatment decision that is made when a physician is presented with a patient who has already been identified as being at high risk for a heart attack (or MI)[53]. The physician[54] has two options: he/she may either choose to (1) simply monitor the patient (do nothing) or (2) place the patient on a cholesterol lowering medication (drug therapy). Since this branch represents a decision, it is considered a decision node and is indicated by a square.

For illustrative purposes only, assume that the physician decides not to put the patient on drug therapy. Once the decision to simply monitor the patient has been made (i.e. do nothing), the subsequent outcome is based solely on chance. The patient may or may not experience an MI (the probability of each possibility is indicated on the respective branch). Because the occurrence of a MI is beyond the control of the patient or physician, it represents a chance node and is illustrated with a circle. If the patient does experience an MI, he/she will either live or die as a result. The final outcomes are represented by boxes at the end of each path. In this case, there are three possible outcomes: (1) the patient lives without experiencing an MI (denoted as L); (2) the patient experiences a MI, but survives (M); or (3) the patient experiences a MI and dies (D).

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[53] "Heart attack" and "MI" (the abbreviation for myocardial infarction, which is the medical term for heart attack) are used interchangeably throughout this chapter.

[54] When clinical decision analysis was first developed, the physician was often viewed as the primary decision maker; however, as will be discussed in the following section, more recent applications of clinical decision analysis are more oriented toward the consumer-patient as the primary decision maker, instead of being expert-based.

The expected utility of an entire branch can be determined by assigning a utility to each outcome and then using a process that Weinstein and Fineberg refer to as "folding back." Basically, this is nothing more than using the probabilities assigned to each branch as "weights." For a simple example, refer to Figure 4-1. Suppose that the probability of having an MI for an individual who demonstrated no symptoms of heart disease was 2 percent (r = .02).[55] Therefore, the probability of not having an MI would be 98 percent (1-r = .98). According to the *Heart and Stroke Statistical Update* published by the American Heart Association (2003), the probability of dying as a result of an MI is approximately 0.5, and is already indicated in the figure. Therefore, the probability of surviving the MI is also 0.5. If the utility associated with L, M, and D were 10, 7, and 0 respectively, then the expected utility could be calculated as:

$$E(U) = .98\,(10) + .02\,(.5)\,7 + .02\,(.5)\,0 = 9.8 + .07 + 0 = 9.87$$

When this branch is part of a larger tree (such as when it appears as the upper branch in the decision tree presented in Figure 4-3), this process can be used to estimate the expected utility of each branch stemming from a decision node; thereby allowing the physician to choose the treatment option corresponding to the path offering the highest expected utility.

4.2 Utilizing Decision Trees to Identify Risk-Dollar Tradeoffs

As described above, decision trees are used in clinical decision analysis to identify the treatment option (path) that offers the highest level of utility, best chance of survival, or some other desired outcome. The application of the decision trees in this study; however, is slightly different. Instead of identifying the branch that maximizes the individual's utility, the expected utility from different branches is equated in order to hold expected utility constant and identify risk-dollar tradeoffs associated with lower levels of heart attack risk. Each decision tree identifies a different state of the world - the current state in which no screening and limited treatment exists, and the desired state in which

[55] According to the American Heart Association, the 10-year risk of an individual with no risk factors is 2% (Wilson et al. 1998).

screening and a better treatment method exist - for both high risk and asymptomatic individuals. By identifying the individual's expected utility in the current state and holding that level of utility constant, the decision trees can be used to set up equations similar to those used by Jones-Lee (1974), such that the WTP for a change in heart attack risk can be determined.

4.2.1 Risk-Dollar Tradeoffs

Michael Jones-Lee (1974) developed an expected utility model that can be used to determine how much an individual would be willing to pay in order to lower the probability of death by a marginal amount. The model assumes two possible states: life and death. If the probability of death is p ($0 < p < 1$); then, the probability of not dying is $1-p$. The model also includes the individual's utility as a function of wealth, W, in each state of the world.[56] Therefore, the individual's initial expected utility is given by:

$$E(U) = (1-p)\, L(W) + p\, D(W),$$

where L(W) is the individual's indirect utility associated with the good state "life" and D(W) is the individual's utility in the bad state "death." The model assumes that L(W) and D(W) are continuous and twice-differentiable, such that $L'(W) > 0$ and $L''(W) < 0$. These conditions imply that in the good state utility increases with increased wealth, but at a decreasing rate. In addition, the individual derives more utility in the good state than in the bad state for a given level of wealth, such that $L(W) > D(W)$. The marginal utility of wealth is also assumed to be greater in the good state than in the bad, such that $L'(W) > D'(W)$. And finally, $L''(W) > D''(W)$, which implies that the individual is more sensitive to changes in wealth in the good state as compared to the bad state.

The individual can make an expenditure, X, to reduce the probability of death to p*, such that expected utility becomes:

$$E(U) = (1-p^*)\, L(W-X) + p^*\, D(W-X)$$

[56] The utility associated with death is derived from wealth being passed on to the individual's heirs.

The expenditure occurs regardless of whether the individual lives or dies, and although the expenditure reduces the probability of death from *p* to *p**, there is no guarantee that the expenditure will prevent death from occurring (Jones-Lee 1974).[57] According to Jones-Lee, the maximum amount an individual would be willing to pay to reduce their probability of death to *p** is defined as the expenditure that will still provide the individual with their initial expected level of utility. Mathematically, the individual's willingness to pay, or Hicksian compensating variation[58], can be found by setting the expected utilities equal and then solving for X using the following equation:

$$(1-p^*)\ L(W-X) + p^*\ D(W-X) = (1-p)\ L(W) + p\ D(W) \qquad (4.1)$$

The marginal willingness to pay for a change in risk can also be found by differentiating the entire expression by *p* and then rearranging terms to solve for $\partial X/\partial p$ (Jones-Lee 1974). Assuming that wealth (W) and the risk of death without the expenditure (p) are constant, differentiating equation 4.1 with respect to *p* will cause the entire right hand side of the equation to go to zero and result in the following expression:

$$- L + (1-p^*)\ L'\ \partial X/\partial p + D + p^*\ D'\ \partial X/\partial p = 0 \qquad (4.2)$$

where $L = L(W-X)$, $D = D(W–X)$, $L' = \partial L(W-X)/\partial X$, and $D' = \partial D(W-X)/\partial X$. Rearranging terms in equation 4.2 and solving for $\partial X/\partial p$, Jones-Lee (1974) provides the following equation which defines the risk-dollar tradeoff:

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[57] This expenditure is made prior to the individual knowing which state of the world they will experience, and is therefore considered an option price. According to Freeman (1999), option price is defined as the maximum amount an individual would be willing to pay in order to reduce a given risk and return to a state in which the risk does not exist, thereby maintaining the individual's initial level of utility.

[58] The Hicksian compensating variation refers to the maximum amount that the individual is willing to pay (WTP) to avoid a loss, such that the individual's utility is equal in both states. When a loss has been imposed on an individual (or group of individuals), then the Hicksian equivalent variation refers to the amount that the individual is willing to accept (WTA) in order to return them to their prior level of utility. As discussed in Chapter 2, the appropriateness of WTA versus WTP is based on the assignment of property rights. The Hicksian compensating variation assumes that the individual will move to a lower level of utility, whereas the Hicksian equivalent variation assumes that the individual will be returned to their prior level of utility before the loss was imposed on them. WTA was used in assessing damages for the Exxon Valdez Oil Spill and illustrated that WTA and WTP measures may, in fact, be considerably different.

$$\partial X / \partial p = [L - D] / [(1-p^*) L' + p^* D']$$

Since L > D, the numerator will always be positive. The denominator will be negative, indicating that a reduction in risk, *p*, requires an increase in expenditures, *X*.

Many decisions regarding risk do not involve life and death, but rather varying degrees of quality of life. Diseases such as multiple sclerosis and chronic conditions like asthma can greatly influence the utility an individual derives from wealth. In fact, Viscusi and Evans (1990) find empirical evidence to indicate that the utility derived from income is higher in the healthy state compared to utility in an ill state. Therefore, it is useful to modify the model developed by Jones-Lee (1974) such that the "good" and "bad" state are not "life" and "death", but rather different states of health.

4.2.2. Developing the Decision Trees

Although the final decision trees presented in Figures 4-1 through 4-5 appear relatively simple, their development required considerable research regarding the various types of treatment used for patients presenting with symptoms of heart disease. In addition, it was necessary to understand how new developments regarding the screening and treatment of vulnerable plaque would alter the current standard of care.[59] Thus, the decision trees were developed after attending vulnerable plaque seminars sponsored by CIMIT (Center for Innovative Minimally Invasive Therapies) at the Massachusetts General Hospital (MGH) and after numerous conversations with several M.D.s familiar with vulnerable plaque research. Once the underlying medical issues were clearly understood, the decisions that would be faced by the patient/physician[60] were simplified

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[59] Information related to this can be found in section 3.9 of Chapter 3 under the heading "Standard of Care."

[60] This analysis is done from the patient's point of view. Although the physician may recommend a particular course of action, most decisions are ultimately that of the patient. Therefore, all decisions that are made by the patient (with or without his/her doctor's advice) will be represented as decision nodes. For the few exceptions where the physician must make a decision without conferring with the patient (for example, when the doctor must decide whether or not to treat the patient while performing the detection procedure described in scenario 5), it is assumed that the physician will follow the "standard of care." Meaning that if the detection procedure reveals a certain level of plaque, treatment will be performed, otherwise, it will not. Since this decision is out of the hands of the patient, and is in essence contingent only on the level of plaque discovered during the detection procedure, it will be represented as a chance node. Throughout this paper, the term "patient/physician" will generally be used when describing a *course*

into five scenarios. The following provides a description of these scenarios that are used to develop the theoretical framework for this project. Some scenarios represent the current state of the world, while others represent hypothetical situations modeling the decisions that would most likely exist if a screening and detection/treatment method did exist.[61] Each scenario is accompanied by a list of relevant assumptions/conditions and by a decision tree that visually illustrates the scenario.

The first three scenarios are related to the benefits associated with a screening method that could be used to identify individuals within the general population who are at risk for a MI due to vulnerable plaque (including those who are asymptomatic). The first scenario illustrates the current situation in which no such screening exists. The third scenario illustrates the hypothetical state in which both screening and treatment exist. Since drug therapy is currently available for those individuals who are identified as being "at high risk" for a heart attack, the second scenario (in which screening is available, but no treatment exists) would never occur. However, it is included as a stepping stone, and will be utilized later in this chapter to isolate the individual's WTP for information obtained from the screening *in the absence* of possible treatment.

The last two scenarios are used to illustrate the benefits associated with developing a more effective treatment for those who have already been identified as being at high risk for a MI due to vulnerable plaque. The fourth scenario describes the current state of the world in which only drug therapy is available, and the fifth scenario describes the hypothetical state of the world in which a more effective detection/treatment is available.

4.3 Theoretical Framework for a New Screening Method

4.3.1 Current State for an Asymptomatic Individual

The first scenario (See Figure 4-1) represents the current state in which no screening is available. Therefore, individuals who do not exhibit symptoms of heart problems are currently "left out of the system" even though they may be at risk for a

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of treatment involving several decisions, which could be made by the patient, physician, or a combination of the two. This term also reflects the collaborative nature with which most medical decisions are made.

[61] It was necessary to simplify the medical process that actually occurs to some degree in order to make the decision trees manageable. However, care was taken not to simplify any element that was thought to be meaningful, given the scope of the analysis.

heart attack. Since screening and treatment are currently not available to these individuals, the following conditions apply:

- **Individual has NO symptoms of coronary heart disease (CHD)**
- **Screening for vulnerable plaque is NOT available**

If the individual's probability of having a heart attack (or MI) is r ($0 < r < 1$), then with probability ($1 - r$) the individual will NOT experience an MI. It should be noted that r is specific to the individual and is largely unknown. The individual may have some information (N^0) regarding r based on family history, past cholesterol tests, and other traditional risk factors; however, as explained in Chapter 3: Medical Background, these factors are not always good indicators of who is at risk for a heart attack. Therefore, the current information held by the individual (N^0) provides very little information as to his/her actual risk of having a heart attack.

The medical literature indicates that an individual who experiences an MI has about a 50 percent chance of survival (American Heart Association 2003). Surviving a heart attack may leave the individual in a state of significant disability, or at the very least, with a weaker heart muscle that puts them at greater risk for a future heart attack and may place limits on their activity. Therefore, it is reasonable to consider the utility associated with three possible health outcomes: the individual lives without experiencing an MI, the individual experiences an MI and lives, or the individual experiences an MI and dies as a result. The indirect utility[62] associated with each health state will be denoted as L, M, and D respectively.

Following the model developed by Michael Jones-Lee (1974) for the willingness to pay for reductions in the risk of death, utility in each state is dependent on the individual's wealth (W); however, this model is modified such that instead of paying to reduce the risk of death, the individual can pay to reduce his/her risk of a heart attack, r.

[62] Consumers will choose the quantities of available goods and services that maximize his/her utility subject to a budget constraint. Therefore, it follows that an individual's optimal utility level will be *indirectly* determined by his/her income and the prices of the goods being purchased (Nicholson 1992 p. 116). The indirect utility function is useful because it is expressed in terms of income and prices, which are measured in dollars. Therefore, by using indirect utility it is possible to examine the effect changes in prices and income will have on consumer utility (Nicholson 1992 p. 117).

In addition, the bad state of the world - having a heart attack – has two consequences: survival and death. Viscusi and Evans (1990) find empirical evidence to suggest that the utility derived from income is higher when the individual is in the healthy state compared to an unhealthy state. Therefore it would follow that L(W) > M(W) > D(W). In addition, the marginal utility of wealth diminishes in each of the health states, such that L'(W), M'(W), and D'(W) are all negative. Applying these indirect utilities to the decision tree in Figure 4-1, expected utility can be written as:

$$E(U)_1 = (1\text{-}r)\ L(W \mid N^0) + r\ (.5)\ M(W \mid N^0) + r\ (.5)\ D(W \mid N^0),$$

where the utility derived from each health state is a function of the consumer's wealth (W), given the current amount of information (N) that the individual possesses on their risk of heart attack. If the individual's utility from death is assumed to be zero, then the individual's expected utility becomes:

$$E(U)_1 = (1\text{-}r)\ L(W \mid N^0) + .5\ r\ M(W \mid N^0) \qquad (4.3)$$

The simple decision tree illustrated in Figure 4-1 will appear as a branch in several other trees and is indicated by chance nodes labeled α. In addition, other branches that appear in more than one decision tree will similarly be labeled to facilitate comparisons across figures.

4.3.2 Intermediate State for an Asymptomatic Individual

The second scenario **(**See Figure 4-2**)** represents an intermediate state of the world in which screening exists, but treatment does not. Drug therapy currently exists for those identified as being at high risk for a heart attack, therefore, the following scenario is not realistic; however, it is possible that individuals would be willing to give up some of their wealth in order to find out more about their risk of having a heart attack, even if a treatment is not available. Therefore, this scenario is included as a stepping stone to isolate the factors affecting the WTP for information provided by the screening in the *absence* of a treatment. Therefore, in the second scenario the following conditions apply:

- **Individual has NO symptoms of coronary heart disease (CHD)**
- **Non-invasive screening for vulnerable plaque IS available to the general public (i.e. routine blood test similar to a cholesterol test)**
- **BUT a treatment does NOT exist**

The individual now has the option to find out more about their risk of having a heart attack by paying some dollar amount for a screening test. Interestingly enough, *regardless* of whether the individual has the screening or not, they will still face the same gamble illustrated in Figure 4-1. As illustrated in Figure 4-2, the only difference between the upper (α) and lower (γ) branches is the amount of information (N) the individual possesses regarding his/her risk of heart attack. Since there is no treatment, the individual's risk of heart attack, *r,* will remain unchanged. Although screening will not lower *r*, it will provide the individual with more information regarding the actual value of *r*. Therefore, by offering individuals more information as to their actual risk of having a heart attack, screening has the potential to enable the individual to make decisions that would enhance his/her utility.

Even though this scenario assumes no treatment is available, there are possible benefits derived from being screened. Namely, individuals found to be "at low risk" receive peace of mind. In addition, this new information regarding the true value of *r* may allow some individuals to alter their behavior in ways that increases their utility. For example, an individual who discovers herself to be "at low risk" after believing that she was "at high risk" may no longer feel compelled to adhere to as strict a routine of diet and exercise, which could potentially increase utility. For an individual found to be "at high risk" this new information can also be beneficial in that it allows him to better prepare for the future. For example, the individual now has the opportunity to obtain more life or disability insurance to provide financial security for his family in the event of a heart attack. Additionally, this new information may lead the individual to spend their time differently or alter their consumption patterns, thereby reducing feelings of regret in the event that death or disability does occur.

Although there are many possible benefits, it is also possible that the information provided from the screening could lower utility for some individuals. An individual who is found to be "at high risk" may experience stress and anxiety from knowing they have a medical condition for which no treatment is available. Therefore, it is not clear that more information will increase the utility in each health state for *all* individuals.

Again, following the model by Jones-Lee (1974), a payment (P_s) is required to receive the screening. The payment will reduce the individual's wealth, but will increase their level of knowledge regarding their risk of heart attack from N^0 to N^1. Therefore, expected utility derived from the screening (lower branch in Figure 4-2) can be expressed as:

$$E(U)_2 = (1\text{-}r)\ L(W - P_s \mid N^1) + .5\ r\ M(W - P_s \mid N^1) \qquad (4.4)$$

Assuming utility is held constant at the initial level of $E(U)_1$, the individual's maximum WTP *for information* (WTP_i) from the screening (when no treatment is available) is defined by setting $E(U)_1 = E(U)_2$. Because this decision is made *ex ante* (prior to the individual knowing whether he/she is at risk), this expenditure is an option price that is paid regardless of whether the individual experiences a heart attack or not. Substituting in for the expected utility using equations 4.3 and 4.4 and changing P_s to WTP_i yields the following expression:

$$(1\text{-}r)L(W \mid N^0) + .5rM(W \mid N^0) = (1\text{-}r)L(W - WTP_i \mid N^1) + .5rM(W - WTP_i \mid N^1) \quad (4.5)$$

As this equation implies, there is clearly a tradeoff between information and wealth. Choosing to have the screening will not change the individual's probability of having a heart attack (because no treatment is available); however, if the individual chooses to pay for screening, then he/she will obtain information (N^1) regarding his/her risk of having a heart attack. Therefore, the maximum WTP for screening when no treatment is available (WTP_i) will be dependent on the dollar equivalent of the marginal utility derived from the additional information (which could be either positive or negative as the previous discussion illustrates). Therefore, it is expected that those who experience a gain in utility from the information will be willing to pay some dollar amount for it, but those individuals for which the information causes disutility will not elect to have the screening, and may even require compensation in order to accept the screening.

4.3.3 Desired State for an Asymptomatic Individual

The third scenario **(**See Figure 4-3**)** represents the desired state of the world in which an asymptomatic individual can be screened for vulnerable plaque, and if found to be at high risk, can receive treatment. Figure 4-3 is very similar to Figure 4-2. However, since the possibility of treatment now exists, a bottom branch is included in Figure 4-3 and the chance node γ becomes a decision node. Drug therapy which is 30% effective currently exists, and it is anticipated that a new treatment which is even more effective will be available in the near future. Therefore, in the third scenario, the following conditions apply:

- **Individual has NO symptoms of coronary heart disease (CHD)**
- **Non-invasive screening for vulnerable plaque IS available to the general public (i.e. routine blood test similar to checking your cholesterol)**
- **A treatment DOES exist in the form of drug therapy which is 30% effective, and a new treatment which is 85% effective also exists.**

The treatment received will reduce the individual's risk of a heart attack r, such that the individual's new level of risk with treatment is r^*. The new lower level of risk will be determined by the effectiveness of the treatment. Therefore, having the new treatment will lower r more than if the individual chooses drug therapy. The expected utility derived from screening is illustrated in the lower branch of Figure 4-3. In this case screening offers information as well as the opportunity for treatment. Treatment is not actually delivered; however, an individual who pays for the screening has the *opportunity* to receive treatment if the results indicate that the individual is at high risk, which occurs if the individual's risk of heart attack, r, is found to be above some threshold amount, z. Therefore, using the lower branch of Figure 4-3, expected utility from screening can be written as:

$$E(U)_3 = (1-p_{(r>z)})[(1-r)\, L(W - P_s \mid N^1) + .5\, r\, M(W - P_s \mid N^1)]$$
$$+ (p_{(r>z)})[\, [(1-r^*)\, L(W - P_s \mid N^1) + .5\, r^*\, M(W - P_s \mid N^1)] \qquad (4.6)$$

Since screening involves an expenditure, utility will be reduced if the screening indicates the respondent is not at high risk. However, as the last scenario illustrated, only those who have a positive marginal utility associated with the information will elect to have the screening.[63] Plus, the other potential gain from the screening is the benefit from the treatment if the individual is found to be at high risk.[64] Holding the individual's utility constant at the level defined by $E(U)_1$, the WTP for screening will be determined by:

$$E(U)_1 = E(U)_3$$

Substituting in equations 4.3 and 4.6, the WTP for screening (WTP_s) is defined by the equation:

$$(1-r)\, L(W \mid N^0) + r\,(.5)\, M(W \mid N^0) = (1-p_{(r>z))}[(1-r)L(W-WTP_s \mid N^1) + .5rM(W-WTP_s \mid N^1)]$$
$$+ p_{(r>z)}\, [\, [(1-r^*)\, L(W - WTP_s \mid N^1) + .5\, r^*\, M(W - WTP_s \mid N^1)]^{65}$$

[63] This lends support to the two-part model included in Chapter 7: Data Analysis

[64] In estimating the total benefits derived from the screening and/or treatment, it would be necessary to consider potential effects on markets for substitute goods. For example, if the screening test identifies individuals who do not currently know they are at risk for a heart attack, the demand for statin (cholesterol-lowering) drugs is likely to increase. Likewise, development of a localized treatment (such as that described in *Survey 2: Treatment*) would most likely reduce the demand for stent procedures, but have little effect on the demand for statins since those having either procedure would still receive drug therapy regardless of the procedure. In addition, another consideration in conducting a benefit-cost analysis would be to consider the potential for offsetting behavior, or the Peltzman effect (Peltzman 1975). Studies (Peltzman 1975, Chirinko and Harper 1993) have shown that auto safety regulations have had little (if any) net effect on the reduction of highway traffic fatalities. One potential explanation is that consumers have a constant demand for health/safety and will therefore engage in offsetting behavior (such as driving faster) in response to additional auto safety features that reduce the probability of a auto fatality (Peltzman 1975). Therefore, given this evidence of the Peltzman effect in the demand for highway safety, it is reasonable to expect that consumers may also engage in some degree of offsetting behavior if an improved treatment which reduces the risk of heart attack is developed.

[65] This equation does not include a cost for treatment, which is consistent with the design of the survey instrument. For those respondents who received a version of the survey in which treatment was available, they were informed that treatment was either 30% or 85% effective (corresponding to the two treatment options); however, no mention of the cost of the treatment was includes. However, this is not necessarily an unrealistic specification. Typically, insurance companies will cover the cost of treatment that is determined necessary. Therefore, if the screening indicates that the individual is at high risk for a heart attack, then the insurance company is likely to cover the cost of drug therapy.

From this equation, it is clear that WTP for screening is a combination of the informational value it provides as well as the expected decrease in risk that treatment offers if the individual is found to be at high risk. Therefore, it is expected that those who are offered a greater effectiveness for treatment will be willing to pay more; however, this may be influenced by their perceived level of risk. If the individual does not perceive their risk to be very high, then they may anticipate that the screening will indicate that they do not need treatment. For example, consider the extreme case of $p_{(r>z)}=0$ in which the individual believes there is zero probability that the screening will indicate that they are at high risk, such that their individual risk of a heart attack, r, is above the threshold level z. In this extreme case, the effectiveness of the potential treatment will have *no impact* on the individual's WTP for screening. In fact, if $p_{(r>z)}=0$ then the last two terms on the right side of the equation become zero. Thus, the expression simplifies to equation 4.5 and is no different from the second scenario in which the screening only offers informational value.

4.4 Theoretical Framework for a More Effective Treatment

The last two decision trees apply to individuals who are already known to be at high risk for a heart attack. The decision tree in Figure 4-4 represents the current options (drug therapy) available to the patient/physician, while the added branch in Figure 4-5 represents the options available if a new detection/treatment method were made available. In scenario 4, the individual has already been identified as being at high risk for MI, therefore, he/she has some additional information (N^1) regarding his/her actual risk of heart attack. However, in scenario 5, the patient now has the opportunity to choose a new detection method that would provide more precise information (N^2) about his/her risk of MI. Notice that if the patient chooses drug therapy, no additional information is gained, which is indicated by the level of information N^1 in the indirect utility function.

4.4.1 Current State for an Individual at High Risk for a MI

Individuals who experience symptoms of coronary heart disease (or who have in the past) are considered "at high risk" for an MI. Therefore, the decisions facing these individuals would be the same as those who are identified as being "at high risk" for MI through screening. Currently, the only treatment available is drug therapy, which is considered to be 30% effective at reducing the risk of heart attack. Therefore, the fourth scenario (See Figure 4-4) represents the current state of the world for those individuals who have been identified as being "at high risk" for a heart attack, given the following conditions:

- **Individual has been identified "at high risk" for MI either through screening or because the individual has symptoms and/or a medical history of coronary heart disease (CHD).**
- **A treatment does exist in the form of drug therapy; however, at best, it is only 30% effective**

Once a patient is identified as being "at high risk" for a MI, he/she has two possible options. The first option is to do nothing. Although this would not be recommended by a physician, a patient does have the right to refuse medical treatment.[66] If the patient elects not to have treatment, he/she will still possess information N^1 regarding his/her risk of heart attack; therefore, selecting this option would simply lead to a branch (γ), which is identical to the branch in Figure 4-2 in which no treatment is available.

The patient's second option is drug therapy, which would involve the patient taking a statin (cholesterol lowering) medication on a daily basis. A very small percentage of patients (<1/10,000)[67] who take statins die from medical complications (such as liver failure). However, because this risk is so small and because the focus of the study is the WTP for a *new* treatment, this negligible risk associated with drug therapy was not mentioned in the survey, and therefore is not included in the decision trees.

Studies have shown that for patients taking statin drugs there is a statistically significant difference in the probability of having a MI, and that drug therapy reduces the

[66] Although the patient does not choose medical treatment, it does not preclude the possibility that the individual may respond to the information that he/she is "at high risk" of a heart attack by adjusting his/her behavior in ways that could potentially improve health (e.g. increased exercise, improved diet).

[67] Any medical risk that is lower than 1/10,000 is simply reported as "< 1/10,000"

risk of heart attack by *an average* of 30% (Ryan 2007). This means that a statin drug may have a larger effect for an individual at *very* high risk of a heart attack, while having a much smaller effect for an individual who is just over the threshold of being "at high risk." Thus, just as the risk of heart attack, *r*, is dependent on the individual, so will the magnitude of the risk reduction resulting from drug therapy. Therefore, the individual's risk of a heart attack while on drug therapy, r^d, is unique to the individual and, like *r*, is largely unknown. However, it is clear that $r^d < r$ due to the fact that the individual's risk of heart attack is lower from drug therapy compared to when the individual receives no treatment.

The decision tree illustrated in Figure 4-4 is essentially the same as the entire bottom branch in Figure 4-3 except, in this case, treatment is defined. The top branch of Figure 4-4 illustrates the expected utility for the individual if he/she refuses treatment, and is given by:

$$E(U)_4 = (1-r)\, L(W \mid N^1) + .5\, r\, M(W \mid N^1) \qquad (4.7)$$

Clearly the expected utility for someone who knows they are at higher risk for a heart attack will be different than the utility, $E(U)_1$, for an individual who does not have this information; therefore, $E(U)_4$ will become the baseline level of utility for those known to be at high risk for a heart attack. Since the focus of this study was the WTP for the new procedure, the out-of-pocket cost for drug therapy was assumed to be zero. Therefore, the expected utility from drug therapy is defined by the bottom branch (λ) in Figure 4-4 such that:

$$E(U)_5 = (1-r^d)\, L(W \mid N^1) + .5\, r^d\, M(W \mid N^1) \qquad (4.8)$$

As stated earlier, $r^d < r$; therefore expected utility[68] from the drug therapy is clearly higher when compared to the expected utility derived from doing nothing. This is why drug therapy is currently the standard of care for those who are identified as being "at high risk" for a heart attack. Although not formally modeled, it is possible that an

[68] As defined by equations 4.7 and 4.8

individual would elect not to have drug therapy if the losses in utility from possible side effects or having to take the medicine on a daily basis outweighed the benefits associated with the reduction in heart attack risk.[69]

4.4.2 Desired State for an Individual at High Risk for an MI

Currently, the only available treatment for those known to be “at high risk” for a heart attack is drug therapy, which is only 30% effective. Therefore, this final scenario (See Figure 4-5) describes the desired state of the world in which a detection/treatment method for vulnerable plaque does exist, such that patients at high risk for a heart attack have a treatment option available to them that is more effective than drug therapy.

- **Individual has been identified “at high risk” for MI either through screening or because the individual has symptoms and/or a medical history of coronary heart disease (CHD).**
- **A NEW method for detecting and treating vulnerable plaque exists that is MORE effective than drug therapy**

Although screening and/or symptoms of coronary heart disease (i.e. chest pain) may place an individual “at high risk” for MI, these are only indicators. As explained in Chapter 3: Medical Background, these “indicators” only provide limited information as to the individual’s true risk of having a heart attack. Therefore, the development of a procedure that could locate pockets of vulnerable plaque within the coronary arteries would allow the physician to better assess the patient’s *actual* risk and determine the best course of treatment (either drug therapy or the new treatment procedure utilizing a heart catheter). Regardless of the final treatment option selected, having this procedure would *increase* the patient’s information regarding his/her actual risk of a heart attack (from N^1 to N^2).

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[69] The decision trees are modeled using the individual’s actual probability of having a heart attack, *r*; however, individuals will make their decisions based on their ***perception*** of this risk. Therefore, if the individual has poor information regarding their actual risk of having a heart attack, they may make decisions that are non-optimizing.

As the lower branch in Figure 4-5 illustrates, the new procedure does involve an additional risk of death. As explained in the previous chapter, this risk of death stems from the possibility of medical complications from the surgical procedure. In the survey, respondents were told that the added risk of death from the procedure was equal to 1/10,000; therefore, the probability of survival (p_s) for this study was 0.9999. However, in writing the equations it will be left as a variable, so that it is clear how changes in the risk of death from the procedure will affect WTP.

In looking at the bottom branch of Figure 4-5, it is interesting to note that once the patient chooses the catheter procedure, all remaining decisions are beyond his/her control; therefore, all the branches stemming from this decision appear as chance nodes. Assuming the patient survives the detection procedure, the physician will then be able to determine if vulnerable plaque is present, such that the new catheter treatment is warranted. Because there is a significant added risk from performing the procedure more than once (due to the anesthesia involved) and because additional procedures are an inefficient utilization of medical resources, the procedure includes *both* detection and treatment (if it is warranted). However, because the patient is medicated and cannot provide his/her informed consent, the decision to treat the vulnerable plaque will be determined by the physician, who is assumed to follow the accepted standard of care. Therefore, once the patient chooses to have the procedure, the resulting outcome (path) is dependent solely on the existing probabilities associated with this treatment option.

If the detection procedure reveals that vulnerable plaque is not present, then the patient will be treated using drug therapy which, as discussed earlier, lowers the individual's risk of heart attack to r^d. However, if vulnerable plaque is detected, then the new treatment will be performed. The new treatment will lower the individual's risk to r^t and because the treatment is more effective than drug therapy, $r^t < r^d$ for each individual. Earlier it was determined that if the individual did not receive treatment at all, expected utility would be equal to:

$$E(U)_4 = (1-r)\, L(W \mid N^1) + .5\, r\, M(W \mid N^1) \qquad (4.7)$$

Since $E(U)_4$ defines expected utility if the individual does not receive any form of treatment, this will be used as the individual's baseline utility level. Following the lower branch of Figure 4-5, the individual's expected utility from the new treatment procedure is given by:

$$E(U)_6 = (p_s)\{ p_v (1-r^t) L(W - P_t \mid N^2) + .5p_v r^t M(W - P_t \mid N^2) + (1-p_v)(1- r^d) L(W - P_t \mid N^2) + .5(1-p_v) r^d M(W - P_t \mid N^2) \} \qquad (4.9)$$

where p_s is the probability of surviving the procedure,[70] p_v is the probability that vulnerable plaque is detected during the procedure,[71] P_t is the price of the treatment, and N^2 is the higher level of information on heart attack risk that is gained from having the procedure. Therefore, the WTP for the reduction in heart attack risk due to the treatment can be found by holding expected utility constant, such that $E(U)_4 = E(U)_6$. Substituting in equations (4.7) and (4.9) gives:

$$(1-r)L(W\mid N^1)+.5rM(W\mid N^1)=(p_s)[p_v(1- r^t)L(W-WTP_t \mid N^2)+.5p_v r^tM(W-WTP_t \mid N^2)] + (p_s)[(1-p_v)(1- r^d)L(W-WTP_t \mid N^2) + .5(1-p_v) r^d M(W-WTP_t \mid N^2)] \qquad (4.10)$$

Assuming that the information effect from the procedure is negligible, WTP for the change in risk associated with the procedure can be found by differentiating 4.10 with respect to *r*. Since risk remains constant without the treatment, the left side will become zero, such that:

$$0 = -p_sp_vL + p_sp_v(1-r^t)L' \boldsymbol{\partial WTP_t/\partial r} + p_s(1-r^t)L \,\partial P_v/\partial r + .5p_sp_vM + .5p_sp_vr^tM' \boldsymbol{\partial WTP_t/\partial r} + .5p_sr^tM \,\partial P_v/\partial r - p_s(1-p_v)L + p_s(1-p_v)(1-r^d)L' \boldsymbol{\partial WTP_t/\partial r} - p_s(1-r^d)L \,\partial P_v/\partial r +.5p_s(1- p_v)M + .5p_s(1-p_v)r^dM' \boldsymbol{\partial WTP_t/\partial r} - .5p_sr^dM \,\partial P_v/\partial r$$

Solving for $\partial WTP_t/\partial r$ gives an expression for the marginal change in WTP for treatment for a change in heart attack risk, and is defined by:

[70] For this study p_s is equal to 1 minus the probability of death from the new treatment procedure; $p_s = 1 - .0001 = .9999$

[71] p_v is dependent on the individual's risk of heart attack, *r*

$\partial WTP_t/\partial r = [p_s p_v L - p_s(1-r^t)L\ \partial P_v/\partial r - .5p_s p_v M - .5p_s r^t M\ \partial P_v/\partial r + p_s(1-p_v)L$
$+ p_s(1-r^d)L\ \partial P_v/\partial r - .5p_s(1- p_v)M + .5p_s r^d M\ \partial P_v/\partial r]\ /\ [p_s p_v(1-r^t)L' + .5p_s p_v r^t M'$
$+ p_s(1-p_v)(1-r^d)L' + .5p_s(1-p_v)r^d M']$ (4.11)

Some simple algebra results in some terms cancelling out, such that equation 4.11 simplifies to:

$\partial WTP_t/\partial r = L - .5M + r^t L\ \partial P_v/\partial r - .5r^t M\ \partial P_v/\partial r + .5r^d M\ \partial P_v/\partial r - r^d L\ \partial P_v/\partial r]\ /$
$[p_v(r^d-r^t)L' + (1-r^d)L' + .5p_v r^t M' + .5(1-p_v)r^d M']$ (4.12)

where $L = L(W\text{-}WTP_t\,|N^2)$, $D = D(W\text{-}WTP_t\,|N^2)$, $L' = \partial L(W\text{-}WTP_t\,|N^2)/\ \partial WTP_t$, and $D' = \partial D(W\text{-}WTP_t\,|N^2)/\ \partial\ WTP_t$.

From equation 4.12, it follows that higher the effectiveness of the treatment, the higher the WTP for treatment; however, the higher the effectiveness of drug therapy, the lower the WTP for treatment. Therefore, this implies that the greater the difference between the effectiveness of the two treatments, the larger the WTP for treatment. In addition, the higher the likelihood of having vulnerable plaque, the greater the expected WTP.[72]

4.5 Application to Survey Instruments

The theoretical framework presented in this chapter is used to develop the two surveys utilized for this study: *Survey 1: Screening* and *Survey 2: Treatment*. *Survey 1: Screening* was developed based on scenarios 1-3 and was administered to a sample representative of the general population. Through this survey, information on the individual's perceived risk of a heart attack, health characteristics, financial resources, and other demographics was obtained. In addition, the survey elicited the individual's WTP for screening. In order to better understand how treatment effectiveness might

[72] The probability of the individual having vulnerable plaque is unknown; however, it may be possible to use the individual's perceived risk of a heart attack as a proxy for this variable in the empirical analysis in Chapter 7.

influence the WTP for screening (as suggested by the third scenario), respondents received versions of the survey in which treatment effectiveness was 30% (corresponding to drug therapy) or 85% (corresponding to the new treatment). In addition, in order to explore the question of whether screening has value if it offers purely informational value (scenario 2), a small arm of the sample received a slightly modified survey in which no treatment was available.

Scenarios 4 and 5 are addressed by *Survey 2: Treatment*. Since these scenarios involve patients who are already known to be at high risk for a heart attack, the sample for this survey only included individuals with doctor-diagnosed heart problems. Like *Survey 1: Screening*, *Survey 2: Treatment* collects information on the individual's perceived risk of a heart attack, health characteristics, financial resources, and other demographics. In addition, respondents for this survey were presented with the treatment options discussed in the final scenario and were asked about their WTP for a more effective detection/treatment method for reducing their probability of experiencing a heart attack.

Figure 4-1: Current State for Asymptomatic Individuals: No Screening Available

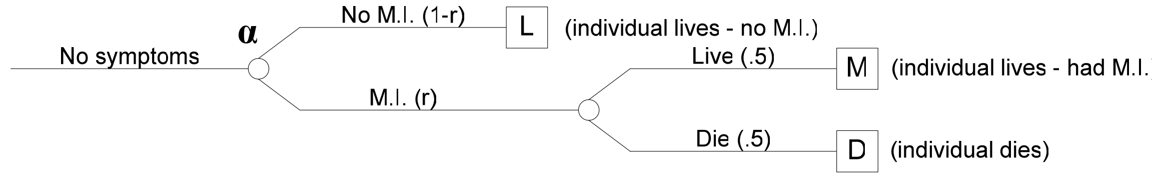


Figure 4-2: Intermediate State for Asymptomatic Individuals: Screening Available, But No Treatment

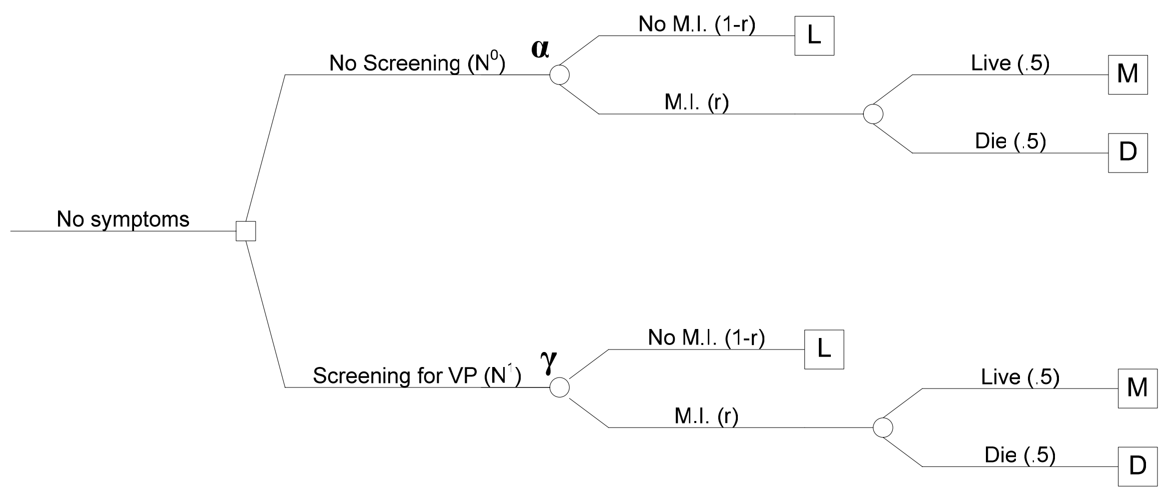


Figure 4-3: Desired State for Asymptomatic Individuals: Screening and Treatment Available

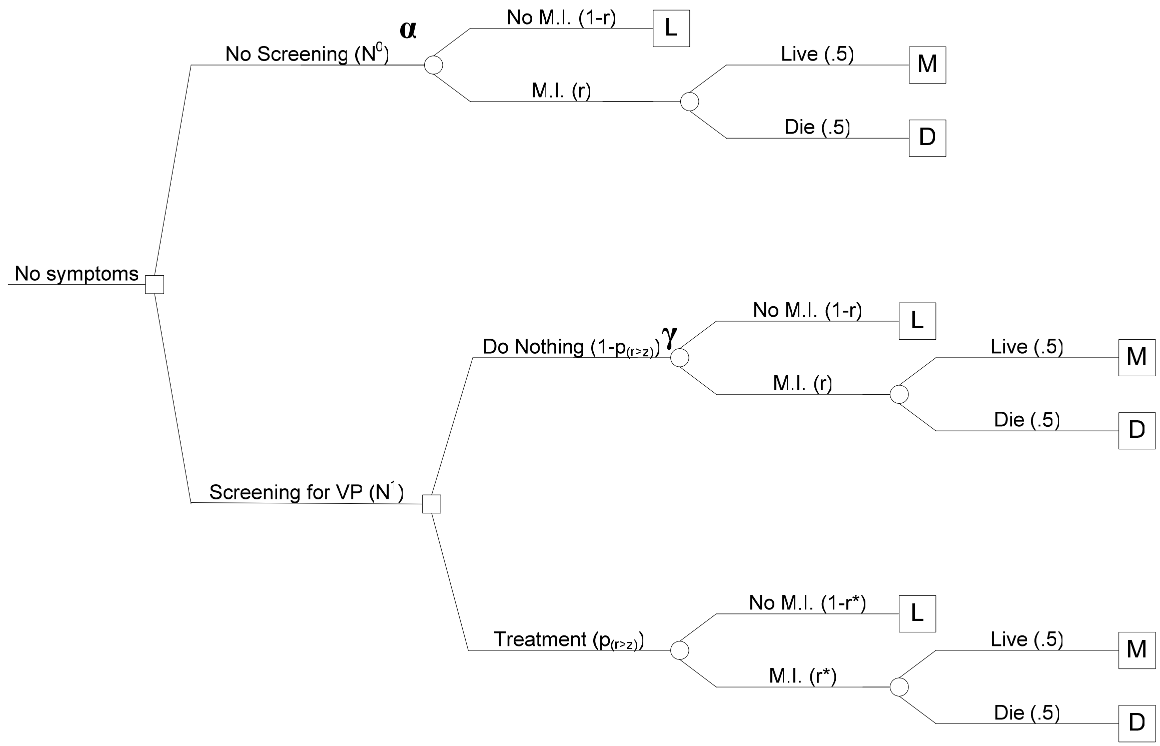


Figure 4-4: Current State for High Risk Individuals: Drug Therapy Treatment

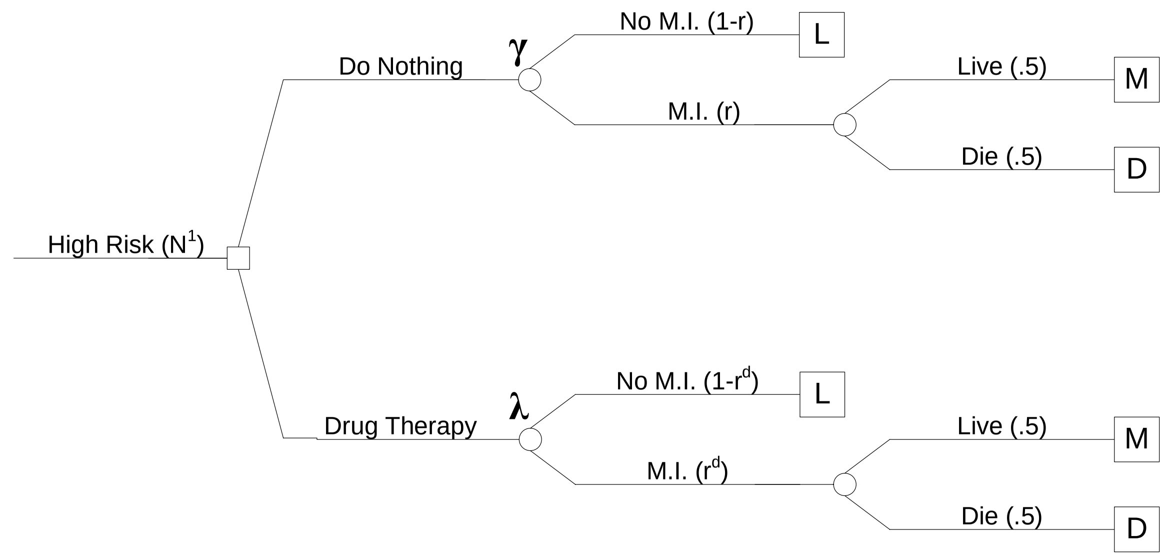
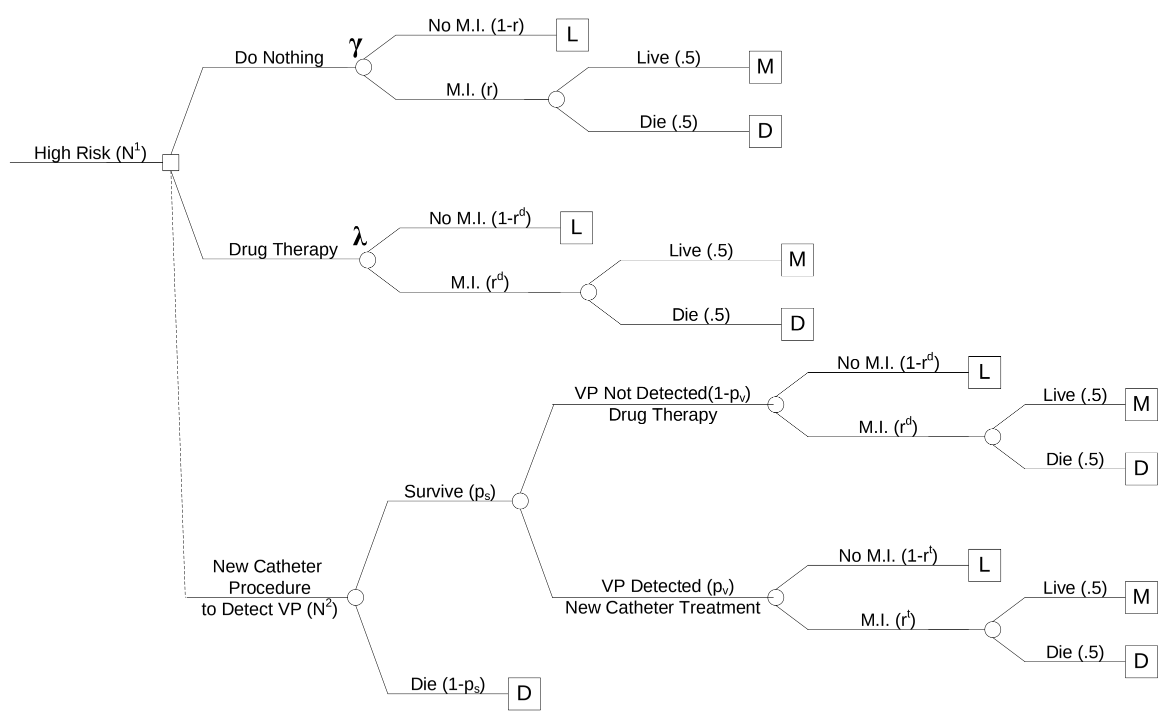


Figure 4-5: Desired State for High Risk Individuals: New Detection / Treatment Procedure



Chapter V: Development of the Web Surveys

The purpose of this chapter is to describe the development of the two web-based survey instruments used in this study. *Survey 1: Screening* was designed to elicit the maximum willingness to pay (WTP) for a screening method that would better identify individuals in the general population who are at risk for a heart attack. The goal of *Survey 2: Treatment* was to determine the value an individual, who is known to be at high risk for a heart attack, places on a procedure that could provide more precise information regarding his/her risk of a heart attack, in addition to providing treatment that could substantially reduce the individual's risk of a future heart attack. Both surveys elicited the respondent's maximum WTP through the use of an iterative bidding process, which utilized the real-time interaction capabilities of a web-based survey.

Web-based surveys are relatively new and provide researchers with several advantages over other survey modes; however, research on web-based survey methodology indicates that there are several issues related to this survey mode that have the potential to affect the quality of the data (Solomon 2001). Therefore, the first half of this chapter explores what is known about web-based surveys - the advantages and potential drawbacks – as well as identifies a set of guidelines for developing an effective and reliable web-based survey. The second half of this chapter explains the development of the individual survey questions included in *Survey 1: Screening* and *Survey 2: Treatment*. In particular, this section focuses on the rationale for including each question, as well as its contribution to the overall purpose of the survey. In addition, explanations as to how the web-based guidelines presented in the first half of this chapter were integrated into the creation of the individual questions (as well as the overall survey format) are included throughout the second half of this chapter in the form of footnotes.

5.1 Emergence of Electronic Surveys

Electronic surveys, which include e-mail and web-based surveys, emerged with the development of e-mail and the Internet. Although the initial use of e-mail surveys dates back to the late 1980's, it was the rapid growth of the Internet during the 1990's that resulted in electronic surveys becoming prevalent (Schonlau et al. 2001). The increased use of e-mail as a means of communication made e-mail surveys attractive to researchers as a way to reach a lot of people in a short amount of time. In addition, electronic surveys (specifically e-mail surveys) can be less expensive to conduct than paper surveys because they eliminate the need for printing, postage, and data entry (Dillman 2000). As a result, the use of e-mail surveys over paper surveys has increased significantly in the past decade.

5.1.1 E-mail Surveys

E-mail surveys are essentially paper surveys delivered via e-mail. The e-mail received by a respondent typically includes a brief introduction to the survey, followed by the actual survey. The respondent may then be instructed to print the survey and mail it back, or if the design allows, fill out the survey electronically and submit it via e-mail (Dillman 2000). Although e-mail surveys have the potentially to reduce the time and cost associated with conducting a survey, e-mail surveys are still limited in much the same way as self-administered paper surveys (Schonlau et al. 2001). In particular, e-mail surveys do not allow for extensive skip patterns (Dillman 2000). As a result, researchers have gravitated toward the use of a more intricate form of electronic survey: web-based surveys (Schonlau et al. 2001).

5.1.2 Web-based Surveys

Web-based surveys are surveys that are administered using the Internet, or world-wide web. Web-based surveys are typically programmed using HTML (Hypertext Markup Language), Java or other web-design computer language, and are accessed by a computer with Internet access using a specific URL (universal resource locator), or "web address" (Dillman 2000, Solomon 2001). Programming a web-based survey in HTML has several advantages including the ability to tailor the survey to each individual based on responses given throughout the survey (Solomon 2001). Web-based surveys also allow answers keyed in by the respondent to be automatically transferred into a database (Solomon 2001), thereby preventing the need for data entry and eliminating the potential for transcription error (Schonlau et al. 2001). In addition, the ability of the Internet to deliver video and audio gives web-based surveys far more versatility than electronic surveys delivered via e-mail (Schonlau et al. 2001). In fact, in Don Dillman's book entitled, *Mail and Internet Surveys,* Dillman asserts that Internet surveys have the potential to revolutionize surveying in much the same way as random sampling techniques did in the 1940's and telephone interviewing did in the 1970's (Dillman 2000). Therefore, due to several distinct advantages, including their greater versatility, web-based surveys have replaced e-mail surveys as the electronic survey of choice (Solomon 2001).

5.2 Potential Drawbacks of Web-based Surveys

5.2.1 Coverage and Self-Selection Bias

By far, the greatest challenge facing the administration of web-based surveys is coverage bias (Solomon 2001, Schonlau et al. 2001). The primary cause of this coverage bias is the lack of computer ownership and access to the Internet among U.S. households (Schonlau et al. 2001). According to a U.S. Census Bureau report, less than 62% of U.S. households owned a computer in 2003[73] (Day, Janus, and Davis 2005). Although this is significantly higher than the 8.2% reported in 1984 (Day, Janus, and Davis 2005), this is far lower than the percentage necessary to generate a reliable random sample of the general population.

It has been argued that although individuals may not own computers, they may have Internet access (and e-mail address) at their place of work. However, the difficulty associated with using e-mail accounts to invite survey participants is that unlike 10-digit telephone numbers, e-mail addresses are not standardized, and it is possible for a single individual to have more than one e-mail address.[74] Therefore, random sampling methods, such as those that have been used for telephone surveys, can not be applied directly to e-mail addresses (Dillman 2000). As a result, web-based surveying often relies on

[73] This is the relevant time period because it is when the web-based surveys used for this study were administered.

[74] It is interesting to note that in the future, phone interviewing will most likely face similar issues. With the emergence of cell phones, some households have chosen to no longer carry (and pay for) a land line, but rather use their cell phone as their "home" number. In addition, it is not uncommon for a single household to include several members who each have their own cell phone. Therefore, 10-digit telephone numbers no longer have a one-to-one correspondence with individual households. In addition, as the use of cell phones increases, generating a sample using only land lines will become less reliable as a means of generating a random sample because it will exclude households who no longer carry land lines, but rather rely solely on a cell phone for their phone service.

recruiting respondents by advertising the survey or posting it where respondents who are interested in the topic may naturally come across it while surfing the web. Because this approach to sampling involves individuals self-selecting into surveys that interest them, these convenience samples do not provide valid data for drawing conclusions regarding the entire population (Pineau and Slotwiner 2003). Although part of this problem could potentially be overcome by mailing the survey invitation (which would then direct the individual to the survey's web address), limited access to the Internet would then become the critical issue. Data analyzed from the Current Population Survey (CPS) indicates that there is a large disparity in computer ownership and Internet access by income, race, and level of education (McConnaughey and Lader 2007). Therefore, this clearly suggests that data obtained using a standard web-based survey approach would not be representative of the general population, but instead would be prone to systematic bias and unreliable results.

One strategy Dillman (2000) suggests for overcoming the coverage bias associated with web-based surveys is to administer the survey using mixed modes. This method acknowledges the existence of coverage bias and attempts to overcome it by collecting additional data from underrepresented groups using an alternative mode of the survey – for example, through a paper or telephone survey. The problem with this strategy is that it introduces the potential for mode effects – that is, inconsistencies in the data arising from obtaining the data using different "modes" or formats of the survey (Dillman 2000).

5.2.2 Minimum Hardware and Software Requirements

Another challenge presented by web-based surveys is that they often require a minimum hardware capacity. In addition, updates in hardware and software occur so rapidly, there is no equipment "standard" on which to base the design of an Internet survey. Thus, web-based surveys may appear differently across respondents due to variations in the size of the monitor being used, the horizontal and vertical configuration of the viewing "window", variations in the operating system (PC versus Macintosh), web browser version, capacity of the hardware, or formatting specifications of the software. These variations (if not caught through extensive pre-testing) can result in the respondent having to scroll to see the entire question, text wrapping to the next line, misalignment of items in tables, or other visual disparities that could inadvertently influence respondents in unknown ways (Dillman 2000).

In addition, Internet connection speeds can vary significantly across users, creating vast differences in the time (from a few seconds to several minutes) it takes an item to appear on the respondent's screen. This is especially true when transmitting larger files such as those that contain audio or video (Schonlau et al. 2001, Dillman 2000) Because there is a tendency for businesses and higher income areas to have better Internet service providers (offering faster Internet connection speeds); variations due to Internet speed can create a systematic disparity across socioeconomic groups (Dillman 2000). As a result, survey designers are encouraged to minimize the size of files and extensively test the entire survey on systems with varying Internet connection speeds (especially those that are slower) to help ensure consistent survey appearance and delivery (Schonlau et al. 2001, Dillman 2000).

5.2.3 Lack of Computer Experience Among Respondents

Another issue for web-based surveys is that it is not uncommon for individuals (especially those who are older) to have limited experience using computers. Even those individuals who have mastered using a word processor or other specific computer application may have difficulty transferring those skills and applying them to the relatively "new" format of an online survey (Dillman 2000). As a result, individuals with limited computer knowledge may have difficulty completing a web-based survey, as compared to the same survey offered in a more familiar paper or telephone format.

To help prevent the introduction of survey error due to lack of computer knowledge, web-based surveys should be designed at a level at which those with limited computer experience would feel comfortable. In addition, the survey should also include any instructions regarding relevant computer functions that are necessary to move through the survey (Dillman 2000). For example, it may be important to inform respondents to click on the button marked "next" when they are ready to move on to the next screen. These basic computer logic functions can be easily overlooked by programmers familiar with computers; however, they are important in keeping response rates high since respondents may abandon a survey if they become confused or unsure of how to continue (Dillman 2000).

5.2.4 Security and Confidentiality

Finally, web-based surveys are prone to security issues because information transferred over the Internet could potentially be viewed by unauthorized individuals. Therefore, administering a web-based survey necessitates utilizing additional security measures, such as encryption, in order to safeguard the confidentiality of the data. In addition, the survey should establish a perceived level of confidentiality for the respondent, such that he/she will feel confident answering the questions honestly (Schonlau et al. 2001, Dillman 2000).

5.3 Advantages of Web-based Surveys

5.3.1 Real Time Interaction

One of the foremost advantages of web-based surveys is that this format allows interaction between the survey and the respondent. Real time interaction allows the computer program generating the survey to tailor the survey questions to the respondent based on his/her prior answers. Therefore, web-based surveys have the advantage of a telephone survey in that they can provide seamless skips based on the respondent's responses, but without the need for extensive human resources to administer the survey (Dillman 2000) and without introducing the possibility of interviewer bias.

5.3.2 Use of Color, Video, and Audio

In addition, web-based surveys can utilize color, audio, and video, which greatly increases the type of information that can be presented. Web-based surveys also have the option of allowing respondents to access pop-up help screens whenever needed. In addition, drop-down boxes for long lists (such as "state of residence") reduce the need for typing and help eliminate data entry error (Dillman 2000).

5.3.3 Shorter Fielding Time & Fewer Human Resources

The nature of the Internet also allows surveys to be administered to geographically diverse populations quickly and easily (Dillman 2000). Therefore, web-based surveys can often be conducted faster than comparable mail surveys (Schonlau et al. 2001) and without the extensive training or manpower required to administer a telephone survey.

5.3.4 Less Expensive "on the Margin"

Finally, the cost of a web-based survey does not increase proportionally with sample size (as is the case with paper and telephone surveys). As a result, "lower costs are often touted as one of the benefits of Internet surveys" (Schonlau et al. 2001, p. 24). Although some e-mail surveys may be administered with a lower overall cost in relation to a comparable paper survey, this is far less likely to be the case with a well-designed web-based survey. Web-based surveys typically have a high initial cost associated with the time required to program and extensively test the survey (Schonlau et al. 2001). However, after the survey is developed and tested, the marginal cost of administering the survey to an additional person is relatively low, if not negligible. This is not to imply that web-based surveys are less expensive overall when compared to a comparable paper survey – in fact, the expense associated with the time and computer resources required to create and extensively test a well-designed web-based survey can far exceed that of a paper survey (Dillman 2000). Therefore, the decision to utilize a web-based survey should stem from the nature of the survey itself, which dictates certain functions that only a web-based survey can provide.

5.4 Decision to Use a Web-based Survey

For this study, the decision to use a web-based survey was driven primarily by the desire to achieve a nationally representative sample utilizing a survey mode that allowed extensive skip patterns and offered real-time interface. The interactive capabilities of the web-based survey meant that an iterative bidding process could be used to obtain each individual's maximum willingness to pay (WTP) for the screening and treatment of vulnerable plaque as a means of better understanding the value individuals place on their health by avoiding a heart attack. Typically, paper surveys have been used to obtain WTP estimates for various goods and services using a dichotomous choice question in which respondents either accept or reject a single bid. Subsequently, econometric techniques such as Cameron's (1988) or Johansson's (1995) parametric approaches or Kriström's (1990) non-parametric approach are then required to derive the mean WTP. This study does not rely on econometric techniques to derive the mean WTP, but rather uses an iterative bidding process to elicit an exact WTP value from each respondent. However, in order for this value to be meaningful from a policy perspective, it was imperative that the sample represent the U.S. population. Therefore, a web-based survey which could be used to administer the iterative bidding process to a national sample was the desired format. As such, an understanding of web survey design was needed in order to create the survey and ensure the reliability of the data collected.

5.5 Guiding Principles for Web Survey Design

The virtually endless possibilities of web-based technology for creating surveys also poses a problem in that it carries with it the vast potential for introducing survey error. Therefore, basic principles have evolved to help govern the design and implementation of web-based surveys. In the chapter entitled "Internet and Interactive Voice Response Surveys" of the book *Mail and Internet Surveys*, Dillman (2000) identifies a comprehensive list of principles intended to guide the design and delivery of web-based surveys. Likewise, Schonlau et al. (2001) includes many of the same ideas in the chapter entitled "Guidelines for Designing and Implementing Internet Surveys" of their online book, *Conducting Research Surveys via E-mail and the Web*. Therefore, the following includes specific guidelines from each of these sources to establish a set of guiding principles that were used to develop the web-based surveys for this study:

- *Introduce the survey with a welcome screen that provides motivation for completing the survey and also include instructions that will direct the respondent to the appropriate web address and to the first question of the survey.* Respondents may be contacted and directed to the web survey either through a mailed invitation or an e-mailed hyperlink; therefore, it is important to make it clear to the respondent that they have arrived at the correct location (Dillman 2000). A simple way to do this is to use a logo that is on both the invitation as well as the welcome screen. The welcome screen will set the tone for the entire survey; therefore, it should motivate the respondent to complete the survey as well as convey that completing the survey will not require extensive or specialized computer knowledge. The final goal of the welcome screen is to move the respondent to the first question of the survey with ease so he/she can begin the survey (Dillman 2000).

- *Utilize a password, personal identification number (pin), or some other means to limit access to the survey to only those invited to respond.* Because web surveys are located on the Internet which can be accessed by anyone who types in the correct web address, it is necessary to limit access to the survey in some manner. Utilizing a password or pin will prevent access to individuals who were not invited to take the survey, as well as prevent invited respondents from completing the survey more than once (Dillman 2000, Schonlau et al. 2001). The password or pin can be included with the survey invitation along with a simple set of instructions informing the respondent on how to use it to access the survey (Dillman 2000). When choosing a password for the survey, it is important to select one that can not easily be guessed. In addition, in typed form, it is very difficult to distinguish the letter “l” from the number “1” or the letter “O” from the number “0”; therefore, it is recommended that these be avoided when creating passwords or pins (Schonlau et al. 2001).

- *Make the first question one that applies to everyone, is easily answered, and is of interest to respondents*. This will convey to the respondent that the survey is on a topic that is of interest to them and that completing it does not require extensive computer knowledge. Therefore, drop-down boxes, scrolling, and other higher level computer functions should be avoided on the first question. In addition, numerous demographic questions should not appear first (Dillman 2000) as they often do in paper surveys – instead, these can be included at the end of the web-based survey.

- *Avoid unconventional formats, instead present questions in a familiar manner (such as those often used on paper surveys).* Web-based surveys should strive to look as much like paper surveys as possible, therefore, it is not advisable to use an unfamiliar format that is likely to confuse the respondent. On a computer screen, individuals tend to start at the upper left hand corner, so this is an ideal location to start a new question (Dillman 2000). This can easily be achieved if each screen only includes one question.

- *Use radio buttons for questions with a relatively small number of answer choices.* Radio buttons are named for the round knobs found on older radios that were used to "tune-in" to a station (Schonlau et al. 2001). Radio buttons appear as circles before each answer choice in a web-based survey and look similar to the "bubbles" that often appear in front of each answer choice on paper surveys. Therefore, radio buttons can give questions on a web-based survey an appearance similar to that of a paper survey, as Dillman (2000) suggests. To select an answer choice using a radio button, all the respondent needs to do is point the cursor at the radio button and "click" the mouse. As such, radio buttons are easy to use and require very little computer knowledge on the part of the respondent. In addition, radio buttons have the added benefit of automatically "deselecting" the respondent's first answer choice if a second answer choice is selected (Schonlau et al. 2001). Therefore, in a self-directed web-based survey (in which an interviewer is not available to answer questions) radio buttons will convey to the respondent that only one answer choice may be selected (Schonlau et al. 2001).

- *Minimize the use of colors.* Color is very easy to add to a survey; therefore, there is a natural tendency to overuse it, and this can lead to potential interference with the survey itself (Dillman 2000). The exact color shown on a monitor is determined by the color palette, which can vary greatly across computers (Schonlau et al. 2001, Dillman 2000). Therefore, web survey programmers should be careful to restrict themselves to a smaller palette to help insure consistency in viewing and also reduce the necessary time it takes to transmit the survey (Dillman 2000). In addition, some combinations of background colors with font colors can make the text difficult to read; therefore, if color is used, it is important to choose colors that have a sufficient amount of contrast (black font on a neutral background, blue font on a bright yellow background). Even red and green, which is a high contrast combination, can cause problems if any of the respondents are color-blind and cannot distinguish red from green. Mistakenly choosing colors that make it difficult for the respondent to read the survey questions can lead to an increased likelihood of non-response or potential survey error. In addition, the use of large blocks of color may inadvertently attract the eye away from what the survey designer intended the respondent to focus on. Similarly, when color is used around word choices of different length, some color bars will appear longer than others, which could possibly influence the respondent's choice. Finally, colors often have meanings associated with them, such as red means "stop" and green means "go." As a result, including color may inadvertently introduce meanings that have no relevance to the survey question being asked, and thereby influence the respondent in unintended ways (Dillman 2000). Appropriate uses of color include intentional "highlighting" to draw the respondent's attention to special elements or directions. Color can also be used (cautiously) to direct respondents to navigational elements that will help them proceed with the survey, assuming that it does not distract the respondent from the survey question (Schonlau et al. 2001, Dillman 2000). Since there is no evidence to support that the use of color enhances response rates, Dillman recommends using color sparingly in web-based surveys in order to help avoid the numerous potential risks associated with it (Dillman 2000).

- *Limit the use of graphics.* Although the web allows a designer to incorporate graphics and video clips with ease, these applications should be used sparingly. Graphics and video require a large amount of information to be transferred and can lead to large variances in the time required to display the survey and result in frustration (and lower response rates), particularly for those using modems or other slower Internet connections (Schonlau et al. 2001). Another potential problem with graphics is that they may unintentionally alter the meaning of a question. Schonlau et al. (2001) present an example from an actual marketing survey in which individuals are asked how many times they have gone shopping within a certain time period. Although the question was intended to inquire about *all* shopping, the picture adjacent to the question shows people shopping in a grocery store. As a result, it is unclear whether respondents are indicating the number of times they have gone shopping at *any* store or have limited their response to include only visits to the grocery store (Schonlau et al. 2001). Therefore, the use of graphics and videos within a web-based survey should be limited and done in such a manner as to not alter the intended meaning of the question.

- *Program the questions as to avoid differences in appearance across different machines.* The display resolution configuration determines the number of pixels that appear horizontally and vertically on the computer monitor. Although there are some configurations that tend to be more common, such as 640 X 800, 800 X 600, and 1024 X 748, there is no definitive standard. Therefore, different settings of the resolution configuration can certainly influence the appearance of a web-based survey. In addition, the actual physical size of the monitor can also affect how the survey is displayed. A survey that appears in its entirety using a larger screen and configuration may require scrolling (either horizontally or vertically) on a smaller screen in order for the respondent to view the entire question with answer choices. Although the proportionality of the survey will tend to stay the same, smaller configurations may also result in wrapping of the text, which can lead to misalignment. This is particularly problematic if it makes the question unclear, or if it leads to the misalignment of headings and their associated choice buttons. To help prevent this from occurring, it is recommended that web survey programmer limit the horizontal width to 600 pixels – this allows even the smallest configurations to present the entire line of text without wrapping, and helps ensure that the survey will be presented consistently regardless of the size or configuration of the monitor. Finally, testing should be done using different types of computers with various configurations in order to ensure the consistency of survey viewing across machines (Dillman 2000).

- *Provide detailed instructions on necessary computer functions required to complete the survey*; however, do not provide extensive instructions at the beginning of the survey as several pages of detailed instruction may make the survey look complicated and deter individuals from proceeding. Instead, Dillman suggests providing specific instructions on necessary computer functions at the time they are needed. For example, instructions on operating a drop-down box may appear in a floating window on the screen in which this type of question first appears. This will provide information on an "as needed" basis, as opposed to testing the respondent's ability to learn and remember several computer functions throughout the survey. Another possible way to accomplish this is include a "help" button on each screen or to provide instructions following the stem of each question using a different font that will easily be recognized by the respondent as instructions rather than an integral part of the survey. Again, these instructions should be clear and limited only to the information needed to perform the necessary computer functions required to answer the specific question being addressed (Dillman 2000).

- *Refrain from overusing drop-down boxes, and always include the direction "click here" in the visual line item of a drop-down box.* This will not only help the respondent identify the presence of a drop-down box, but will also provide clear instructions on how to make the answer choices visible. Drop-down boxes are appealing to web survey programmers because they can hide a lot of information until it is needed. For example, when asking a respondent which state he/she lives in, a drop-down box can be accessed that lists all 50 states (Dillman 2000). Although the advantage of this is clear from a programming perspective, drop-down boxes do have some potential drawbacks that should be addressed. First, if data is collected using both web and paper surveys, the use of drop-down boxes only on the web-based version of the survey can present issues related to mixed modes. If the survey is not being administered using additional modes, then drop-down boxes should still be reserved for questions which have several possible answer choices. Clearly, using radio buttons for yes/no questions is more efficient (and a more logical) choice than using a drop-down box. In addition, Dillman suggests that when using a drop-down box, the visual line item (the one item that is visible even when the drop-down box is not activated) should simply read "click here" and that the first answer choice should then be included on the next line (which is hidden). This suggestion has two positive effects. First, it prevents unnecessary bias because it does not allow the default answer choice to be visible while the other possible choices are hidden; and second, it helps prevent the respondent from unintentionally skipping a question. When a default choice is displayed, respondents are more likely to think they have already responded to that question and because closing a drop-down box may move the cursor unexpectedly on the screen, it can make it easy for the respondent to lose their place in the survey. Therefore, including the words "click here" in the visible line item will clearly indicate which questions still remain to be answered and help the respondent avoid unintentional skips in completing the survey (Dillman 2000).

- *Include a mechanism in the survey design that allows respondents to skip questions.* Although it may seem advantageous that the format of web-based surveys could essentially be used to "force" respondents to answer each question in order to proceed with the survey, this is certainly not advisable. First, designing a web-based survey in this manner could potentially cause problems from a human subject protection prospective if permission for the survey was granted under the proviso of voluntary participation in the survey and on each question. In addition, the respondent may not feel that any of the possible answer choices adequately match their intended response (Dillman 2000). Therefore, from a human subject protection standpoint, it is necessary to program the survey such that the respondent is allowed to skip any question item. In addition, from a research perspective, it may also be advisable to include a choice of "prefer not to answer" or "I don't know" as a possible answer choice, such that unintentional skips can be distinguished from other causes of item non-response.

- *Let the questions dictate the design of the web-based survey.* Web surveys can either be constructed such that each screen includes a single question with a "next" button that will make the next screen (and question) appear, or it can be designed such that the web-based survey looks similar to a paper survey with respondents scrolling to view all the questions. Dillman (2000) recommends following the paper survey format with scrolling, which permits respondents to move back and forth between questions. As such, this format enables respondents to view previous questions when making decisions about subsequent questions, and because this format requires less interaction with the host computer, it minimizes transmission time (Dillman 2000). However, Schonlau et al. (2001) disagree and recommend including only one (or a few) questions per screen in order to prevent excessive scrolling that may give the respondent the impression that the survey is too long; thereby increasing abandonment and lowering response rates. However, both are in agreement that questions which are intended to be considered together, should be grouped; and that when questions are meant to be completed in a specific order, they should appear on their own screen (Dillman 2000, Schonlau et al. 2001). In the latter case, respondents may be reminded of previous information when it is likely to be needed, or the survey can allow the respondent to move back and forth only within a certain section of the survey.

- *Give respondents a sense of where they are in the survey to avoid abandonment close to the end.* In a paper survey, it is easy for respondents to judge how much of the survey remains at any given point; however, the same is not true with web-based surveys. Therefore, it is recommended that the survey include a graphical progress indicator or other mechanism that gives respondents a sense of how much of the survey remains to be completed. The rationale is that by keeping the respondent informed of his/her progress, they are less likely to abandon the survey because they have a sense of how much remains (Schonlau et al. 2001, Dillman 2000). For example, even a simple transitional phrase such as "Finally, please answer a few questions about yourself" will indicate that the survey is near completion and encourage respondents to answer the last few remaining questions (Dillman 2000).

- *Avoid 'check-all-that-apply and other question formats that have not traditionally worked well on paper formats.* Questions that ask the respondent to "check all that apply" have not traditionally worked well in paper surveys; therefore, these types of questions should be avoided in web-based surveys as well. The problem with "check all that apply" questions is that respondents have a tendency to satisfice – that is, simply check boxes until they feel satisfied that they have checked enough boxes to adequately answer the question. Therefore, an alternate to this is often used in telephone surveys in which the respondent is asked a series of yes/no questions. This same approach is recommended for web-based surveys. Each question can be presented separately with answer choices of "yes" and "no" which the respondent can select by clicking on the appropriate radio button. Another question type that can create issues on paper surveys, as well as web-based surveys, is open-ended questions. On paper surveys, open-end questions are typically not well received, with respondents often providing little information or information for which the meaning is unclear. The good news regarding the potential use of open-ended question on web-based surveys is that there is preliminary evidence that respondents may provide more specific responses when using an electronic format when compared to a paper survey (Dillman 2000). Regardless, open-ended questions should still be used sparingly due to the difficulty they pose in reporting and making comparisons across respondents.

- *Overall, keep it simple.* Utilizing a relatively simple web-based survey will increase the probability of a uniform survey being viewed across varying systems (Dillman 2000) and avoid many of the other issues discussed above. As a result, the best programmers of web-based surveys are likely to be those who can create a relatively simple survey that is efficient in size and can be transferred quickly and with a low likelihood of crashing the receiving system (Dillman 2000). Furthermore, simple web-based surveys that load faster have been found to have higher response rates compared to "fancier" versions that require more time to load (Solomon 2001).

5.6 Development of the Survey Instruments

In addition to adhering to the guiding principles on web survey design presenting in the first half of this chapter, developing the survey instruments also required an understanding of the medical process and types of decisions a patient would be asked to make regarding his/her heart-related health. Therefore, information was collected by attending seminars on vulnerable plaque at the Massachusetts General Hospital in Boston as well as having several discussions with researchers and physicians in the field (See Chapter 3: Medical Background). As the medical background suggests, there are two economic questions of interest. First, what are individuals willing to pay for a screening method that will better identify those at risk for a heart attack; and second, how much will those individuals found to be at high risk for a heart attack be willing to pay for a more effective treatment method? To address these questions, two survey instruments were developed: *Survey 1: Screening* and *Survey 2: Treatment* (See Appendix A).

Survey 1: Screening would be administered to adults in the general population. After providing respondents with some new information on the cause and potential risk factors associated with heart attacks, each individual would be asked about his/her maximum WTP for a screening test that would indicate if they were at high or low risk for a heart attack. *Survey 2: Treatment* would be administered to adults with doctor-diagnosed heart problems. These individuals (who are already at high risk of having a heart attack) would be asked to value a procedure that would more precisely determine their risk of a heart attack, as well as provide treatment which could significantly reduce their risk of a future heart attack.

Since the medical decisions respondents would be asked to consider are preventative in nature, both surveys were designed from an *ex ante* perspective. When making the decision to have a blood test designed to identify those at risk for a heart attack or to undergo a procedure to obtain more exact information on that risk, the patient does not know if he/she will eventually experience a heart attack. Therefore, medical decisions involving uncertainty lend themselves to an ex ante approach in which the respondent is asked about his/her willingness to pay *before* the actual risk is known. Even though the sample for the second survey is comprised of those who have doctor diagnosed heart problems (including individuals who have experienced one or more heart attacks), the relevant question is still prevention – prevention of a *future* heart attack that could result in permanent disability or even death.

The following includes a detailed description of the thought process that went into the creation of the questions included in the survey instruments, including how each question (or set of questions) contributed to the overall purpose of the survey (See Appendix A for survey instruments). Once the initial surveys were created, focus groups were conducted to refine them, and then the completed surveys were submitted to Knowledge Networks (KN) for programming (Background information on Knowledge Networks and the reasons why this company was chosen to administer the web-based surveys is presented in Chapter 6: Data Collection).

5.6.1 Initial Question

Following Dillman's advice, both *Survey 1: Screening* and *Survey 2: Treatment* begin with a question that is easy to answer and applicable to everyone taking the survey. The purpose of this question was to generate interest in the survey as well as convey the ease of completing the survey in an online format. With this in mind, the first question (which was the same for both surveys) asked the respondent how important it was for their doctor to include them in decisions regarding their own health. The question included three answer choices: "very important", "somewhat important", "not very important" and respondents indicated their answer by simply clicking on a radio button[75] next to the desired answer choice. Given that 99.8% of the respondents who saw this question completed the entire survey, it appears that this opening question was quite effective in achieving its intended purpose.

5.6.2 Warm Up Questions

A contingent valuation survey typically begins with a series of "warm-up" questions in which the respondent is familiarized with the good or service he/she will be asked to value later in the survey. In *Survey 1: Screening*, the warm-up section includes a

[75] Radio buttons were used almost exclusively throughout the two online surveys. The use of radio buttons allows the web-based survey to closely reflect the format of a paper survey, as Dillman (2000) suggests. In addition, radio buttons do not require the higher level of computer experience needed to correctly use drop-down boxes.

series of questions related to the respondent's experience with heart conditions and treatments, as well as a risk assessment quiz published by the American Heart Association (AHA). This quiz lists several risk factors typically used by physicians to assess a patient's risk of having a heart attack and is designed to remind/inform the respondent of factors that could influence his/her own risk of having a heart attack. In *Survey 2: Treatment* the warm-up section consists of the same "experience" questions used in *Survey 1: Screening*. In addition, it includes a set of questions designed to get the respondent thinking about how having a heart attack could affect his/her ability to work and overall quality of life.

In both *Survey 1: Screening* and *Survey 2: Treatment,* the questions used to obtain information about the individual's experience and/or familiarity with heart disease are questions 2-7. These questions are worded exactly the same in both surveys and include items such as: "Have you ever experienced a heart attack?"; "Have you ever taken medication to reduce your cholesterol?"; "Do you have a relative in your immediate family who has experienced a heart attack?; and if so, "Were you involved in making the decisions regarding the treatment of this family member's heart condition?"[76] The original intent of this series of questions was to identify individuals who were familiar with heart related conditions and possible treatments such that the sample could be split – with more familiar respondents being directed to *Survey 2: Treatment.* However, during a conversation with Dr. Bill McCready, Vice President of Client Development at Knowledge Networks, it was discovered that health data obtained when individuals joined the panel was available and could be used to create two distinct samples – one for each survey. Therefore, it was decided that *Survey 1: Screening* would be administered to a sample representing the general population, and *Survey 2: Treatment* would be administered to individuals with doctor-diagnosed heart conditions. From a survey design standpoint, this method was clearly superior and therefore, was the method chosen for this study. However, even with this change, the familiarity questions still provided

[76] For multi-part questions such as this one, the web-based survey was an excellent survey format in that it allowed skip patterns that were completely unobserved by the respondent. Those who answered "yes" to the first part of the question received the follow-up question; whereas those who answered "no" would simply receive the next question.

information that could provide valuable information in explaining the individual's WTP. Therefore, these questions remained in the opening section of both surveys.

The final question in this series (question #8) asked respondents if they have ever experienced a life threatening condition or illness. Discussion from focus group participants indicated that those who had experienced life threatening conditions or illnesses in the past (not necessarily related to the heart) tended to be willing to pay more for screening and subsequent treatment; therefore, this question was included so it could be used as a possible explanatory variable of an individual's WTP for screening/treatment.

Following this initial set of questions,[77] the two surveys diverged slightly. *Survey 1: Screening* included a risk assessment quiz published by the American Heart Association (AHA). The purpose of this quiz was to provide information to respondents regarding their risk of having a heart attack based on the criteria typically used by a physician to assess a patient's risk of a heart attack. The risk assessment quiz asked respondents to answer "yes", "no" or "don't know"[78] to a series of traditionally accepted risk factors, including: "Are you a man over 45 years old"; "Are you a woman over 55 years old"; "Do you smoke, or live or work with people who smoke every day"; and "Are you 20 pounds or more overweight for your height and build."[79] Because respondents completing *Survey 2: Treatment* had already experienced a heart attack or been diagnosed with a heart problem (and therefore were already aware that they were at high risk of a heart attack), this quiz did not seem pertinent. However, information regarding the effect a heart attack could have on an individual's quality of life was relevant, especially since heart attack outcomes can vary substantially. Therefore, the final segment of the warm-up section for *Survey 2: Treatment* focused on an individual's quality of life following a heart attack.

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[77] In the online version of the surveys, each of the first eight questions appeared one at a time on its own screen. This allowed the font size to stay large and prevented the respondent from having to scroll. Possible answer choices (including "I don't know" for some questions) appeared immediately below the question stem and the answer choices were selected simply by clicking the corresponding radio button.

[78] This is the format recommended by Dillman (2000) because it more closely reflects the method used in telephone surveying and is preferable to the "check-all-that-apply" format which is subject to satisficing.

[79] These questions could certainly be viewed together; however, keeping the font size sufficiently large prevented all the items from appearing on a single screen. Therefore, the questions were grouped with 3-4 items appearing together on a series of three screens.

The quality of life section included two parts – the first section provided information on heart attack outcomes, including the fact that "about half of the people who experience a heart attack die as a result." The text further stated that "for those who do survive, the results can vary substantially – from 'no difference' for some, to others who are left permanently disabled…" Information on chronic symptoms experienced by those who have had a heart attack was presented in a table, such that individuals could assess how having a heart attack may affect their lives. Before moving on, respondents were asked to review the table carefully and told that in a moment they would be asked how having a heart attack could affect their life.[80]

The second part of the quality of life section asked respondents to indicate how a heart attack *would affect* or *has affected* different aspects of their life. The exact wording of the question was tailored to the individual based on his/her response to an earlier question "Have you ever experienced a heart attack?" If the respondent answered "yes" to this question, they were asked to assess the degree to which the heart attack *has affected* their life including their "ability to perform daily functions"; "ability to effectively complete work duties"; "ability to provide for family"; and "overall quality of life." The question was set up as a matrix with radio buttons corresponding to each of the five possible answer choices ranging from "not at all" to "extremely."[81] For the respondents who had not experienced a heart attack, the wording to this question was slightly altered to read "Imagine that you experience a heart attack and survive…" Respondents were asked to reflect on the amount of physical exertion required by their daily lives and work, as well as their ability to handle stress during a typical day. They were then asked to "indicate to what extent each area of your life would be affected by these symptoms" using the same matrix question described above.

Both the risk assessment quiz in *Survey 1: Screening* and the quality of life questions in *Survey 2: Treatment* provided a natural transition into the next section of the survey – the individual's perceived risk of having a heart attack.

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[80] Respondents in the focus group for *Survey 2: Treatment* indicated that this was a very effective question that really got them thinking about the impact a heart attack could have on their quality of life.

[81] Following Dillman's advice on basic survey design (for paper or web-based surveys), all answer choices for questions such as this contained a neutral response and an equal number of positive and negative options, presented in either ascending or descending order (Dillman 2000).

5.6.3 Perceived Risk

It is expected that an individual's WTP for screening and/or treatment of heart attacks would be related to his/her perceived risk of having a heart attack. Therefore, in conducting this study, it was necessary to obtain both an estimate of the individual's perception of risk as well as their change in perceived risk upon receiving the new information on the cause of heart attacks. For paper surveys this has been accomplished using a visual analog scale in which the respondent is asked to place an "X" (or other mark) on a horizontal line that measures 10 cm in length and ranges from "no risk" at one endpoint to "certain risk" at the other. A reference point somewhere in between is often provided to give the respondent an "anchor" on which to base his/her assessment of risk for the proposed situation. Then, the respondent's perceived risk is obtained by measuring the distance from 0 to his/her mark. As such, this method will result in a measure of perceived risk that is continuous between 0 and 10.[82] The advantage of using this method is that once new information is provided, respondents can be asked to assess their risk a second time, such that the change in perceived risk can be calculated and will represent a meaningful quantitative variable.

To emulate this method using the computer, respondents were asked to assess their risk using a computerized version of the visual analog scale. The figure was labeled "Annual Risk of Fatality (Deaths per 100,000 Persons)." The horizontal line started at 0 "no risk" and continued to 100,000 and beyond (as indicated by an arrow). Two anchors were included – 19 (corresponding to the risk of fatality from an auto accident) and 50 (which was labeled "high risk"). Respondents were asked to use the scale as a guide and enter the number that they felt best reflected their risk of having a heart attack within the next year.

The risk of fatality from an auto accident was selected as a reference point for several reasons. First, it was felt that since most respondents would be familiar with driving (and riding in a car), they could relate fairly easily to this level of risk. Also, from a theoretical standpoint, this reference works well because it is a risk that remains fairly constant over time and throughout a person's life (See Table 5-1), unlike the risk of

[82] Measuring out to 1 or 2 decimal places and then multiplying by 10 will result in a continuous measure of perceived risk ranging from 0 to 100, where 0 is "no risk" and 100 is "certain risk"

cancer that tends to increase with age. Table 5-2 includes statistics for actual death rates from a sudden heart attack (acute myocardial infarction) by age group. Table 5-2 clearly shows that the risk of death from a heart attack increases substantially for each age group, particularly for individuals 55 years of age and above.[83] A comparison of Tables 5-1 and 5-2 indicates that for individuals below the age of 45, the risk of dying from a heart attack is lower than the risk of dying in a car accident; however, this relationship is reversed for individuals over the age of 45, such that the risk of dying from a heart attack becomes greater than the risk of dying in a auto accident. Therefore, it is expected that younger people would place their perceived risk of a heart attack below that of a car accident, while an older individual (particularly one who is over 55 and has other risk factors) would be more likely to place their perceived risk of a heart attack above that of a car accident. In fact, discussion from the focus groups indicated that many of the participants followed this logic when selecting their level of perceived risk.

The value of 19 which corresponds to an annual risk of fatality from an auto accident of 19/100,000 was based on the number of fatalities per 100,000 registered vehicles as reported in national fatality statistics published by the U.S. Department of Transportation and the National Highway Traffic Safety Administration for the year 2000.[84] Two other statistics were considered - including the number of fatalities per 100,000 population (15.23) and the number of fatalities per licensed driver (21.94) (U.S. Department of Transportation 2002). The fatality rate for the entire population of 15.23 was significantly lower than the fatality rate of 21.94 for licensed drivers, presumably because a significant portion of the population is comprised of minors. Since this survey was only being administered to adults, it seemed that using the fatality risk per 100,000 population would underestimate the auto fatality risk faced by an *adult*.[85] In addition,

[83] The significant decrease in death rates between 1979 and 1995 for acute myocardial infarction is most likely due to the substantial improvements in the treatment of heart disease that occurred during that time period; however, death rates from heart attack have remained fairly constant in the last decade, therefore, the 1996 values (the year for which data was available) are most likely good estimates of current death rates from heart attack.

[84] This was the most current data available at the time the survey instruments were developed.

[85] Table 5-2 also supports the use of the higher value. As the table indicates, death rates from car accidents are higher for individuals who are elderly - ranging from 18.3 per 100,000 (for individuals 65 -74 years of age) to 30.1 per 100,000 (for individuals 85 years of age and over). Since the samples, particularly the sample for *Survey 2: Treatment* includes a large percentage of elderly individuals, the use of the higher value as the mean fatality risk from auto accidents seems appropriate.

restricting this statistic to licensed drivers seemed too narrow in that many individuals (including the elderly) may be unlicensed but are still placed at risk (and are well aware of that risk) as *passengers* in a vehicle. Therefore, it seemed most appropriate to use 19.27 (fatalities per 100,000 registered vehicles), which was rounded to 19. An added feature of using the number 19 (as opposed to 15) was that respondents would not feel constrained to selecting numbers rounded to the nearest 5, thereby helping to ensure a continuous variable for perceived risk.

After indicating their level of perceived risk of having a heart attack within the next year, respondents were given new information on vulnerable plaque as a cause of heart attacks. The information provided was based on a news segment that aired on the television program 20/20 in January 2001. The purpose of the new information was to make the respondent aware of a potential misconception regarding who is at risk for a heart attack, and to make them aware that those who show no signs or symptoms of heart problems may still be at risk for a fatal heart attack. Focus group participants indicated that the new information section of the survey was clear, concise, and easy to understand.

After reading the new information, respondents were asked again about their level of perceived risk. First, they were asked a qualitative question about the degree to which the new information had changed their level of perceived risk. Then they were asked to quantify their new level of risk a second time using the computerized visual analog scale described earlier. As a result, information could be obtained on the individual's perceived risk before and after receiving the new information, as well as a qualitative and quantitative measure of their change in perceived risk resulting from the new information.

5.6.4 Willingness to Pay

The goal of *Survey 1: Screening* was to estimate the WTP for a simple blood test that would screen for those at risk for a heart attack and the goal of *Survey 2: Treatment* was to estimate the WTP for a treatment method that is more effective than medication, the current standard of care. Therefore, the WTP section of the survey was a key element of the surveys in that it would elicit the individual's maximum WTP for either the screening or the treatment. This was accomplished using an iterative bidding process in which the respondent would receive up to five bids, each of which could be accepted or rejected. The first bid was selected at random, then, subsequent bids were based on the accept/reject pattern of the respondent, utilizing the web's capacity for real-time interaction. Prior to the bidding process, respondents were provided with a framework in which the hypothetical good they were being asked to value was presented. In addition, they were asked questions intended to remind them of their budget constraint. And finally, several steps were taken throughout the WTP section of the survey to help prevent the possibility of hypothetical bias.

In *Survey 1: Screening*, respondents were given a scenario in which their regular physician recommends an additional blood test as part of their routine exam. The physician explains that studies have shown that people with low cholesterol and no other risk factors can still be at risk for a heart attack, and that this additional test would provide better information on the patient's risk of having a heart attack. If the test comes back negative, it will give the patient peace of mind, but if it comes back positive, then further testing could be done to see if treatment is necessary.[86] The respondent is then asked to take a moment to think about what information from this screening would be worth to them.

While the respondent reflects on how much they would value this test, they are presented with information on hypothetical bias. The rationale for including this section is consistent with Cummings and Taylor's (1999) finding that using a "cheap talk" script, in which hypothetical bias is explained directly to respondents being asked to value a good as part of a contingent valuation survey, can reduce the occurrence of hypothetical bias in the data. Therefore, using a script modeled after the original "cheap talk" script used by Cummings and Taylor (1999), respondents were told about hypothetical bias and how it often leads to respondents saying they would pay more for a good or service than they actual would if the purchase decision were real. Following the explanation of hypothetical bias (which included two full screens), respondents were asked if they

[86] This is similar to the type of information that would typically be presented by a doctor at a routine visit (if such a test existed). It is interesting to note that many decisions regarding our health are made "on the spot" and without perfect information. Therefore, it was thought that the information on risk factors and the brief description of the risk due to vulnerable plaque presented in the first part of the survey would be comparable to information that would be provided by a physician in a clinic/hospital setting prior to an individual being asked to make a decision regarding the screening.

understood hypothetical bias, to which they could select either "yes" or "no, I would like further clarification." If the respondent requested further clarification, they were directed to an additional screen that provided more detailed information on hypothetical bias, including an example.[87] After being presented with the additional information, those respondents were once again asked if they understood hypothetical bias.[88]

Following the discussion on hypothetical bias, respondents were asked how much they typically spent each month on medical care. The purpose of this question was to remind respondents of their actual purchase decisions regarding health care. In addition, the wording following this question, which read: "Based on what I am already spending for medical care, how much do I have *available* to spend on this test" was also designed to remind respondents of their budget constraint before proceeding to the WTP section of the survey.

As stated earlier, an iterative bidding process was used to elicit the respondent's maximum WTP for the screening (treatment). Each respondent received up to five possible bids using the following question format: "If this blood test (procedure) costs $____, would you choose to have it done?" The question was framed in this manner to reflect an actual purchase decision in which the consumer is offered a good or service at a given price, which he/she can choose to accept or not. To avoid starting point bias, one of five possible starting bids was selected at random by the computer.[89] If the respondent answered "yes" to the question, the bid was doubled. If the respondent answered "no" then the bid was reduced by half. Once the respondent's answers established a relevant range of possible WTP values, subsequent bids were derived by dividing the remaining range in half. For example, if the first bid is $40 to which the respondent answers "no" the bid will decrease to $20. If the respondent answers "yes" to $20, then the computer will split the difference between the upper and lower values, and generate $30 as the next bid.

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[87] Only 12 out of 268 respondents (4.5%) for *Survey 1: Screening* and 28 out of 295 respondents (9.5%) for *Survey 2: Treatment* requested additional information and viewed the more detailed explanation of hypothetical bias.

[88] A total of 5 out of 268 respondents (1.9%) for *Survey 1: Screening* and 6 out of 295 respondents (2.0%) for *Survey 2: Treatment* answered "no" to both hypothetical bias questions – more specific information on how these observations influence the overall results of this study is included in Chapter 6: Data Collection.

[89] The starting bids for *Survey 1: Screening* were $10, $40, $50, $60, and $100. The starting bids for *Survey 2: Treatment* were $1,000, $2,000, $5,000, $8,000, and $10,000.

The iterative bidding process continues until either (1) the respondent's answers converge and result in a maximum WTP (to within a specified margin of error)[90] or (2) the respondent receives a maximum of five bids.[91] For example, if the bidding sequence described above continues such that the respondent answers "no" to $30, then a fourth bid of $25 would be generated. If the respondent answers "yes" to $25, then the bidding process would end and the individual's maximum WTP would be recorded as $25 (after 4 bids). The use of this algorithm allowed the bids to cover a large range of values if necessary,[92] while at the same time enabling the program to quickly narrow the range to converge on the respondent's maximum WTP.

If, after a series of five bids, the respondent's WTP could not be determined, then the respondent was reminded of the range of WTP values obtained through the bidding process and then asked to state the maximum amount they would be willing to spend to have the test.[93] For example, if the respondent was given an initial bid of $40 and they chose "yes" the following bid would be $80. If the respondent answered "yes" again, the third bid would be $160. A "no" response to $160 would then yield a fourth bid of $120. Another "no" response would result in a fifth (and final) bid of $100. During the bidding process, the computer was programmed to keep track of the respondent's highest "yes" bid and lowest "no" bid. Therefore, if the respondent said "no" to $100, the computer would recognize that the respondent was willing to pay at least $80, but not $100 or more. The bidding process would conclude (since the maximum of five bids had been reached) and the respondent would receive the following reminder and question:

You indicated that you would pay at least $80 {computer will insert highest "yes" bid}, but less than $100 {computer will insert lowest "no" bid}.

What is the most you would be willing to spend *out of pocket* for this test to find out if you are at increased risk for a heart attack?

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[90] The margin of error was $5 for *Survey 1: Screening* and $100 for *Survey 2: Treatment.*

[91] The iterative bidding process terminated after a maximum of five bids in order to prevent the survey from appearing too redundant and prevent respondents from abandoning the survey.

[92] If the respondent received a starting bid of $40 for *Survey 1: Screening* and continued to answer "yes" to each subsequent bid, their fifth (and final) bid would be $640. The lowest start bid was $10 and the highest was $100, which yields a possible bid range of $0 to $1600 across respondents.

[93] A similar version of this question was used for individuals who answered "yes" to every bid.

Enter dollar amount here [_________]

Immediately following the bidding process, the respondent is asked to state how certain they are that they would actually pay this amount. Respondents use a scale of 0 ("not sure at all") to 10 ("definitely sure") to indicate how certain they are that they would *really* pay this amount out of pocket for the test. After stating their degree of certainty, the respondent is reminded of their previously stated WTP amount and given the opportunity to revise it if they so chose.[94] The survey reads: "Earlier you said that you would pay $____{computer will insert previously stated WTP amount} for this test. Now that you have had a chance to consider how sure you are about this decision, please enter the amount you would *definitely* (beyond any doubt) pay for this test."

During a focus group, one participant remarked that the number of times an individual expected to get the test may affect how much they were willing to pay for it. If the respondent expected this was an annual test (as suggested in the survey), he/she may be willing to pay less for it than if they felt it was something they would only need to purchase once in their lifetime. Therefore, the final question in this section asked respondents how many times they expected to get this test over the course of their lifetime.

For *Survey 2: Treatment*, the WTP section followed a format very similar to that of *Survey 1: Screening*; however, there were a few differences. In *Survey 2: Treatment*, the wording of the initial scenario was modified to support a more immediate need for potential treatment. Again, respondents for this survey are individuals with doctor-diagnosed heart problems. Therefore, in *Survey 2: Treatment*, the section describing the good began with: "Suppose you begin to experience chest pain. You immediately go see your regular doctor..." The respondent is then informed by the doctor that his/her tests indicate that he/she is at <u>high risk</u> for a heart attack and two possible treatment options are presented. The physician explains that the standard treatment for patients with this

[94] Respondents did not feel compelled to revise their WTP due to the inclusion of the certainty question. In fact, 131 out of 268 individuals (48.9%) sampled for *Survey 1: Screening* did not choose to revise their maximum WTP amount following the certainty question. A relatively large percentage (32.8%) of these individuals reported a 10 on the certainty scale, indicating that they were "definitely sure" of their initial WTP value. For *Survey 2: Treatment*, 109 out of 295 individuals (36.9%) sampled did not choose to revise their maximum WTP following the certainty question, and 33 of those 109 respondents (11.2%) reported a 10 on the certainty scale, indicating that they were "definitely sure" of their initially stated WTP.

condition is to prescribe a cholesterol-lowering medication; however this treatment is only 30% effective. Therefore, the physician recommends a new treatment option that involves a minimally invasive procedure. The physician explains that the procedure *in addition* to medication will reduce the risk of heart attack by 85%. The physician further explains that the procedure does have a small risk of death associated it – about 10 out of 100,000 people who have the procedure die from complications. To make this risk level less abstract for the respondent and to relate it back to the perceived risk scale presented earlier in the survey, the doctor qualifies this risk by stating the following: "To put this in perspective, your risk of dying in a car accident each year is about twice this high or 19 out of 100,000." The respondent is then told that another trusted physician was consulted for a second opinion and both doctors agree that the new procedure (with medication) is the recommended treatment. The respondent is shown a table clearly illustrating the two treatment options, including the effectiveness of each treatment as well as the additional risk of death associated with the procedure. Respondents are then asked to indicate which treatment option they would choose based on the risk and effectiveness of each option. Their choices include: "Procedure and Medication", "Medication Only", "Not sure, I would like more information before deciding."

The option for additional information was included in response to comments made by focus group participants who completed *Survey 2: Treatment*. It is expected that individuals will spend more time considering the implications of undergoing a more invasive procedure before consenting (compared to time and consideration given before consenting to a simple blood test such as the one presented in *Survey 1: Screening*). Therefore, it was very encouraging when focus group participants made comments clearly indicating that prior to making their decision to undergo the procedure they had considered things such as: the opportunity cost associated with recovery time, if they could afford to take time away from work, and possible arrangements for childcare while they are hospitalized. These comments demonstrated that the focus group participants were taking the hypothetical situation presented in the survey seriously and basing their decision on actual limiting factors (and resources) for their household.

Because these factors were clearly important considerations for many individuals when faced with this treatment decision, respondents were given an option of requesting additional information before making a treatment choice. By selecting "Not sure, I would like more information before deciding" the respondent was directed to an additional screen in which the doctor who would be performing the procedure provides more specific information on what the procedure entails, including the use of a sedative; a description of how the procedure is performed; the expected level of discomfort that can be expected during the procedure; the projected length of stay in the hospital; expected recovery time; and anticipated time away from work.[95]

Following this additional information regarding the procedure, respondents were once again asked to make a treatment choice. Those who selected "Medication Only" received an open-ended question asking why they chose not to have the procedure.[96] Respondents who chose "Procedure and Medication" were presented with information on hypothetical bias described earlier and reminded of their budget constraint by asking the same question regarding monthly medical expenditures used in *Survey 1: Screening*. However, because the treatment method described in *Survey 2: Treatment* could significantly reduce the individual's risk of having a heart attack (whereas the screening test described in *Survey 1: Screening* only provides information on that risk), it is expected that the individual would place a much more substantial value on the treatment. Therefore, respondents for *Survey 2: Treatment* were also asked about the amount of money they currently had available in savings. Although the answer choices to the savings question included broad ranges in order to minimize refusals, it was anticipated that some respondents would chose not to provide an answer to this relatively personal question.[97] However, regardless of whether the respondent answers the question or not, the mere presence of the savings question immediately prior to the bidding still serves the purpose of reminding respondents of their available financial resources when making decisions regarding their WTP for the treatment.[98]

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[95] The content of the information provided was based on questions asked by focus group participants. However, it was presented to respondents in a manner designed to closely reflect the way it would be presented to a patient prior to making this type of decision in an actual clinic/hospital setting.

[96] Additionally, respondents who answered "no" to a zero bid (during the iterative bidding process) were also directed to an open-ended question which asked the respondent to please explain why they chose not to have the procedure even when it was offered for free.

[97] 27 out of 295 respondents (9.2%) refused the question asking about the amount they currently have in savings.

[98] After completing the extensive willingness to pay section of the survey, it would be natural for respondents to want to stop taking the survey. Therefore, in order to prevent respondents from abandoning

5.6.5 Demographic Questions/ End of the Survey

The final section of the survey consisted of demographic questions. Since Knowledge Networks already had a great deal of demographic information on each of its panel members (including age, race, marital status, education, etc.) it was not necessary to ask those questions again. Therefore, this section included only four questions related to: general health status, life insurance, existence of dependents (such as a child or elderly parent) that did not reside at the same address, and level of financial security of the respondent's family if he/she were to die suddenly.

Survey 1: Screening concluded by thanking the individuals and making them aware that the November 22, 2002 issue of *U.S. News and World Report* describes a blood test that some researchers now believe could provide additional information on who is at risk for a heart attack. In *Survey 2: Treatment* respondents were also thanked and reminded that the proposed treatment they were asked about was hypothetical, but that clinical research is currently being done such that this type of procedure could become available in the near future.

5.7 Addressing Hypothetical Bias

As discussed in Chapter 2 (Literature Review), one of the main criticisms of contingent valuation studies is the occurrence of hypothetical bias. Therefore, because the goods being valued in *Survey 1: Screening* and *Survey 2: Treatment* do not represent actual purchase decisions, several methods were employed in the survey to help prevent the possibility of hypothetical bias from occurring.

The first method was the use of an abbreviated "cheap talk" script modeled after the one used by Cummings and Taylor (1999). Focus group participants reported that they understood the concept of hypothetical bias from the information provided in the survey. In addition, specific comments made by focus group participants while discussing how each individual had arrived at their WTP revealed that several

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the survey so close to the end, the following verbal cue (consistent with Dillman's advice) was given to indicate that the survey was near the end: "To complete this survey, please answer a few questions about your background…"

participants had taken hypothetical bias into account either directly or indirectly when determining their maximum WTP for the screening/procedure.

A second means of preventing the existence of hypothetical bias was to remind respondents of their budget constraint. This was achieved in *Survey 1: Screening* by asking respondents how much they spend on medical care each month. In addition, respondents for *Survey 2: Treatment* were asked about the amount they had available in savings. After answering these questions, respondents were then asked to consider how much they have available to spend and if they would really choose to spend their money in this way (a reminder of the tendency for hypothetical bias to enter into the response). Individuals participating in the focus groups seemed to take these prompts seriously and again, based on their comments during the discussion, took several moments during the course of the survey to reflect on their decisions and really evaluate the benefits and costs associated with them.

Another method used to eliminate hypothetical bias included the use of a certainty scale. Following the iterative bidding process and determination of the individual's initial WTP, each respondent was asked to assess their degree of certainty using a scale of 0 to 10 (with 0 being "not sure at all" and 10 being "definitely sure") that they would really be willing to pay this amount out of pocket. This type of certainty scale was first used by Champ et al. (1997) in comparing hypothetical dichotomous choice questions about donations to a public good with actual donations to the public good. After indicating their degree of certainty, respondents were given an opportunity to enter a revised amount of what they "would *definitely* pay" for this test/procedure.

In the original survey given to focus group participants, a second certainty question was included after the respondent stated their final WTP. However, this certainty question was formatted as a fixed-choice which more closely reflected an actual purchase decision. Respondents were asked "Would you have the screening (procedure) if it were offered to you at a price of $_____ {computer would insert respondent's stated WTP amount}?" Answer choices included the following: definitely yes, probably yes, not sure, probably no, definitely no. The motivation for including this question was that Blumenschein et al. (forthcoming 2007) conducted a field experiment offering a diabetes management program delivered by a pharmacist, and found that individuals who were "definitely sure" of their response in a contingent valuation exhibited no hypothetical bias compared to similar individuals who made real purchase decisions about the program (For a detailed discussion of the effect these methods had on the data collected for this study, see Chapter 6: Data Collection).

5.8 Conclusions

This chapter highlights several guidelines that were instrumental in developing the two web-based surveys used for this study: *Survey 1: Screening* and *Survey 2: Treatment*. In addition, this chapter provides a detailed explanation on how each survey question was developed and discusses the motivation for including each question in the survey instrument. By giving careful attention to the recommendations governing web-survey design, the surveys created for this study served as a valuable and reliable tool in the data collection process.

In addition to providing a set of guidelines for developing a web-based survey and explaining the process by which the two surveys used for this study were developed, this chapter also offers a practical understanding of the extensive computer resources and expertise that is required to program and administer a reliable web-based survey. As Dillman (2000) points out, it is not necessary (or even desirable) to have a programmer who creates a survey that utilizes the most cutting edge technology, but rather it is far more important that the programmer understand how differences in hardware and software capabilities can affect the consistency of viewing, such that the web-based survey can be designed with this in mind. This type of understanding requires expertise as well as extensive computer resources in order to adequately test the survey and feel confident that visual aspects of viewing the survey will not affect the data collection process. As such, this chapter provides support for the decision to outsource the programming and fielding of the survey instruments used for this study.

Knowledge Networks, the organization chosen to program, test, and administer the surveys for this study, specializes in the design and administration of web-based surveys. As such, they clearly demonstrated their extensive knowledge of web-based programming and understanding of the principles presented in this chapter throughout the programming process. In addition, outsourcing the fielding of the surveys addressed the remaining issue of coverage bias. Utilizing their nationally representative panel, Knowledge Networks offers a unique (and highly marketable) sampling method designed to overcome the coverage bias typically associated with web-based surveys. Background information on Knowledge Networks as well as detailed description of their recruiting and survey administration process is included in the following chapter.

Table 5-1: Death Rates (per 100,000 individuals) from Motor Vehicle Accidents

Year	Under 1 year	1-4 years	5-14 years	15-24 years	25-34 years	35-44 years	45-54 years	55-64 years	65-74 years	75-84 years	85 years and over	mean - age adjusted
1996	5.7	5.3	5.2	29.2	19.1	15.6	14.1	15	18.3	28.3	30.1	16.2
1995	4.7	5.2	5.4	29.5	19.8	15.4	13.9	14.6	17.6	28.6	31.4	16.3
1979	6.5	9.8	8.3	45.6	28.8	21	18.6	18.2	20.7	28.7	24.4	23.2

Source: The Disaster Center

Table 5-2: Death Rates (per 100,000 individuals) from Acute Myocardial Infarction

Year	Under 1 year	1-4 years	5-14 years	15-24 years	25-34 years	35-44 years	45-54 years	55-64 years	65-74 years	75-84 years	85 years and over	mean - age adjusted
1996	*	*	*	0.2	1.4	8.4	36.9	111.4	262.1	608.0	1465.1	42.0
1995	*	*	*	0.2	1.4	8.9	38.5	115.8	274.9	634.5	1517.6	43.8
1979	*	*	*	0.2	2.4	21.1	94.6	258.9	577.2	1135.2	1916.3	88.2

Source: The Disaster Center

Chapter VI: Data Collection

The purpose of this chapter is to describe the data collection process used for this study, as well as provide an overview of the type and source of data collected. In addition, this chapter includes a discussion of the study design; sampling methodology; the three versions for *Survey 1: Screening*; pre-testing of the survey instruments; and background information on Knowledge Networks, the company that was chosen to administer the web-based surveys. Response rates and the effects of the methods incorporated into the surveys to prevent hypothetical bias are also discussed.

As stated in Chapter 1, the objective of this research is to estimate demand curves for (1) a new screening method that would better identify those at risk for a heart attack and (2) a new minimally-invasive procedure for the detection and treatment of vulnerable plaque. Willingness to pay (WTP) estimates for each of these "goods" will provide insight into the value individuals place on health, specifically the value they place on avoiding a heart attack. In addition, a better understanding of the marginal effects of factors that influence demand for these services will allow society to make more efficient decisions in the delivery of our scarce health care resources.

6.1 Study Design and Sampling Methodology

This cross-sectional study utilized two contingent valuation surveys in order to better understand the WTP for information on heart attack risk and the WTP to reduce that risk. *Survey 1: Screening* was given to a national random sample of adults in the general population. These respondents were asked to value a blood test that would provide them with additional information on their risk of having a future heart attack. *Survey 2: Treatment* was administered to adults with previously diagnosed heart problems. These respondents, who are more familiar with heart related issues, were asked to value a procedure that would provide more precise information on their risk of heart attack than could be obtained from the screening alone. In addition, the procedure they were being asked to value would also allow for the treatment of vulnerable plaque if it was detected, thus reducing their potential risk of a future heart attack.

In both *Survey 1: Screening* and *Survey 2: Treatment*, the respondent's WTP was elicited through an online survey utilizing an iterative bidding process. The iterative bidding process, which allowed subsequent bids to be based on past responses, was similar to that generated by an interactive computer program used by Viscusi, Magat, and Huber (1991). In the Viscusi, Magat, and Huber study, they obtained a nationally representative sample by recruiting volunteers in a mall whose visitors were known to have demographics that closely reflected those of the U.S. population. Like their study, one of the goals of this study was to also achieve a nationally representative sample, but through the use on an online survey. Online surveys, however, have the inherent problem of being prone to bias due to the uneven access of computers and the Internet across socioeconomic groups. Therefore, to overcome the potential for coverage bias and achieve a nationally representative sample, Knowledge Networks was selected to administer the online surveys.

6.2 Knowledge Networks

6.2.1 Background on Knowledge Networks and its Founders

Knowledge Networks (KN) was founded as a private company in 1998 by two Stanford University professors and has established itself as a reputable and reliable resource for researchers conducting online surveys. Knowledge Networks and the company's co-founders, Norman Nie and Douglas Rivers, have received recognition from national organizations, including the American Association of Public Opinion Research (AAPOR) who awarded them the 2001 Innovators Award for "their development of a probability sampling method for Internet based surveys in the United States" (McPhee 2001). In addition, the founders of Knowledge Networks have each served for several years in well respected positions in academia, and prior to establishing KN, "had already made significant contributions in the development of quantitative tools to facilitate social science research" (McPhee 2001).

Norman Nie, the current Chairman of Knowledge Networks, received his Ph.D. from Stanford University. Prior to that position, he was a professor of Political Science at the University of Chicago and a Senior Study Director at the National Opinion Research Center for more than 25 years. He founded SPSS, which has become prominent among statistical software used in research and business applications. In addition, Nie has served as chairman of SPSS and as Director of the Stanford Institute for Quantitative Studies in the Social Sciences. His co-founder, Douglas Rivers, has equally impressive credentials. Rivers received his Ph.D. from Harvard University and holds the position of Professor at Stanford University and Senior Fellow at the Hoover Institute. Rivers currently serves as the CEO of Knowledge Networks and is considered "a leading authority on the application of statistical methods to social science" (McPhee 2001).

6.2.2. Why Knowledge Networks?

Knowledge Networks and its founders have established well respected reputations in statistically based research methods. Although this was certainly an important consideration, the main determinant in selecting KN to administer the web-based surveys was the fact that KN has established a panel of randomly selected households; thereby allowing researchers to obtain a national random sample through an online survey. Previously, data collected through web based surveys were prone to selection bias, which made data collected in this manner subject to credibility issues. However, Knowledge Networks has overcome this potential shortfall by offering Internet access to all of the households that participate on its panel.

6.2.3. How is KN's Panel Selected?

In creating its panel, Knowledge Networks uses random digit dialing to obtain a sample of phone numbers. Addresses corresponding to those phone numbers are then located using a reverse directory, and a letter is mailed to those households. These letters of introduction are followed a few days later by a phone call inviting members of the household to participate on the panel. In return for completing no more than one survey per week, panel members receive free Internet access. If a household does not have a computer, KN provides WebTV equipment at no charge. Therefore, this reduces the possibility of selection bias as any U.S. household with a telephone has the potential to be invited and to participate in Knowledge Network's panel.

6.2.4 How are KN's Surveys Administered?

Once a household chooses to participate, each panel member receives a password protected e-mail account and is asked to respond to no more than one survey per week (household members between the ages of 13 and 18 can become members of the panel with the written permission of their parents; however, no panel member under the age of 18 was contacted for this study). Surveys for which that panel member has been chosen will appear in their mailbox. Participation in the Knowledge Network panel and in any individual survey is completely voluntary; therefore, if a panel member chooses not to participate in a survey, they will simply receive another one.

Prior to viewing a survey, panel members are asked to provide their informed consent. In return for their consent, KN agrees to uphold their previously agreed upon policy of privacy and terms of use for the information provided. This includes protecting the panel member's identity so that it cannot be linked to the information provided in the survey. Since panel members can easily withdraw their participation from any survey or from the entire panel at any time, it is of interest as to whether there has been an effect as a result of individuals leaving the panel over time. A study by Josh Clinton examined the effects of attrition on the KN panel. According to his study, he found "no evidence of systematic panel attrition among any population subgroup" (McPhee 2001). His results also suggest that individuals who participate on the panel for an extended period of time are not systematically different in terms of attitude and behavior from those who have just joined the panel (McPhee 2001).

6.2.5 Commitment to Research Involving Human Subjects

Knowledge Networks has worked with researchers from leading universities across the United States, and is therefore familiar with the standards governing research involving human subjects. In fact, over the years, KN's has made modifications to their materials in response to requests from Internal Review Boards from certain universities. This compliance with past IRB requests, along with KN's desire to maintain their reputation and profitability, provided assurance that Knowledge Networks would continue to demonstrate a high level of care in regards to protecting the rights of the individuals being asked to participate in this survey. An application for this study was submitted to the University of Kentucky Internal Review Board (IRB), and approval was granted in January, 2003. Upon receiving approval, Knowledge Networks was contracted to begin programming the online surveys.

6.3 Survey Instruments – Versions of *Survey 1: Screening*

As stated earlier, both web-based surveys utilized an iterative bidding process to elicit the respondent's WTP.[99] In *Survey 1: Screening*, respondents were first given warm-up questions, including a heart attack risk assessment quiz published by the American Heart Association. After reflected on these risk factors, respondents were asked to indicate their perceived risk of having a heart attack in the next year using a visual analog scale that started at 0 (no risk) and went to infinity (100,000 and beyond). Two benchmarks were included: 19, a measure of the annual risk of fatality from a car accident (19/100,000)[100], and 50, which was labeled "high risk".

After indicating their initial perceived level of risk, respondents were provided with new information on who is at risk for a heart attack, including a description of vulnerable plaque and the role it plays in causing heart attacks. Following the new information, respondents were asked to again assess their perceived risk, this time taking into account the new information. Respondents were then told of the new blood test that could provide them with additional information regarding their risk of heart attack.

In order to better understand how treatment effectiveness would affect the WTP for screening, there were three (3) versions of *Survey 1: Screening.* The majority of the respondents who completed *Survey 1: Screening* received a survey in which the treatment effectiveness was either 30% (corresponding to the existing drug therapy) or 85% (the effectiveness assigned to the new procedure). In addition, a small number of respondents received a version of the survey in which "no treatment" was available. The purpose of this survey "arm" was to determine how much individuals would pay for the screening if it *only* offered informational value. Even with no treatment available, the information

[99] An advantage of iterative bidding is that more information about a respondent's WTP is obtained compared to other elicitation formats such as dichotomous choice in which only an upper or lower bound on WTP is obtained. The additional information may come at the cost of incentive incompatibility in any format that elicits WTP responses beyond the first dichotomous choice question. For further discussion, see Alberini, Kanninen, and Carson (1997), Whitehead (2002), and Watson and Ryan (2007).

[100] From the *2000 Traffic Safety Facts* published by the U.S. Department of Transportation and the National Highway Traffic Safety Administration.

received from the screening could potentially allow individuals to plan their consumption and savings activities better.

The contract with Knowledge Networks included a total of 500 observations to be obtained from the two web-based surveys. Although it is not possible for Knowledge Networks to determine in advance the exact number of individuals who will respond to each survey, past response rates give them a good indication of the number of individuals that need to be invited in order to achieve a specific number of respondents. Therefore, in determining how the 500 observations would be divided between the two surveys, it was planned that 270 observations would be obtained from *Survey 1: Screening*, while the remaining 230 would come from *Survey 2: Treatment*. An additional 40 observations were devoted to *Survey 1: Screening* in order to create the "no treatment" arm discussed above (See Figure 6-1: Planned Sampling Distribution).

To elicit the WTP for screening, each respondent received an initial dollar amount to which they could respond "yes" or "no". To avoid starting point bias, the computer was programmed to select one of several starting points for each survey.[101] Based on the respondent's answers, the computer would provide up to four (4) additional bids. If the bidding process did not sufficiently narrow the WTP value to within a specified margin of error ($5 for the screening and $100 for the treatment), respondents were reminded of the range they had selected through their bids and then asked to enter "the most you would be willing to spend *out of pocket* for this test."

Survey 2: Treatment followed the same format as *Survey 1: Screening* with two main modifications. Because the panel members invited to take *Survey 2: Treatment* were limited to individuals with doctor-diagnosed heart problems, it was reasonable to assume that these individuals were already familiar with the risk factors associated with coronary heart disease. In fact, 110 individuals in the sample (37%) had already experienced a heart attack. Therefore, the first difference between the surveys is that instead of using the risk assessment quiz included in *Survey 1: Screening*, the warm-up

[101] Starting points for each survey were based on the median and range of WTP values obtained from the initial focus groups. Starting points for *Survey 1: Screening* were $10, $40, $50, $60, and $100. Starting points for *Survey 2: Treatment* were $1,000, $2,000, $5,000, $8,000, $10,000. One of these 5 starting points, corresponding to the appropriate survey, was randomly selected by the computer program for each respondent.

questions for *Survey 2: Treatment* included questions regarding the impact a heart attack could have or has had on the respondent's ability to work, perform daily functions, and on their overall quality of life.

The second significant difference between the surveys is that in *Survey 2: Treatment*, respondents had the option to choose their preferred treatment method. Therefore, prior to eliciting their WTP for the procedure, respondents were given the opportunity to select whether the procedure was indeed their preferred method of treatment. After being asked to consider a hypothetical situation in which they were told by their regular physician (and another trusted physician) that their initial tests indicated they were at high risk for a heart attack, respondents were asked to make a treatment choice. They could either select "Medication only" which is 30% effective or the "Procedure and Medication" which was stated as being 85% effective. Although the "Procedure and Medication" option did offer a higher level of effectiveness, the survey also stated that it had an *additional* risk of death equal to 10/100,000.[102] Respondents who chose "Medication only" as their preferred treatment option were given an open-ended question asking why they chose not to have the procedure, while those who selected the procedure completed the bidding process to determine their maximum WTP.

6.4 Pre-Testing

A total of four focus groups were conducted prior to administering the online survey. Two focus groups (one for *Survey 1: Screening* and one for *Survey 2: Treatment*) were conducted in November 2002 using paper versions of the surveys. Two additional focus groups (one for each survey) were conducted in March 2003 using the online surveys programmed by Knowledge Networks. All of the focus groups were conducted following the guiding principles set out in Richard Kruger's book entitled *Focus Groups*.

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[102] Drug therapy does have a risk of death; however, patients who undergo the type of procedure described in this survey would have already been diagnosed as being at high risk for a heart attack and therefore would most likely already be taking a cholesterol lowering medication. Since both treatment options included drug therapy (and the associated risks), the survey focused only on the marginal increase in risk of death associated with the procedure when presenting the treatment options. The additional 10/100,000 (1/10,000) risk of death associated with the procedure stems primarily from the risk of death due to infection resulting from the minimally invasive procedure and from other complications that could arise from the anesthesia used in performing this procedure.

Prior to conducting the focus groups, the survey was also given to four individuals (2 males and 2 females, ages 48-61) as an initial pre-test in November 2002. The most significant finding from this pre-test was that the "cheap talk" dialog, which closely followed the original cheap talk script proposed by Cummings and Taylor (1999), was too lengthy for a web-based survey. All of the pre-test participants indicated that they wanted to abandon the survey during this section. Following a suggestion made by one of the participants, this section was significantly reduced in length. However, due to a concern that shortening the cheap talk script would diminish its effectiveness, an optional screen that provided more detailed information on hypothetical bias was added to the online survey.

In the final version of each survey, respondents were asked if they understood hypothetical bias after reading the shortened explanation. Those who responded "no" were presented with the secondary screen that provided them with additional information on hypothetical bias, including an example. Specific comments made by focus group participants, who clearly indicated that they considered hypothetical bias before stated their final WTP, confirmed that the abbreviated "cheap talk" script was indeed effective.

6.4.1 Initial Focus Groups: Paper Survey

Conducting a focus group for both *Survey 1: Screening* and *Survey 2: Treatment* using the online format was clearly an important step prior to administering these web-based surveys nationwide. However, realizing that making significant changes (that would require additional computer programming) would be costly, initial focus groups for each survey were conducted using a paper version of the surveys. The purpose of the initial focus groups was to ensure the clarity of the survey questions (both in terms of intended meaning and interpretation by the respondent) in order to establish the basic format of the surveys prior to programming. Participants for the first two focus groups were recruited from a local scrapbooking group and Newcomer's Club in Hopkinton, Massachusetts. Upon completing the focus group session, which lasted about an hour and a half, each participant received a small photo album (valued at about $15) as a thank you gift.

During the focus group session, participants completed the survey, and then as a group were led in a discussion by the facilitator using a series of predetermined questions. Each group was asked about the length of the survey, clarity of the questions, and the process by which they arrived at their final WTP. In these initial focus groups, participants were not given bids (as would be done later in the online versions), but rather were asked to respond to an open-ended WTP question. The WTP values obtained in these initial focus groups were then used to establish the relevant range of starting bids that appeared in the online surveys. Key statistics from these initial focus groups can be found in Appendix B.

6.4.2 Follow-up Focus Groups: Online Survey

After the programming for the online surveys was completed by KN, a second set of focus groups were conducted (one for each survey). Again, participants included individuals in the community of Hopkinton, MA, including a group of seniors with doctor-diagnosed heart problems from the local Senior Center. At the completion of the session, each respondent was given a $15 gift certificate to either a local restaurant or grocery store as a thank you gift for participating.

During the focus group sessions, each participant was seated at his/her own computer and given an opportunity to complete the online survey. The group then came together around a table to discuss the survey. For the discussion, each participant was given a paper version of the survey so they could refer to specific questions or sections of the survey they completed online. Other than a few minor wording changes, the only significant change that resulted from the online focus groups was the deletion of the second follow up question which asked how sure the respondent was of his/her final stated WTP amount. It was determined that this question was redundant because a follow up certainty question was asked after the end of the iterative bidding. Therefore the second certainty question was deleted from the final versions of the surveys.

6.5 Survey Data

6.5.1 Survey Administration

Survey 1: Screening was fielded from May 9, 2003 through June 1, 2003 and was given to a sample representing the general population. Knowledge Networks invited 552 panel members to participate. Of those, 269 consented. Respondents for *Survey 1: Screening* took an average[103] of 16 minutes to complete the survey, which is consistent with the time it took for focus group participants to complete this survey. Only one individual did not complete the survey, resulting in a final sample size of 268 and a response rate of nearly 49%. Table 6-1 compares the sample for *Survey 1: Screening* to the U.S. population in regards to several key demographics, including gender, age, race, marital status, education, employment status, and household income. The sample from this study is a bit more middle income and better educated, but overall, it is quite similar to the U.S. population.

The fielding of *Survey 2: Treatment* also began on May 9, 2003 and lasted for approximately two (2) weeks, ending on May 26, 2003. Because respondents who are more familiar with a good tend to provide more reliable estimates (Mitchell and Carson, Chapter 8, 1989), potential respondents for *Survey 2: Treatment* were limited to panel members with doctor diagnosed heart problems. 466 panel members were invited, of which 295 consented and completed the survey,[104] resulting in a response rate of 63%.

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[103] KN allows respondents to leave the survey and return at a later time to complete the survey. Data obtained from KN includes the "duration"; however, this variable measures the total amount of time that elapses starting when the survey is first accessed until is completed; therefore, a few of the duration times are extremely high (>10,000 minutes, which represents several days). 90% of the sample completed the survey in 35 minutes or less; therefore, the median time of 16 minutes is a better measure of central tendency (compared to the mean of 441 minutes – approximately 7 hours and 20 minutes).

[104] The median completion time for *Survey 2: Treatment* was 28 minutes. A natural break appears in both surveys the duration variable between the 2-3 hour mark, which could suggest that some individuals leave the survey to conduct outside research prior to completing the WTP section. Interestingly, a larger percentage of the sample appears to leave *Survey 2: Treatment* (12.5%) as compared to *Survey 1: Screening* (6.7%). Focus group discussion indicated that individuals did take additional time to reflect on the decision to have the more invasive treatment procedure compared to the blood test for screening. Unfortunately, no information is available regarding the reason panel members leave and return to the survey; therefore, is not clear whether respondents left the survey to reflect and/or possibly collect additional information, or if the higher rate was simply due to the fact that the *Survey 2: Treatment* sample was more elderly and therefore was more likely to take breaks while completing the survey.

6.5.2 Response Rates

Both surveys had good response rates; however, during the fielding process there was a noticeable difference in how quickly panel members chose to participate in the surveys. In fact, due to a slightly slower rate of response than KN's average, *Survey 1: Screening* was fielded for an additional week. Interestingly enough, panel members responded very quickly to *Survey 2: Treatment*, such that during the two week fielding period, significantly more observations were obtained than were originally contracted (See Figure 6-2: Actual Sampling Distribution).

The difference in the response rates between the two surveys can most likely be attributed to the consent screen that panel members saw prior to beginning the survey. In addition to requesting consent from the participant, the consent screen also indicated the topic of the survey. Looking at the summary statistics of those who responded to *Survey 1: Screening*, it appears that younger individuals in the general population saw the topic of heart attacks and felt the survey was not of interest to them, therefore, they did not consent to the survey. Whereas *Survey 2: Treatment*, which was only offered to those with doctor-diagnosed heart problems, appears to have been of very high interest to the targeted panel members. The consent screen for both surveys followed the example provided by KN (See Appendix C: Informed Consent Screens); however, in hindsight, it may have been better to omit the specific topic of the survey and perhaps include only a general statement about health or not include the topic at all. However, this may have simply led to a high non-completion rate if those who were not interested in the topic chose to abandon the survey upon discovered the topic. As is stands, only 1 out of the 564 respondents (< 0.2%) who gave their consent did not sufficiently complete their survey to be included in the sample; thus, yielding a 99.8% completion rate for all the respondents who began the surveys.

6.5.3 Hypothetical Bias

Hypothetical bias is the tendency of respondents in contingent valuation surveys to say "yes" they would be willing to pay a specified amount more often than they would actually pay that amount. Therefore, several methods were integrated into this survey to avoid the potential for hypothetical bias. These include the use of an abbreviated version of the "cheap talk" script initially proposed by Cummins and Taylor (1999), inclusion of a series of questions to remind the respondent of their budget constraint, the use of a certainty scale in which respondents assess the certainty of their stated bid, and finally, the use of a follow-up certainly question utilized during the focus groups.

Prior to respondents receiving a series of iterative bids, they were first asked to consider what this test/procedure would be worth to them. While respondents reflected on how much they would value the good, they were presented with a shortened version of Cummings and Taylor's (1999) "cheap talk" script in which the potential for hypothetical bias was discussed. The motivation behind the "cheap talk" script is the idea that informing individuals about the tendency of respondents in contingent valuation surveys to say "yes" they would be willing to pay a specified amount more often than they would actually pay, will then cause them to take hypothetical bias into account in stating what they would do. Therefore, before asking respondents to make decisions regarding their own WTP for the test/procedure, they were first given an abbreviated "cheap talk" script followed by a question asking if they understood hypothetical bias. If they answered "no" or indicated "I would like additional information" they were provided with further explanation, including an example.

For *Survey 1: Screening*, 263 of the 268 respondents (over 98%) indicated that they understood hypothetical bias. The mean WTP for the remaining five observations[105] was $38, far below the sample mean of $94, suggesting that it is highly unlikely that these observations artificially inflated the final WTP value obtained in this study. In *Survey 2: Treatment,* 289 of the 295 respondents (98%) indicated that they understood hypothetical bias. Of those that indicated they did not understand hypothetical bias, four stated WTP values ($0, $100, $400, and $2,000) were far below the sample mean of $7,821. The remaining two observations included stated WTP values of $30,000 and $80,000. These two observations are in the top 5% of the values obtained, and therefore may suggest the presence of a small degree of hypothetical bias. Excluding these two observations reduces the mean WTP for the procedure to $7,499, a difference of $322 (4.1%). Excluding all six observations (all those who indicated they did not understand

[105] The stated WTP values for these 5 observations were $0, $0, $10, $40, and $140. $140 is in the top 25th percentile, suggesting a possibility of hypothetical bias. Excluding this observation from the sample yields a WTP value of $93.84 (which is not significantly different from the mean WTP using the entire sample).

hypothetical bias), reduces the mean WTP for the procedure to $7,594, a difference of $227 (2.9 %) from the mean WTP derived when using the entire sample.

An additional measure to reduce the presence of hypothetical bias in the data set was the inclusion of questions designed to remind respondents of their budget constraint. While respondents reflected on what the test/procedure was worth to them, they were asked about the amount of money they currently spend out of pocket for medical care. They were also asked about the amount of money they currently have available in savings. As expected, some respondents did not choose to answer the savings question, however, it served its purpose in reminding respondents of the amount of money they currently have available in savings (and perhaps other sources) to spend on this test/procedure. In addition, by taking a few moments to consider their available funds and ask how they typically spend their money on medical care, respondents are more likely to consider their budget constraint when stating their WTP for the test/procedure.

Another method used to reduce the occurrence of hypothetical bias was the inclusion of a certainty question. Following the iterative bidding process and determination of the respondent's initial WTP, respondents were asked to assess "how certain are you that you would pay this amount" using a scale of 0-10. A certainty scale was first used by Champ et al. (1997) who compared hypothetical dichotomous choice questions about donations to a public good with actual donations to the public good. After indicating their degree of certainly, respondents were then given an opportunity to enter a revised amount of what they "would *definitely* pay" for the test/procedure. Discussion from the focus groups indicated that the use of a certainty question followed by a chance to revise their stated WTP amounts appeared to be an effective way of eliciting their true WTP. Interestingly enough, the focus groups showed that respondents would sometimes (justifiably) revised their bids upward because evaluating their certainly and having time to reflect on their WTP gave them time to consider additional sources or available funds. For example, in the focus group for the treatment, one participant increased her maximum WTP from $10,000 to $25,000. When asked about this increase she explained that her life was important and that she would certainly pay as much as she would for a car. Therefore, it would be worth it to her to sell her car, take out a second mortgage, or ask family members for help in order to obtain the funds necessary to pay this amount for the procedure.

The final and closely related method of preventing the admission of hypothetical bias into the data was the utilization of a follow-up certainty question in the focus groups. In the versions of the survey that were given to the focus group participants, a second certainly question was included after the final WTP value was given. This question asked the respondent how certain they were that he/she would pay the stated amount. However, this time, instead of a certainty scale, participants were asked how sure they were that they would pay this amount by selecting one of the following: definitely yes, probably yes, not sure, probably no, definitely no. This follow up question used in the focus group indicated that almost all participants were "definitely sure" of their response by the end of the survey.[106] In a field experiment that offered a diabetes management program delivered by a pharmacist, Blumenschein et al. (forthcoming 2007) found that individuals who were "definitely sure" of their responses in contingent valuation were not statistically different from individuals who made real purchase decisions about the program. Therefore, based on the responses to this question by the focus group participants, it was determined that the combined use of an abbreviated cheap talk script, and providing an opportunity for respondents to revise their stated WTP after assessing their certainty seemed to provide an effective method for reducing the occurrence of hypothetical bias in the data. In fact, the results of a study by Whitehead and Cherry (forthcoming 2007) suggest that these two approaches to mitigating hypothetical bias (cheap talk and a certainty follow-up question) are complements rather than substitutes, and therefore, should be used together to help eliminate the possibility of hypothetical bias.

6.6 Health Data

In addition to the data collected through the online surveys, detailed health information on each respondent was also obtained from KN. Upon joining the KN panel, extensive health data is collected on each individual. This health data contains several variables of interest to this study, including frequency of exercise, amount of stress, body

[106] This question was not included in the online survey because it was considered redundant.

mass index (BMI), and numerous chronic conditions and diseases, such as high cholesterol, hypertension, and diabetes. Therefore, this health data, together with the survey data, provided a rich data set from which to conduct the data analysis presented in the following chapter.

Table 6-1: Comparison of U.S. Census Data to those who were Invited and Completed

Survey 1: Screening

Characteristics		U.S. Census (CPS, Feb. 2002)	Invited (n=552)	Completed (n=268)
Gender	Male	48.0%	48.9%	53.4%
	Female	52.0%	51.1%	46.6%
Age	18-29	21.7%	21.9%	16.0%
	30-44	31.1%	30.8%	28.7%
	45-59	25.8%	23.7%	24.6%
	60+	21.4%	23.6%	30.6%
Race/Ethnicity	White	72.7%	70.1%	76.9%
	Black	11.6%	12.3%	8.2%
	Other	4.7%	6.0%	6.0%
	Hispanic	11.0%	11.6%	9.0%
Employment Status	In labor fource	64.0%	70.0%	64.6%
	Not in labor force	36.0%	30.0%	35.5%
Marital Status	Married	57.3%	59.8%	60.4%
	Not married	42.7%	40.2%	39.6%
Household Income	Under $10,000	7.5%	7.8%	7.1%
	$10,000 - $24,999	18.5%	17.6%	19.0%
	$25,000 - $49,999	29.2%	33.5%	35.8%
	$50,000 - $74,999	19.9%	21.2%	20.5%
	$75,000 or more	24.9%	19.9%	17.5%
Education	Less than HS	16.4%	10.1%	9.0%
	High School	32.0%	33.9%	36.6%
	Some College	27.4%	30.4%	28.0%
	College	24.3%	25.5%	26.4%
Region	Northeast	19.1%	17.6%	18.3%
	Midwest	22.8%	24.6%	25.7%
	South	35.6%	35.3%	32.1%
	West	22.6%	22.5%	23.9%

*CPS data are weighted. (Census data provided by KN)

Figure 6-1: Planned Sampling Distribution

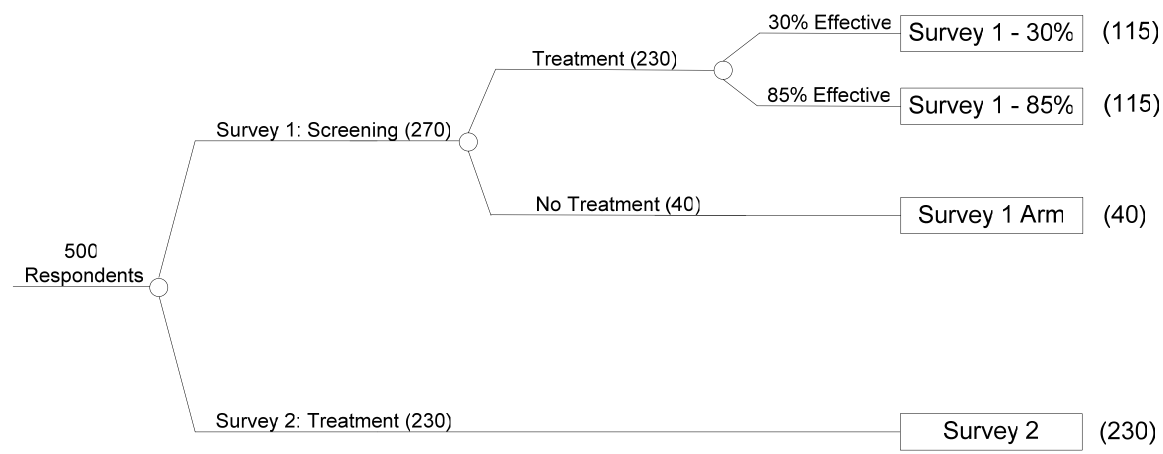
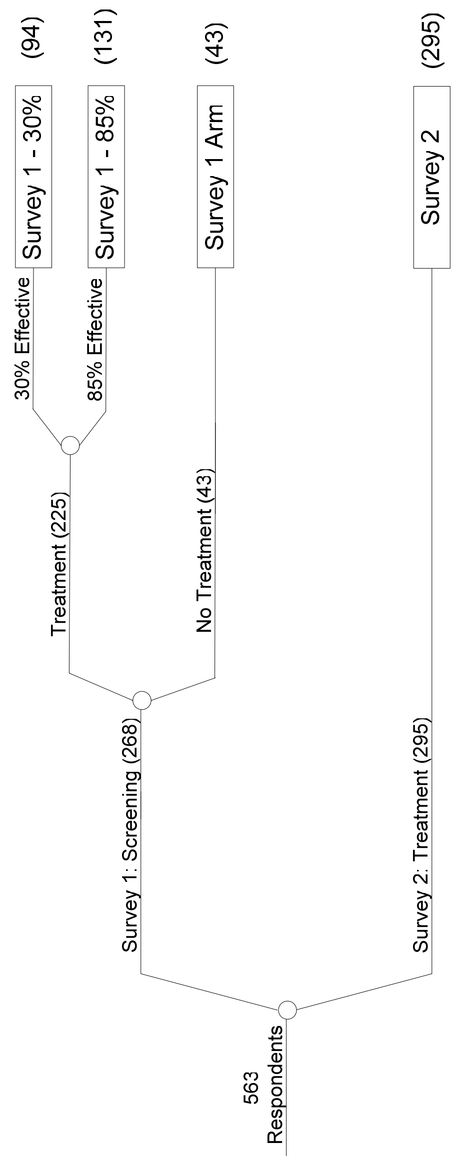


Figure 6-2: Actual Sampling Distribution



Chapter VII: Data Analysis and Results

The primary purpose of this chapter is to present the results of the study, including the mean value obtained for the willingness to pay (WTP) for (1) a new screening method that will better identify those at risk for a heart attack, and (2) the mean WTP for a more effective treatment method for those individuals who have been identified as being at high risk for a heart attack. The chapter includes a brief discussion of the data preparation and how a single WTP value was defined for each respondent. Summary statistics for the key variables used in the econometric analysis are presented. In addition, the chapter includes models of general health and perceived risk for both data sets. These models are included because WTP is greatly influenced by the respondent's perceived risk of having a heart attack, which in turn, is affected by the individual's general health. Therefore, these models are reported to gain a better understanding of the individual factors affecting these variables and the role they play in influencing WTP.

To further explore the factors that influence WTP for a new screening method and a more effective treatment, a censored regression model and a two-part model (probit with OLS) are used to isolate the marginal effects of individual factors on the respondent's WTP. Overall, the general health and perceived risk models provide evidence supporting the reliability of the data set, including the reported mean WTP for screening and treatment. In addition, the results from the WTP regressions offer insights regarding the factors that may influence consumer WTP for the screening and treatment of vulnerable plaque. Finally, the chapter concludes by making a connection between the WTP for treatment obtained in this study and the value of a statistical life (VSL).

7.1 Data Preparation

7.1.1 Item Non-response and Internal Consistency Checks

For observations in which there was item non-response, the sample mean was assigned, and then the models were run with and without those observations to check for potential differences in the results. In addition, some internal consistency checks resulted in a few minor adjustments – for example, a few individuals checked that they were *both* "a male over 45" and "a female over 55." Using data obtained from Knowledge

Networks on the respondent's actual age and gender allowed for the correction of this survey error. Appendix D includes a detailed accounting of adjustments made to the data sets in preparation for analysis, as well as a complete list of the variables available in the two data sets used for this study.

7.1.2 Defining WTP

As described in Chapter 5, the use of an iterative bidding process with follow-up questions elicits a single WTP value from each respondent. If the bidding process itself does not establish an initial WTP amount, respondents are reminded of the range they were willing to pay based on the answers given for each bid and are then asked to enter the most they "would be willing to spend *out of pocket*" for the test/procedure. After the initial WTP value is established, respondents are then asked to assess how sure they are on a scale of 0-10 (0=not sure and 10=definitely sure) that they would actually spend this amount. Following the certainty question, respondents are reminded of their initial WTP and asked to enter the amount they "would definitely pay for this test/procedure."

For those who completed the process, a single WTP value was obtained. However, a few respondents did not complete the entire process. In many of these cases, the respondent did not answer the final WTP question after indicating that he/she was very certain (10) of their earlier stated amount. Thus, it is reasonable to assume that the individual was satisfied with their earlier amount, had expressed that they were definitely sure they would spend this amount, and did not feel it was necessary to enter the number again. Therefore, for observations in which the respondent did not complete the final WTP question, the initial WTP value was used. Initial WTP is a good measure of the respondent's actual WTP because it was obtained either by the bidding process narrowing the respondent's WTP down to within the pre-specified margin of error, or it was entered directly by the respondent. The only disadvantage of using this value is that it may have a greater tendency to be subject to hypothetical bias because it was determined prior to the respondent considering the follow-up certainty question. However, as stated previously, many of the individuals for whom this value was used indicated that they were very certain of their initial WTP, therefore, this is considered a very good measure of the respondent's true WTP.

There were a few respondents in both surveys for which the respondent did not offer an initial WTP or final WTP value. In these cases, the bidding process did not sufficiently narrow the range and the respondent did not complete the follow-up question asking for their WTP. For these few observations, the highest "yes" bid was used as a measure of the respondent's WTP. Presumably the respondent may be willing to pay more than their highest "yes" bid, therefore, this serves as a lower bound. Although using this value may understate the individual's true preference, it is the best available measure because it will not artificially inflate the mean WTP for screening/treatment.

There was only one observation for which the process described above could not be used to obtain the respondent's WTP. For one observation in *Survey 1: Treatment*, the respondent only spent a total of 8 minutes on the entire survey (significantly less than the average), skipped both the initial and final WTP questions, and all the bidding questions. With no available information on which to base the respondent's WTP, the observation was dropped from the sample, resulting in a final sample size of 268 for *Survey 1: Screening*. This process of defining WTP was also applied to data from the second survey (with no necessary exclusions); therefore, the full sample of 295 was utilized for analysis of the *Survey 2: Treatment* data.

7.2 Summary Statistics for *Survey 1: Screening* Data

An overview of several key demographic and health variables for the sample data obtained from *Survey 1: Screening* can be found in Table 7-1. These summary statistics are also included for the *Survey 2: Treatment* data for easy comparison of the two samples. A complete list of the variables used in analyzing the *Survey 1: Screening* data can be found in Table 7-2. Table 7-2 also includes descriptors of each of the variables and more detailed summary statistics, including minimum/maximum values and frequency distributions.

7.2.1 Demographics

The sample for *Survey 1: Screening* includes 268 individuals (age 18 or older) from the general population who responded to the survey invitation and offered their informed consent. The sample for the WTP for screening includes slightly more men

(53%) than women (47%). The individuals comprising the sample range from 18 to 83 years of age, with the mean just under 48 years old. Over 90% of the sample competed high school, with approximately 55% attending at least some college. Five percent of the individuals in the sample earned an associates degree, 17% earned a bachelor's degree, and 9% completed a graduate or professional degree. Slightly more than three-quarters (77%) of the sample is white, 8% is black, 9% is Hispanic, and 6% represent other ethnic groups. Sixty percent of the individuals included in the sample are married, and the average household size is 2.6. Approximately 65% of the sample is in the labor force, 20% is retired, and 6% is disabled. Mean household income for this sample is $48,223. A fairly large percentage of respondents (85%) indicated that they were heads of their household, and a majority of the respondents (83%) in this sample reside in a Metropolitan Statistical Area (MSA).

7.2.2. Health Statistics

Of the 268 individuals in the general population sample, approximately 12% have self-reported heart disease and nearly 5% have experienced a heart attack. Seventeen percent are currently taking or have taken medication in the past to reduce their cholesterol. Mean self-reported health status is 3.4 on a 1-5 scale (1=poor and 5=excellent). Body Mass Index (BMI) for this sample ranges from 16 to 62, with a mean of 28.3. The ideal range is 18.5 to 24.9; therefore, using published definitions based on BMI, nearly 30% of the sample is overweight, 17% is obese, and over 19% of the sample is comprised of individuals considered to be very obese. Thirty-five percent indicated they have elevated cholesterol levels, 32% suffer from high blood pressure, and 8% are diabetic. Thirty-four percent of the individuals in the sample indicate that they live or work with people who smoke everyday, and 40% have a family history of heart problems or have a member of their immediate family who has experienced a heart attack.

7.3 Summary Statistics for *Survey 2: Treatment* Data

As mentioned above, an overview of several demographic and health variables for both data sets is presented in Table 7-1 for easy reference and comparison purposes. A complete list of the variables, descriptors, and more detailed summary statistics used in analyzing the *Survey 2: Treatment* data can be found in Table 7-3.

7.2.1 Demographics

The sample for *Survey 2: Treatment* includes 295 individuals (age 18 or older) with doctor-diagnosed heart problems who responded to the survey invitation and offered their informed consent. The sample for the WTP for treatment is evenly comprised of men (50.5%) and women (49.5%). The sample includes individuals between the ages of 18 and 91, with a mean of just under 64 years old.[107] Since this sample is limited to individuals with doctor-diagnosed heart problems, which tends to be more common after age 55, it is not surprising that this sample has a much higher mean age compared to the general population sample obtained for the screening survey (See Table 7-1 for a comparison of the two samples). Given the considerably older age of the sample, there is relatively little difference in the level of education for the two samples. Over 86% graduated from high school, and 47% attended at least some college. Seven percent earned an associates degree, 15% earned a bachelor's degree, and over 6% completed a graduate or professional degree. In terms of race, nearly 88% of the sample is white, 7% is black, 3% is Hispanic, and 2% is representative of other ethnic groups. Approximately two-thirds (66%) of the sample is married, and the average household size is 2.3. A large percentage of the sample (47%) is retired, and 10% are disabled. Approximately 34% of the sample is in the labor force, and the mean income is $43,538. A fairly large percentage of respondents (87%) indicated they were heads of household, and a majority of the respondents (87%) in this sample reside in a Metropolitan Statistical Area (MSA).

7.3.2. Health Statistics

Of the 295 individuals with doctor-diagnosed heart problems included in this sample, 75% report they have heart disease and over 37% have experienced a heart

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[107] *Survey 2: Treatment* was only administered to individuals with doctor-diagnosed heart problems. Since heart problems are more common in elderly individuals, this sample included a high percentage of individuals over the age of 65. Therefore, an additional age category (Age 75 and above) was included for all the data analysis completed for *Survey 2: Treatment* to account for any differences in general health, perceived risk, or WTP for this age group

attack. Nearly 63% are currently taking or have taken medication in the past to reduce their cholesterol. Mean self-reported health status is 2.8 on a 1-5 scale (1=poor and 5=excellent). Body Mass Index (BMI) for this sample ranges from 16 to 77, with a mean of 29.2. As stated above, the ideal range is 18.5 to 24.9; therefore, using published definitions based on BMI, nearly 38% of this sample is classified as overweight, 23% is obese, and 16% of the sample is comprised of individuals considered to be very obese. Approximately 40% of the individuals in the sample suffer from hypertension (high blood pressure), 22% are diabetic, and 58% have a family history of heart problems or have a member of their immediate family who has experienced a heart attack.

7.4 General Health

Respondents for both *Survey 1: Screening* and *Survey 2: Treatment* were asked to report their health status using a five category scale (1=poor health, and 5=excellent health). Self-reported general health was found to play a significant role in perceived risk, which in turn, helped explain the WTP for screening. Therefore, to better understand general health, a standard OLS (Ordinary Least Squares) regression was run on self-reported health status. Following Grossman's model of health production, the independent variables include age, education, significant decreases to the health stock (as measured by the respondent reporting having had a life threatening condition or illness), and several lifestyle variables, including amount of stress, frequency of exercise, and amount the individual exceeds his/her ideal body mass index (BMI). The effects of household income and frequent visits to the doctor's office have on health status are also explored.

7.4.1 General Health Model for Survey 1: Screening

In the general health model using data from *Survey 1: Screening* (See Table 7-4, Column 1), age is negative and significant, as expected, with coefficients becoming increasingly negative for each age category. All of the coefficients on education are positive, with the coefficient on bachelor's degree significant at the 5% level. The positive effect of education on health is consistent with Grossman's prediction that more educated individuals will tend to have higher levels of health, all else constant. The regression results also support the fact that individuals who have experienced a life threatening condition or illness have a significantly lower general health *ceteris paribus*, indicating a reduction in the health stock for these individuals. In addition, individuals who report being under higher levels of stress or who are above their ideal body weight (as measured by the amount the individual exceeds his/her ideal BMI) also have a statistically (at the 1% level) lower self-reported general health status. Finally, increased frequency of exercise, which represents an investment in health according to Grossman's model, is highly significant and has the expected positive effect on the individual's general health.

Other specifications of the general health model include the addition of two variables, frequency of visits to a doctor and household income, which were included to measure investments in (or access to) health care (See Table 7-4, Columns 2, 3, and 4). Although it was anticipated that going to the doctor would improve health, the highly significant negative coefficient on frequency of doctor visits did not demonstrate that these "investments" in health were having a positive impact on the individual's health status. Instead, it appears that this variable is standing in for the effect of "chronic" conditions – that is, those that require a significant amount of care, yet treatment creates little improvement in overall health.[108] This hypothesis is further supported by the fact that inclusion of frequency of doctor visits in the model (Table 7-4, Column 2) reduces the coefficients on the age variables, particularly for those who are 65 and over.

Including household income as an independent variable (See Table 7-4, Column 3) yields a positive coefficient that is significant at the 1% level. Including household income does increase the explanatory power of the model; however, not surprisingly, it reduces the coefficients of the education variables and makes them statistically insignificant.

It was thought that differences in attitudes toward health and the individual's willingness to make investments in health may be reflected in their degree of being overweight. Therefore, instead of using a continuous variable that captures the amount an individual is over their ideal BMI, many of the models analyzing data from *Survey 1:*

[108] A simple regression conducted with frequency of doctor visits as the dependent variable and chronic back pain, arthritis, asthma, and diabetes as the independent variables strongly supports the hypothesis that frequency of doctor visits is capturing the effect of chronic conditions in the general health equation.

Screening include dummy variables for the following weight categories: overweight, obese, and very obese.[109] Individuals are assigned to each category using their individual BMI and standardized ranges for each weight category that are defined as: overweight (24.9 < BMI < 30); obese (30 ≤ BMI < 35); and very obese (BMI ≥ 35) (Partnership 2007). Inclusion of these weight categories in the general health regression (See Table 7-5) yields very similar results to those just discussed when amount over ideal BMI is used as the weight variable (Table 7-4). When the weight dummies are used in place of amount over BMI, the coefficients on the other covariates remain essentially unchanged; however, the marginal effects on overweight, obese, and very obese do suggest that the relationship between increased weight and general health is not necessarily linear (See Table 7-5). As expected, the coefficients on overweight, obese, and very obese are all negative; however, the t-values indicate that those individuals who are classified as overweight have no statistically significant difference in their self-reported general health status from those who are not overweight; while individuals who are classified as "obese" and "very obese" have statistically significant lower general health. In addition, the coefficient on very obese is larger in magnitude than the coefficient on obese. Therefore, the farther the individual is above their ideal weight, the larger the decrease that can be expected in that individual's general health.

7.4.2 General Health Model for Survey 2: Treatment

Comparable regressions performed on data for *Survey 2: Treatment* indicate very similar results (See Table 7-6). The coefficients on age become increasingly negative with higher age categories, with age having a statistically significant decrease on general health for those individuals who are 55 years of age or older. In general, education has a positive effect on health status, with statistical significance for individuals who hold some type of college degree. This finding is consistent with the efficiency of health production Grossman predicted for individuals with higher levels of education. As before, an individual who has experienced a life threatening condition reports a lower level of general health *ceteris paribus*. Higher levels of stress and being overweight lower the individual's general health by a statistically significant amount, while increased

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[109] The excluded category is those individuals who are at (or slightly below) their ideal (normal) BMI.

time spent exercising has a statistically significant positive effect on general health. Again, those who visit the doctor more often (See Table 7-6, Column 3), tend to have lower general health, suggesting that, as discussed previously, this variable is acting as a proxy for chronic conditions. In addition, the fact that inclusion of this variable in the model decreases the coefficients on the age variables (particularly for individuals 75 and over) offers further evidence to support that this variable is capturing the effect of chronic illnesses on health. And finally, as observed in the data from *Survey 1: Screening*, income has a statistically positive effect on the individual's self-report general health. Overall, factors explaining the variation of general health status for both samples are consistent with economic theory and provide confidence as to the reliability of the data sets.

7.5 Perceived Risk

As discussed in Chapter 5, respondents for both *Survey 1: Screening* and *Survey 2: Treatment* were asked to enter the number that best represented their perceived risk of having a heart attack in the next year using a computerized version of a visual analog scale. The visual analog scale went from 0 (labeled no risk) to 100,000 and included two anchors – 19, which corresponds to the annual fatality rate from a car accident (19/100,000), and 50 (which was labeled "high risk"). Respondents were asked to assess their perceived risk twice – once prior to receiving new information on vulnerable plaque as a cause of heart attack (*Initial Perceived Risk*) and once immediately after receiving the new information (*Perceived Risk after New Information*).

For the general population sample completing *Survey 1: Screening,* mean perceived risk was 15.07 prior to the new information and 17.92 following the new information. Since the visual analog scale indicated that risk was per 100,000 individuals, these values indicate an average increase in perceived risk of about 3/100,000 due to the new information. For the *Survey 2: Treatment* sample, mean perceived risk is significantly higher (which is expected given the health history of these individuals), with a mean *Initial Perceived Risk* of 26.56, mean *Perceived Risk after New Information* of 30.22, and *Change in Perceived Risk* equal to 3.65.

Although the actual clinical risk associated with experiencing a heart attack is specific to the individual (and can depend on several factors), one of the primary determinants of heart attack risk is age. Table 5-2 includes the annual risk of fatality from an acute myocardial infarction (heart attack) for twelve different age groups. As Table 5-2 clearly indicates, the risk of fatality from heart attack increases substantially for those individuals 55 years of age and above. The mean age-adjusted fatality rate for the population is reported as 42 / 100,000. According to the American Heart Association, approximately 47% of heart attacks are fatal; therefore, this value implies that the mean annual probability of experiencing a heart attack is 89 / 100,000. This value is higher than the annual perceived risk indicated by the individuals completing the survey; therefore, it appears that both individuals in the general population and those with doctor-diagnosed heart problems tended to *underestimate* the probability of experiencing a heart attack.[110] To gain a better understanding of the factors influencing perceived risk, an OLS regression was estimated using both measures of perceived risk (before and after the new information) as the dependent variable. The perceived risk models include various risk factors for heart attack, while controlling for level of education, cholesterol medication (which would tend to lower the individual's perceived risk), and, in some specifications, the individual's general health. These models account for approximately 30% of the variation in *Initial Perceived Risk* and 25% of the variation in *Perceived Risk after the New Information*.

7.5.1 Initial Perceived Risk with Risk Factors from AHA Quiz

As part of the warm-up section in *Survey 1: Screening*, respondents were asked to complete a risk assessment quiz published by the American Heart Association (AHA). As discussed in Chapter 5, the quiz contains 11 risk factors that are traditionally used by physicians to assess a patient's risk of having a heart attack. The eleven risk factors (labeled r1 through r11) are all dummy variables, with 1 representing a "yes" response and 0 otherwise. Regressions including these risk factors are presented in Table 7-7

[110] For *Survey 1:Screening*, maximum values for *Initial Perceived Risk* and *Perceived Risk after New Information* were 80 and 100 respectively. For *Survey 2:Treatment*, values were similar with a maximum value of 85 for *Initial Perceived Risk* and maximum value of 100 for *Perceived Risk after New Information.*

(using *Initial Perceived Risk* as the dependent variable) and Table 7-8 (using *Perceived Risk after the New Information* as the dependent variable).

The first regression in Table 7-7 (See Column 1) includes the set of eleven AHA risk factors, and controls for cholesterol lowering medication, and education. With *Initial Perceived Risk* as the dependent variable several of the AHA risk factors are highly significant, including (1) being a male over the age of 45, (2) being a female over the age of 55, (3) having high cholesterol, (4) being 20 pounds or more overweight, and (5) having coronary heart disease or having had a prior heart attack. All of the other risk factors (with the exception of low HDL[111]) have the expected positive sign. Taking medication to lower cholesterol lowers the individual's probability of having a heart attack, therefore, the negative coefficient on medication is expected; however, it is not statistically significant. Education was highly significant and negative at all levels, with coefficients larger in magnitude for college degrees, suggesting that those with more education have lower levels of perceived risk.

Because some of the risk factors include more than one variable (i.e. male over the age of 45), another regression was performed on *Initial Perceived Risk* separating out these variables (See Table 7-7, Column 3). Specifically, risk factors r1 (male over age 45), r2 (female over age 55), and r11 (heart disease or heart attack) were replaced with variables for gender, age, and independent variables for heart disease and heart attack. In separating out these risk factors, there are two things that become of interest.

First, the two risk factors that include gender and age are highly significant (at the 1% level) in the first specification; however, by separated these out, it appears that age is the driving factor. The coefficient on male is positive, however, it is not statistically significant. In contrast, the age categories are positive and significant above 45 years of age. In fact, the "55 to 64" and "65 and above" age groups are consistently significant (at the 1% level and 5% level respectively) across all specifications (See Tables 7-7, 7-8, and 7-9). The second finding of interest results from separating out heart disease and heart attack in the last risk factor (r11). Independently both variables are still significant; but in

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[111] Many respondents answered "I don't know" for this risk factor. This is not unexpected since this is the risk factor with which respondents would be the least familiar, therefore, making it the most difficult to recall while taking the survey. "I don't know" responses were coded as "no"; therefore, this is most likely causing the negative sign on this variable.

separating out these factors, the coefficient on heart attack is much larger than that of heart disease (See Table 7-7, Column 3). This is not unexpected since those who have experienced a heart attack are at higher risk of having another attack. Therefore, the larger coefficient on heart attack provides validity to the model, indicating that those who have experienced a heart attack in the past have a higher perceived risk compared to those individuals who have simply been diagnosed with heart disease.

To explore whether those who have suffered an injury or illness in the past may feel more at risk for a heart attack, general health was included as a possible explanatory variable in the perceived risk model (See Table 7-7, Columns 2 and 4). The coefficient on general health is negative and highly significant, indicating that those individuals with lower self-reported general health status will tend to have higher levels of perceived risk. As expected, including general health in the regression does affect the coefficients of some of the covariates, such as diabetes; therefore, the two specifications discussed above are presented both with and without general health included in the model.

7.5.2 Perceived Risk after New Information with Risk Factors from AHA Quiz

Table 7-8 includes the same regressions reported in Table 7-7, but uses *Perceived Risk after the New Information* as the dependent variable (instead of *Initial Perceived Risk*). As described in Chapter 5, the new information presented to the respondent includes a description of vulnerable plaque and explains that individuals with no symptoms of heart disease can still be at risk of a potentially fatal heart attack. Like the previous specifications, age is positive and significant for higher age categories (See Table 7-8, Column 3). As expected, having high cholesterol increases perceived risk and is significant at the 5% level with a small decrease in the marginal effect from the *Initial Perceived Risk* model. Smoking becomes significant at the 10% level and the coefficient on r9 (20 pounds or more overweight) becomes considerably larger. Heart disease is no longer significant, although having experienced a heart attack is still positive and significant at the 5% level. When general health is added to the model, it is still negative and highly significant across specifications (See Table 7-8, Columns 2 and 4). The education variables are also still negative, although many lose some degree of significance in the various specifications.

In general, using the individual's self-reported perceived risk obtained *after* the new information was presented results in a lower R-squared with less explanatory power compared to the same specifications using perceived risk *prior* to the new information. Given that the new information essentially states that traditional risk factors for heart attack are no longer thought to be good predictors of who is at risk for a heart attack, the loss of explanatory power provides evidence to suggest that respondents understood the new information and adjusted their perceived risk accordingly. After the new information, it appears that in stating their perceived risk, respondents tended to place more emphasis on whether they live/worked in a smoking environment and on whether they were overweight, two factors that are commonly known to be associated with heart disease. In general, it appears that the new information was effective in dislodging (at least to some extent) beliefs regarding the reliability of traditional risk factors in predicting heart attack risk. This is evident by the lowered predictive ability of the models presented in Table 7-8 (compared to Table 7-7) and the larger amount of "noise" that entered respondent's perceived risk assessment after the new information was presented; whereas their initial perceived risk relied more heavily on the traditional risk factors (r1 – r11) presented in the risk assessment quiz.

7.5.3 Perceived Risk – General Risk Factors – Survey 1: Screening Data

Substituting in for various factors in the risk assessment quiz was clearly useful in identifying that age, rather than gender, was the driving force behind risk factors r1 (male over 45) and r2 (female over 55) being significant. Therefore, other substitutions are made and reported in Table 7-9. Risk factor r9 "are you 20 pounds or more overweight" is fairly ambiguous, and as the general health model indicates, differences may exist depending on the degree to which the individual is above their ideal BMI. Therefore, the variables overweight, obese, and very obese (as defined earlier) are substituted for r9. Risk factor r3 asks respondents whether their father or brother had a heart attack before age 55 or their mother of sister had a heart attack before age 65. An additional survey question asks if the respondent has a relative in their immediate family (regardless of age) who has experienced a heart attack. Therefore, a more broadly defined dummy variable for *Family History of a Heart Attack* is included that is equal to 1 if the individual responded "yes" to either of these questions.

The health panel data obtained from Knowledge Networks contains detailed information on respondents' health behavior and medical history. Therefore, this information was also incorporated into the model. Instead of using risk factor r8, which asks the respondent if they typically get less than 30 minutes of physical activity per day, a variable for exercise that captures the frequency with which the individual exercises on a weekly basis was included. In addition, medical information on diabetes and hypertension were available, such that these two variables were broaden to include any individuals who had a past medical history of these two conditions. Several individuals were unsure of their HDL, and as a result this was coded as a "no" – and most likely accounts for the negative sign for r6 in the regressions presented in Table 7-7. Since those with High Cholesterol often have a low HDL, risk factors r5 and r6 were combined into a single variable to indicate that the respondent has a medical problem related to cholesterol – either their total cholesterol is too high or their good cholesterol (HDL) is too low – both of which place the individual at higher risk for a heart attack. Finally, race is added as a control variable.

Although race was not included in the AHA risk assessment quiz, the AHA website includes race as a major risk factor for coronary heart disease (a contributing factor for heart attack); therefore, it was added to the regression. Interestingly enough, many people typically think of "white males" as being at high risk of a heart attack, thereby suggesting that whites may be at higher risk. However, according to the AHA, African Americans tend to have higher blood pressure than whites, and therefore, are at higher risk of heart disease. In addition, Mexican Americans, American Indians, native Hawaiians, and some Asian Americans are also at higher risk of heart disease, partly as a result of higher rates of obesity and diabetes in these groups (American Heart Association 2006). Therefore, based on this information, whites would be expected to have a *lower* risk of heart attack compared to non-whites, all else constant.

The model including the substitutions described above is presented in Table 7-9, Columns 1 and 2. *Initial Perceived Risk* is used as the dependent variable in Column 1, whereas the dependent variable in Column 2 is *Perceived Risk after the New Information*.

A comparison of the *Initial Perceived Risk* model (See Table 7-9, Column 1) to the regression presented in Column 3 of Table 7-7 reveals very similar results. Age categories 45 and above are still significant, with very little change in the marginal effects. Being overweight is still negative and significant; however, as expected, the coefficients in the new model increase with each higher overweight category. Heart disease and heart attack are still significant and positive, with only a small decrease in the coefficient on heart disease, which falls from 7.6 to 6.6. Since obesity is likely to increase heart disease, this decrease is most likely due to the inclusion of the weight dummies. In the new specification having a cholesterol problem is not significant; however, it is significant at the 10% level in the *Perceived Risk after the New Information* specification. The education control variables are also still negative and significant with very little change in the marginal effects.

Although the overall R-squared does not really change between the two specifications, it is thought that the models presented in Table 7-9 Columns 1 and 2 (Compared to Table 7-7, Columns 3 and 4) include variables comprising better information, and therefore are likely to provide more precise estimates of the marginal effects. In addition, this set of risk variables is included in the extended version of the WTP equations discussed later in this chapter; therefore, it is helpful to see their effect on perceived risk for comparison purposes.

Since the individual's self-reported general health is highly significant in the perceived risk equations (See Table 7-7 Columns 2 and 4); the two remaining factors[112] that were significant in the general health model - having experienced a life threatening condition and level of stress - are substituted in for general health (See Table 7-9, Columns 3 and 4). Neither variable is significant in the model explaining *Initial Perceived Risk*; however, having experienced a life threatening condition or illness is significant at the 10% level when explaining *Perceived Risk after the New Information* (Table 7-9, Column 4) therefore, it is possible that this variable may play a role in explaining the WTP for screening.

[112] Age, Education, Exercise, and Amount Overweight were also significant, but are already included in the model.

7.5.4 Perceived Risk – General Risk Factors – Survey 2: Treatment Data

The *Survey 2: Treatment* data also includes two measures of perceived risk – one before and one after receiving new information on who is at risk for a heart attack (See Table 7-10). This model uses several of the same risk factors included in the perceived risk equations for analyzing the *Survey 1: Screening* data. However, since respondents completing *Survey 2: Treatment* were not asked to complete a risk assessment quiz (they already know they are at high risk for a heart attack), there are a few variables, such as information about living/working in a smoking environment, that were not available. Health variables including high cholesterol, hypertension, exercise, BMI, and diabetes, were obtained from the health data provided by Knowledge Networks as discussed in Chapter 6. The remaining health variables – family history of heart attack, heart attack, and expected/actual decrease in the quality of life following a heart attack – were collected as part of the survey.

The regression results (See Table 7-10) indicate that perceived risk is higher (and significant) for the 55 to 65 age group across all specifications. This is not surprising given that physicians typically start treating heart disease more aggressively after age 55. In addition, having high cholesterol or having experienced a heart attack results in a statistically significant increase in an individual's perceived risk. Because the consequences of a heart attack can vary from virtually no effect to a severe permanent disability, a variable was included to capture the "severity" of the heart attack as measured by the reduction in quality of life that resulted from (or is expected to result from) a heart attack. This variable was highly significant (at the 1% level) and positive across all specifications indicating that the more severe the heart attack was (or was expected to be), the higher the perceived level of risk. Like the perceived risk equations for the *Survey 1: Screening* data, general health is negative and significant at the 1% level. The education variables are also negative and significant for individuals with a Bachelor's or graduate degree. This may be due, at least in part, to those with higher levels of education having a better understanding of the visual analog scale; and therefore, stating smaller and more "precise" measures of risk. Finally, including whether the individual has had a life threatening condition or illness in the past also significantly increases perceived risk (See Table 7-10 Columns 3 and 4), as well as increases the explanatory power of the model. Overall, the models presented in Table 7-10 explain approximately 30% of the variation in perceived risk for the *Survey 2: Treatment* data.

Interestingly, taking cholesterol lowering medication does not significantly reduce perceived risk in any of the specifications, for either the *Survey 1: Screening* data or the *Survey 2: Treatment* data. Currently, statin (cholesterol lowering) medications are only about 30% effective and take a long time to work; therefore, the findings from the perceived risk models suggest that individuals recognize the shortcoming of the drug therapy treatment currently available, and lends support to the need for a new, more effective treatment method.

7.6 Willingness to Pay

The goals of this study were to (1) determine the WTP for a screening method that would better identify individuals in the general population who are at risk for heart attack, and (2) determine the WTP for a new treatment method that is more effective than the currently available standard of care. One of the distinct advantages of using a multiple-bounded dichotomous choice question in comparison to a single-bounded dichotomous choice question is that significantly more information is obtained from each respondent. In fact, in this study, using an iterative bidding process with follow-up open-ended question elicited an exact WTP value from each respondent. Therefore, the mean WTP obtained in this study did not rely on econometric techniques, but rather was simply the mean of the reported WTP values from each respondent.

7.6.1 Mean WTP for Screening and Treatment

The distribution of the maximum WTP amounts for screening is illustrated in Figure 7-1. The mean WTP for screening is $94 with a median of $50, and standard deviation of $143. This distribution includes 16 individuals who chose not to have the screening and were assigned a WTP=0. In addition, some individuals indicated during the bidding process that they would have the test, but only if it were offered for free, and therefore also had a WTP=0. However, most of the respondents indicated that the test is valuable to them and provided a positive WTP for the screening that ranged from $1 up to $1,000. These WTP values include positive amounts for some individuals who were told that no treatment existed, which provides evidence that individuals place a value on the information provided by the screening even when no treatment is available; thereby suggesting that having this information increases the individual's utility because it allows for better planning and allocation of the individual's time.

The distribution of the maximum WTP amounts for treatment is illustrated in Figure 7-2. The mean WTP for treatment is $7,821 with a median of $2,500 and standard deviation of $21,084. This distribution includes 43 individuals who chose not to have the procedure. Of those, 36 individuals chose medication as their treatment option, while 7 individuals did not select either treatment. Since none of these respondents were willing to have the procedure, they were all assigned a WTP=0.[113] In addition, there were others who chose the procedure, but during the bidding process indicated that they would only be willing to pay $0 for it. Therefore, these respondents also have a WTP=0. However, many of the respondents reported positive values of WTP, ranging from $1 up to $300,000[114], indicating that a new, more effective treatment would be of value to them.

7.6.2 General Models for Analyzing Health Data

In addition to the mean WTP, it is also of interest to determine which factors influence WTP. Understanding the factors that affect WTP can provide insight into which individuals have the highest demand (and benefit) for the screening/ treatment. Since the medical expenditures of many of these individuals are covered by Medicare, understanding the specific factors that drive demand could potentially assist policy makers in making determinations as to who should receive the treatment and who should not. Typically this could be accomplished by simply regressing a set of explanatory variables on WTP. However, health data often present difficulties in econometric analysis because the data is often characterized by (1) an outcome variable (in this case WTP) which is non-negative, (2) a substantial number of zeros, and (3) a positively skewed distribution for the non-zero observations (Manning et al. 2001). Therefore, analyzing the data creates challenges in order to obtain estimates of the marginal effects

[113] Before exiting the survey, all of the respondents who did not select the procedure were asked an open-ended question asking them to explain why they did not want the procedure even if it were offered for free.
[114] The potential for outliers is addressed later in this chapter in the WTP models.

for the covariates that are both unbiased and precise, which is warranted for policy decisions.

For the *Survey 1: Screening* sample, a total of 31 (12%) of the 268 observations indicated a WTP=0. Fifteen of these individuals indicated they would have the screening if it were offered at no out-of-pocket cost to them, however, the remaining 16 indicated that they would not have the screening even if it were offered for free. These individuals were identified by their response to a zero bid. Those that answered "yes" to a zero bid continued with the survey, while those who answered "no" to a zero bid were directed to an open-ended question asking why the respondent chose not to have the screening even when it was offered for $0 (free). Almost half of the respondents who said they would not have the screening had received a version of the survey in which "no treatment" was available. In fact, almost all of the respondents who chose not to have the screening and had a "no treatment" version of the survey, indicated in their response that having no treatment available was their reason for choosing to forego the screening. Other respondents whose surveys included a treatment option indicated that they would prefer not to know so they did not worry. Some indicated a distrust of doctors and/or medicine that would prevent them from having the treatment if the test came back positive, and one indicated that he/she had had two heart attacks already, implying that the screening would have little additional benefit (See Table 7-11 for all open-ended responses to *Survey 1: Screening*).

For the *Survey 2: Treatment* sample, a total of 62 (21%) of the 295 observations indicated a WTP=0. Nineteen of these individuals indicated they would have the screening if it were offered at no out-of-pocket cost to them, however, the remaining 43 indicated that they would not have the screening even if it were offered for free. Thirty-six of those individuals chose drug therapy as their treatment and 7 individuals "refused" treatment (by not selecting either treatment option). During the survey, respondents were presented with the possible treatment options and then asked to select the treatment they would prefer.[115] Respondents who chose the procedure continued with the iterative

[115] This was prior to the iterative bidding, therefore, it is assumed that respondents were selecting their preferred treatment option based solely on the treatment without regard to the potential cost. Comments from focus group participants indicate that at this point in the survey, respondents assumed that the cost of the treatment selected would be covered by insurance.

bidding portion of the survey; however, as mentioned above, 19 of those respondents indicated a WTP=0. Those respondents who selected drug therapy or refused treatment were directed to an open-ended question asking them why they chose not to have the procedure. Several of the respondents indicated that they were already taking a cholesterol medication or that they had other medical conditions that made the procedure unsuitable for them. Some respondents stated that they were concerned about the risk associated with the procedure, had a fear of surgery, felt they were too old, or would simply like more time to consult with their own doctor (who they trusted) or other outside resources (Internet) before making a decision. (See Table 7-12 for all open-ended responses to *Survey 2: Treatment*).

One approach for handling the relatively large number of zeros observed in these data sets is to model WTP using a tobit[116] equation. The tobit model is also referred to as the censored regression model because it is based on the premise that some of the observations are censored, or unobserved. When the dependent variable is censored, values in a certain range are all transformed or reported as a single value. A classic example of this from labor economics is the number of hours worked by women. A large percentage of married women choose not to work, therefore, their hours are simply recorded as a zero. Another example discussed by Greene (1993) is the demand for tickets to an event held at an arena. The capacity of the arena is limited, therefore, when a sellout occurs, demand for tickets above the seating capacity is unobserved, which results in a truncated distribution.

A similar argument could be made for the data in these samples. It is possible that some people would experience disutility from having the screening/treatment. As the open-ended responses suggest, this may stem from any number of reasons, including the risk associated with the procedure, a distrust of physicians/medicine, or the anxiety caused by the knowledge that you are at risk for a potentially fatal condition for which treatment does not exist. In cases such as these, it is not unreasonable to assume that some individuals may require payment in order to compensate them for their loss of utility in order to induce them to accept the screening/treatment. However, since the potentially negative WTP for these individuals is unknown, their actual WTP is censored

[116] Named in reference to Tobin (1958) who first proposed the model (Greene 1993).

and simply recorded as a zero. Interestingly, those who choose to have the test/procedure when it is offered for free actually have a WTP=0, so these observations are not truly censored. Therefore, these observations are distinguished from each other such that only those not having the test are treated as censored data in much of the econometric analysis.[117]

Another method for handling the large number of zeros is to treat WTP for the screening/treatment as a two part decision using a hurdle model. In this two-part model, the individual's decision to participate is modeled using a probit or logit specification; then, the outcome variable is modeled using a separate regression but only includes those observations for which participation is observed. The use of a two-part model has become a common practice in analyzing health data, in particular health expenditures. In a study by Deb et al. (2006), which uses a two-part model to investigate the effect of health insurance on medical expenditures, they state "individuals…are more likely to choose [health] insurance based on personal characteristics such as overall health status, the existence and severity of chronic health conditions and physical limitations, preferences for risk, preferences over intensity of treatment, and so on" (Deb et al. 2006 p. 1082). Therefore, it could similarly be argued that an individual's choice of treatment (in the absence of insurance) would also be based on similar factors. Deb et al. (2006) further state that if all of these factors can be included as explanatory variables in the expenditure equation, then this "will adequately control for the influence of these factors" (Deb et al. 2006 p. 1082); however, since many of these factors are unobservable, inclusion of some factors will only control for a portion of this effect; and, as a result, lead to biased coefficients in the expenditure equation. Thus, Deb et al. (2006) recommend modeling the selection of treatment separately from that of expenditures.

7.7 Modeling WTP for Screening

The two approaches discussed above are used to model the WTP for screening. First, a censored regression model is used and then a two-part model (comprised of a probit which models the decision to have the screening test, followed by an OLS

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[117] The cnreg function in STATA is a generalization of tobit that allows the user to designate the censored group. Therefore, instead of all WTP=0 being censored (which occurs when the "tobit, ll" function is used), only those who chose <u>not</u> to have the test will be treated as censored data (TEST=0).

regression on WTP, which only includes those individuals who chose the screening test). For these models, two general specifications are reported - a basic model that includes control variables for income, risk aversion, level of education, treatment effectiveness, and measures of perceived risk as the explanatory variables; and a more detailed model that includes specific risk factors substituted in for perceived risk.

7.7.1 Basic Model: WTP for Screening

The censored regression on WTP presented in Table 7-13 utilizes the STATA command cnreg, which is a generalized tobit function. Using the tobit command would assume that all WTP=0 observations are censored, and would not distinguish between those who chose to have the test when it was offered for free, versus those individuals who chose not to have the screening at any price (those observations that are truly censored). Therefore, using the cnreg function allows only those who chose not to have the screening to be treated as censored observations. Explanatory variables in the censored regression on WTP include household income, whether the respondent lives in a MSA (to account for nominal differences in income), life insurance[118] (as a measure of the individual's degree of risk aversion), the amount of the individual's average monthly spending on medical care (excluding insurance premiums), level of education, treatment effectiveness (30% or 85%)[119] as indicated on the respondent's survey, a measure of the individual's perceived risk, and controls for the starting bid and the respondent's level of certainty regarding their initially stated WTP. Perceived risk can be measured by the respondent's *Perceived Risk* (after the new information was presented to them), or as a combination of their *Initial Perceived Risk* and *Change in Perceived Risk*[120] that resulted from the new information.

In the first specification (See Table 7-13, Column 1), household income is positive and significant at the 1% level. The coefficients on MSA, life insurance, and

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[118] The life insurance variable was also included to capture the individual's willingness to spend financial resources to ensure the wellbeing of their family (spouse and children). During the focus groups, several individuals indicated that they would expend financial resources on the screening for heart attacks to help ensure that they would be around for their spouse or to care for their children. Because not all individuals share this trait, it was felt that whether or not the individual had life insurance would be a better proxy for this unobservable benevolence, as opposed to simply including children and/or married in the regression.
[119] "No Treatment" is the omitted category.
[120] Change in Perceived Risk = Perceived Risk (after new information) minus Initial Perceived Risk

medical spending are all positive, as expected, although not significant. The marginal effect of education on WTP is negative, with significance at the 1% level for those with a graduate degree. The negative coefficients on education were not the expected result;[121] however, this is a consistent finding across all specifications for the entire study, and appears reflective of a change in how consumers gather information before making decisions regarding their health care.

In the past, patients would rely almost solely upon their physician as a source of information related to available treatment options, and when faced with medical decisions would often defer to the physician's recommendation. However, focus group comments, the open-ended responses to these surveys, and conversations with practicing MD's indicate that with the emergence of the Internet, individuals now have another reliable source of information on potential medical care, and this has changed the role of the physician in consumer medical decision making. A growing number of patients, particularly those who are more educated, now view their physician as *one* source of information, and are more likely to research information on their own using the Internet. The opening question for both surveys asked respondents how important it is for their physician to include them in medical decisions regarding their health. Ninety-one percent of those completing *Survey 1: Screening* and 99% of those completing *Survey 2: Treatment* indicated that it was *very important* that they be included in decisions regarding their health. Clearly, this indicates that individuals want to understand their health and be included in making decisions affecting their health.

Although a physician may still have some patients who say "Whatever you think is best, Doc" and defer to their physicians opinion, there is evidence to suggest that this is becoming much less common. Benbasset et al. (1998) discuss how updates in the medical code of ethics regarding the rights of patients to be informed about their medical care has changed the doctor-patient relationship over the last few decades. They explain that the doctor-patient relationship can be viewed as a continuum. At one extreme is the paternalistic model in which the physician is assumed to have the best interest of the patient in mind and therefore acts with authority and autonomy in making treatment

[121] Grossman's (1972) theory suggests that those with higher education would be more likely to make investments in health; therefore, a positive relationship between higher levels of education and WTP would be expected

decisions for the patient. Benbasset et al. state that this type of doctor-patient relationship was not uncommon in the 1950's. At the other extreme is the informative model in which the doctor simply provides information, and the patient is primarily responsible for decisions regarding his/her care. Along this continuum lie varying degrees of shared decision-making in which the doctor provides advice and the patient participates by asking questions and expressing preferences regarding treatment options. From a review of the literature, Benbasset et al. found that individuals who have more severe illnesses, have lower levels of education, are of a minority ethnic group, are male, and/or are elderly have a tendency to prefer a passive role in clinical decision-making (Benbasset et al. 1998). Therefore, it follows that these individuals would be more likely to rely on their physician in making decisions regarding their medical care.

Based on these findings, it is not surprising that patients with higher levels of education may now view their physician's recommendation as simply that "a recommendation." Therefore, the negative coefficient on education may suggest that individuals with higher levels of education are more familiar researching information on their own, and are therefore less likely to select a medical test *on the spot* simply because their physician recommends it. Instead, it appears that highly educated individuals are more likely to conduct their own research and consider that information *in conjunction* with their physician's recommendation[122] prior to making a medical decision.

In the WTP model, the coefficient on the individual's level of perceived risk (after the new information) is positive and significant at the 10% level. To test whether the individual's WTP is dependent more on their *prior* perceived risk or perceived risk stemming from the new information, *Initial Perceived Risk* and *Change in Perceived Risk* are included in the model (See Table 7-13, Column 2). The coefficients on the other covariates remain essentially unchanged; however, *Initial Perceived Risk* becomes significant at the 5% level and *Change in Perceived Risk* is not statistically different from zero. This implies that the WTP for screening is not influenced by the new information, but rather by the individual's prior (established) perception of risk.

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[122] Comments from the focus groups and the open-ended responses indicate that the level of trust the individual has with their doctor will affect how much weight is place on his/her recommendation. Although the survey indicated that the information presented was from their regular physician, some of those individuals who refused treatment clearly did not accept this statement.

To further test whether there is a difference between those who have strong priors on their *Initial Perceived Risk* compared to those with weak priors, dummy variables were created using the respondent's *Initial Perceived Risk* and the strength of this prior. During the survey (immediately following the new information), respondents were asked the following question: "After reading this new information, I feel my risk of having a heart attack within the next year is now…" Possible responses included: much higher, somewhat higher, the same, somewhat lower, or much lower. For those who indicated that their risk remained "the same" after reading the new information, it is presumed that these individuals have strong priors regarding their risk of heart attack. For those who indicated that their risk was either much higher/lower, the new information greatly affected their perception of risk, suggesting weak priors regarding their risk of heart attack. When these variables are included in the regression (See Table 7-13, Column 3), there is a positive and significant (at the 5% level) effect on WTP for *Initial Perceived Risk*, but only for those with strong priors regarding their risk of heart attack. This suggests that those who have a higher perceived risk *and* have more prior knowledge about their risk (or at least believe they do) will have a higher WTP for the screening, compared to those with a higher perceived risk who do not feel as confident about the accuracy of their prior knowledge,

The starting bid was included as a control variable in all the WTP specifications. The coefficient on *Starting Bid* is positive and significant at the 5% level, indicating some degree of starting bias in the data. As discussed in Chapter 2, the contingent valuation literature has shown that bidding games are often prone to starting point bias. Unfortunately, as the empirical results will continue to indicate, the iterative bidding process used for *Survey 1: Screening* and *Survey 2: Treatment* is also subject to some degree of starting point bias. However, as will be shown later in this chapter (See Section *7.9: Correcting for Starting Point Bias*) the correction procedure suggested by Whitehead et al. (1995) is used to correct for the marginal effect of starting point bias such that unbiased estimates of WTP are obtained.

The final specification (See Table 7-13, Column 4) includes dummy variables for treatment effectiveness (30% and 85%)[123] as presented on the respondent's survey. In the

[123] "No Treatment" was the omitted category.

censored regression on WTP, treatment effectiveness is not significantly different from zero. This finding contradicts the expectation from the theoretical model developed in Chapter 4, and suggests that a two part model or Heckman model may be a more appropriate method of analyzing the decision to select and pay for screening.

The basic two-part model includes a probit on whether the individual chooses to receive the screening test (TEST=1), and an OLS regression on WTP for those individuals who chose to have the screening. Explanatory variables for the probit model are essentially the same as the censored model, with the exception of medical spending.[124] In addition, the starting bid and certainty of the respondent's WTP are not included as those are not relevant to the decision to have the screening.

Table 7-14 includes a specification similar to the censored model, using various measures of perceived risk. As before, using *Change in Perceived Risk* with dummies for strong and weak priors on perceived risk offers the best fit (See Table 7-14, Column 3). Household income and MSA are positive as expected, although neither is significant. Life insurance is positive and significant at the 5% level implying that those who are more risk averse are more likely to get the screening. Education is positive for those with a high school education or less, but becomes negative for individuals who have attended at least some college. Although none of the coefficients on education are significant, the signs are consistent with the earlier discussion that those with more education are more likely to conduct their own research when presented with new information before making a health-related consumer decision.

In terms of perceived risk, *Change in Perceived Risk* is positive and significant at the 10% level. This indicates that the new information increases the probability that the respondent will choose to have the screening test. In particular, the coefficient on this variable indicates that the brief information presented in the survey increased the base likelihood of the respondent getting the screening by 3%, *ceteris paribus*. The negative coefficient (significant at the 10% level) on perceived risk for those with weak priors suggests that those individuals with higher levels of perceived risk, who are less certain

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[124] Medical spending was asked immediately prior to respondents entering their final WTP as a means of reminding respondents of their budget constraint; therefore those who answered "no" to a zero bid (indicating that they did not want the screening at any price) did not complete the medical spending question. See Table 7-15 for a comparison of the probits in Table 7-14 when the mean value of medical spending is assigned to the individuals who chose not to have the test.

of those risk assessments, are less likely to get the screening (at least when it is initially presented to them).[125]

So far, the results of the probit model have been largely consistent with those of the censored regression. However, in terms of treatment effectiveness, there is a noticeable difference between the two models. The censored regression indicates the effectiveness of the treatment (for those whose screening indicates they are at high risk) has no statistical effect on WTP. However, the probit model indicates that treatment effectiveness is positive and highly significant (at the 1% level) in the respondent's decision to have the screening. These inconsistent findings bring up an important point regarding the potential validity of using a censored regression in analyzing health data. As discussed earlier in section *7.6.2: General Models for Analyzing Health Data*, different factors may be responsible for the decision to have treatment and other variables responsible for determining the WTP. If all of these variables only affect one of these outcomes and all relevant factors are included in the model, then the tobit can produce reliable results. However, if individual factors influence both the decision to get the screening and the WTP, or if unobservables driving each of these outcomes is omitted from the regression, the marginal effects may not be accurate. The probit clearly indicates that the effectiveness of available treatment influences the decision to have the screening. This is further supported by the open-ended responses of those who chose not to have the screening, many of whom indicated they did not want the screening if treatment was not available. Therefore, it appears that the two-part model may offer more accurate results compared to the censored model.

The second part of the model includes an OLS regression on WTP for those respondents who chose the screening.[126] If the tobit is in fact, capturing the combined effects of the two-part decision, then we would expect household income to be positive and significant, a graduate level education to be negative and significant, and strong priors on *Initial Perceived Risk* to be positive and significant. A comparison of the OLS regression in Table 7-16, Column 3 to the censored regression in Table 7-13, Column 3

[125] It is possible that those individuals would choose to have the screening once they had an opportunity to research more about it on their own.
[126] This includes some respondents for which their WTP=0 (those who would have the screening, but only if it were offered at no out-of-pocket cost to them).

suggests that the tobit model is in fact picking up the effects of the OLS regression; however, the tobit model fails to indicate the significance of treatment effectiveness in the decision to have the screening. Therefore, based on the basic models that include general measures of perceived risk, it appears that the two-part model is more appropriate than the censored regression; and as such, the two-part model is likely to provide more accurate estimates on marginal effects compared to the censored regression.

Another possible way to analyze the data is using a Heckman selection model. The Heckman selection model is an appropriate choice if the correlation between the error terms of the selection equation and regression equation is not equal to zero ($\rho \neq 0$); that is, if there is a relationship between the two equations. A classic application of the Heckman selection model from labor economics is the estimation of a wage equation for women. Applying the Heckman model to this example includes specifying a wage equation that follows the standard model in which the wage is determined by education, experience, and other relevant factors. In addition, a separate selection equation is also defined which models the woman's decision to participate in the labor force. If the choice to participate in the labor force is made randomly, then the error terms between these two equations will not be correlated ($\rho = 0$), making it appropriate to analyze each decision (and treat the equations) separately. However, if the error terms are correlated ($\rho \neq 0$), then analyzing the equations separately (without taken the selection bias into account) could result in biased coefficients. This is likely to occur if women who only have the ability to earn lower wages in the labor market tend to find a higher value for their productivity elsewhere (i.e. the home); thereby making these women less likely to participate in the labor force. If this is indeed the case, then it follows that observed wages will be biased upward as observed wages will tend to be limited to those women who can earn higher wages. However, using a Heckman selection model will adjust for the selection bias; thereby providing unbiased coefficients on the covariates for the wage equation (Maddala 1983) .

To test whether the Heckman selection model is appropriate for this study, two specifications of a Heckman selection model are applied to the *Survey 1: Screening* data and reported in Table 7-17. Model 1 (Table 7-17, Columns 1 and 2) includes *Initial Perceived Risk* and *Change in Perceived Risk* as dependent variables; while Model 2

(Table 7-17, Columns 3 and 4) includes the strength of the individual's priors on perceived risk. Model 1 includes the basic probit equation from Table 7-14, Column 2 as the selection equation, and the basic OLS on WTP from Table 7-16, Column 2 as the regression equation. Model 2 includes the basic probit equation from Table 7-14, Column 3 as the selection equation, and the basic OLS for WTP from Table 7-16, Column 3. Results of the Heckman models (See Table 7-17) are highly consistent with those from the two-part models. In terms of the WTP for screening, the marginal effect of household income is positive and highly significant, as is the individual's self-reported level of initial perceived risk. Including the strength of the individual's prior on perceived risk indicates that those who have strong priors have a statistically significant higher WTP, *ceteris paribus*. Like the two-part model, education in the Heckman model has a negative effect on WTP and is statistically significant for those individuals with a graduate education. In terms of the decision to have the screening test, the selection equation results indicate that higher levels of education decreases the probability of having the screening, and like the probit equation, this result is significant for those individuals with an associates or graduate degree. The Heckman selection equation also indicates that treatment effectiveness is an important factor in the decision to have the screening; In fact, the second Heckman model (Table 7-17, Column 4) indicates that having a treatment available that is 85% effective increases the base probability of having the screening by 34%.

Overall, the results of the Heckman selection model and two-part model are very similar, although the marginal effects differ to some degree. Therefore, which is the best choice? The Heckman selection model provides an estimate of $\lambda = 139.11$ and the results of the likelihood ratio test ($\chi^2 = 54.33$ and $p=0.000$) which, according to the Stata reference manual, is equivalent to testing the null hypothesis that $\rho = 0$, indicate that the null hypothesis can be rejected in favor of the alternative hypothesis $\rho \neq 0$. Therefore, these results clearly support (econometrically) the use of the Heckman model in analyzing the data for *Survey 1: Screening*. However, in choosing the most appropriate model, it is also important to understand what the coefficient results *imply* about WTP. The Heckman selection model reports coefficients that represent the marginal effects of the covariates on WTP assuming that ***all*** individuals will have the screening. Following the example used earlier for women's wages, it is clear to see why it is important to take into account the wages that *could* be earned by women, including those who choose not to participate in the labor force. However, in estimating the demand for screening, it is not clear that this is the information that is most relevant to the questions being addressed by this study.

Clearly, the responses to the open-ended questions for both *Survey 1: Screening* and *Survey 2: Treatment* indicate that some individuals would rationally choose not to have the screening/treatment. Therefore, if the goal of this study is to better understand the *actual* anticipated demand for screening/treatment and its associated marginal effects, then the Heckman model (although mathematically appropriate) may not provide the most useful information. In fact, according to the Stata reference manual, the Heckman model is most appropriate "when the goal is to analyze an underlying regression model or to predict the value of the dependent variable that would be observed in the absence of selection" However, "when the goal is to predict an actual response, the two-part model is usually the better choice" (p. 70). In addition, Manning, Duan, and Rogers (1987) find that for data sets with a non-significant number of zeros, in which these zeros represent actual observations (rather than censored data), the two-part model can perform better than a selection model. It is important to note that for this study the general results of the Heckman model are consistent with the basic findings of the two-part model. However, because the goal of this project is to better understand *actual* anticipated demand for screening/treatment, the focus will be on the two-part model, and as such, will utilize those measures of marginal effects in analyzing the influence of various factors on WTP.

7.7.2 Detailed Model: WTP for Screening

To further explore which specific risk factors may be influencing the decision to have screening and also the determination of WTP for that screening, more detailed models are reported that include specific risk variables in place of a general measure of the respondent's perceived risk. The risk variables include the set of risk factors used earlier in the perceived risk equations (age, gender, race, family history, cholesterol problems, diabetes, hypertension, amount of exercise, amount overweight, smoking or being exposed to second-hand smoke on a daily basis, and taking cholesterol lowering medication).

Table 7-18 presents the results of the probit model including the individual risk factors. In comparing the basic probit model (Table 7-14, Column 3) to the associated detailed probit model (7-18, Column 3), the pseudo R-squared increases from 0.2205 to 0.3929, indicating that the detailed model containing individual risk factors provides a better fit for the data, and explains approximately 39% of the variation in the decision to have the screening. In the detailed model (Table 7-18, Column 3), household income becomes significant at the 5% level. The coefficient does increase quite a bit from the basic model; however, the significance of the income variable in the detailed model (along with the higher R-squared) suggests that the marginal effect of income in Table 7-18, Column 3 is the more precise estimate. MSA remains positive and insignificant, although the coefficient increases in the detailed model. Life insurance is positive and significant at the 1% level. Like income, the coefficient for life insurance increases and becomes more significant in the detailed model. The signs on the education variables remain the same as the basic model, with some relative changes in the coefficients. In addition, the coefficients are significant for those individuals who have attended some college or received an associate's degree. The coefficients on the treatment effectiveness dummies are still positive and highly significant at the 1% level, although the marginal effects do increase to some extent in the more detailed model. In terms of risk factors, those that are significant include: male, hypertension, exercise, and heart attack. The coefficient on male is negative and significant at the 5% level, indicating that men are less likely to get the screening compared to women. Those individuals who have (or who have had) high blood pressure are more likely to get the screening and those who exercise more frequently are less likely to get the screening. Perhaps the most interesting finding is that those who have had a heart attack are far less likely to get screening. However, this is consistent with the theory developed in Chapter 4 because these individuals know they are at high risk of having a heart attack; and therefore, would receive little benefit from the information provided by the screening.

Table 7-19 presents the results of the OLS regression on WTP for those who chose the screening. In the detailed model including the risk factors, household income is positive and significant at the 1% level. The marginal effect is .000933, resulting in an income elasticity of willingness to pay for screening equal to 0.48.[127] This value should not be confused with the income elasticity of demand which, as Flores and Carson (1997) demonstrate, can vary substantially from this value and may even have a different sign. Therefore, the income elasticity of willingness to pay of 0.48, which is positive and less than one, does not indicate that screening is a necessity, nor does it provide evidence that screening is a normal good. In fact, the income elasticity of demand can only be found using the income elasticity of willingness to pay if additional information on cross-price elasticities and the budget shares of other available goods is known, such that it can be included in the calculation (Flores and Carson 1997).

The coefficient on life insurance is positive and significant at the 10% level. MSA and medical spending also indicate a positive effect on WTP, but it is not significant. The coefficients on education are negative with *Some College* and *Bachelor's Degree* significant at the 10% level and *Graduate Degree* significant at the 1% level. Having high cholesterol (or low HDL) is positive and significant at the 5% level and increases WTP for screening by approximately $46. In addition, the negative and significant coefficient on race, indicates that whites are willing to pay approximately $43 less for the screening compared to non-whites. To see if the new information has an effect on WTP in the detailed model, *Change in Perceived Risk* was added to the model, however, it was not significantly different from zero.

A comment made by a discussant, when research from this paper was presented at the ASHE (American Society for Health Economists) conference, suggested that it may be valuable to estimate WTP for men and women separately, as factors that influence WTP may vary across gender. Therefore, to test whether there is a statistically significant difference between the coefficients of the pooled model versus when the gender subgroups are treated separately, a likelihood ratio test was conducted comparing the restricted (pooled) model, to the unrestricted (coefficients are allowed to vary across gender) models. The null hypothesis for the likelihood ratio test is that the coefficients are equal (indicating that the data can be pooled); therefore the resulting $\chi^2 = 45.6$ and p-

[127] (.000933 * 48,223)/94 = 0.48, where 48,223 is mean household income and 94 is the mean WTP for screening.

value of 0.04 indicate that there is a statistically significant difference between the coefficients and that the subgroups should be treated separately. Columns 3 and 4 of Table 7-19 include the detailed regression on WTP for the female sub-sample (Table 7-19, Column 3) and male sub-sample (Table 7-19, Column 4). Although the samples are significantly smaller, n=119 for females and n=133 for males, the results of the likelihood ratio test suggest that gender differences exist in regards to factors that influence WTP. For women, household income, education, frequency of exercise, weight, and diabetes are significant; whereas for men, the significant factors include the effectiveness of treatment, high cholesterol, and obesity.

Since one of the issues regarding the analysis of health data is the accuracy of different models in estimating the marginal effects of the independent variables, Table 7-20 provides a comparison of WTP models for OLS (for TEST=1), the censored regression (cens: TEST=1), the standard tobit (with all WTP=0 observations treated as censored data), and the associated OLS regression (for WTP>0). Based on the above analysis, it appears that the two-part model is the most appropriate in explaining the decision to get screening and estimate the individual's subsequent WTP for screening. In addition, the detailed models for each of these provide information on specific risk factors that are likely to affect the individual's decision to get screening as well as determine their WTP for the test.

7.8 Modeling WTP for Treatment

As mentioned earlier the mean WTP for a new, more effective treatment procedure is $7,821. To better understand the factors influencing the demand for treatment, a two-part model was used, which includes a probit to model the decision to have the procedure, and an OLS regression on WTP for those who chose the procedure as their preferred treatment option.

Tables 7-21 and 7-22 present various specifications for the probit model on the decision to have the treatment procedure, and Table 7-23 reports the results of the OLS regression for WTP for those individuals who chose the procedure. Table 7-21 includes two basic probit models. The first (Table 7-21, Column 1) closely mirrors the specification used for the *Survey 1: Screening* data. Explanatory variables include household income, MSA, life insurance, education, and measures of perceived risk. In addition, the decision to have the procedure may be influenced by the existence of an alternative treatment, drug therapy. Those individuals who are already taking cholesterol lowering medication may feel that the expected benefit from the procedure is not as great because they are already receiving some form of treatment. Therefore, a dummy variable is included to control for the possibility that the individual is already receiving treatment by taking a cholesterol lowering medication.

In the first basic probit model (Table 7-21, Column 1) household income is positive and significant at the 1% level, indicating that individuals with higher levels of income are more likely to get the procedure. The sign on MSA is negative; however, it is not statistically different from zero. Life insurance has a positive coefficient, although it is also not significant. As before, the education variables are all negative, with those individuals who have earned a graduate degree having a significantly lower likelihood of having the procedure. The *Change in Perceived Risk* variable is positive and significant at the 5% level. It is interesting to note that in this specification, *Change in Perceived Risk* is significant, while *Initial Perceived Risk* is not statistically significant at all. Therefore, it appears that the decision to have the procedure is influenced far more by the change in risk resulting from receiving the new information than on past priors concerning the risk of heart attack. As expected, the sign on cholesterol medication is negative, but it is not significant at the 10% level.

As part of *Survey 2: Treatment*, the new treatment procedure was described to respondents before they were asked to select a treatment. Those familiar with a heart catheterization procedure, which involves inserting a small tube into the upper thigh and "threading" it through the blood vessels up into the coronary arteries of the heart, would quickly recognize that the new procedure described in the survey is very similar in nature to a heart catheterization procedure they may have had performed in the past. After the procedure was recommended by the physician, the respondent was asked to select their treatment option – the new procedure or drug therapy. The respondent was also given the option of requesting additional information. Those that requested additional information were provided with more detailed information provided by the specialist who would be performing the procedure. The specialist explained the use of a sedative, the expected length of time needed for recovery (and away from work), as well as provided a general description of what the procedure entailed.

During the survey, it was expected that those individuals who have had a heart catheterization procedure in the past would recognize that they were already somewhat familiar with the new procedure being presented to them; and as a result, would be more willing to choose the new treatment. Likewise, those who requested additional information may feel less comfortable with the procedure and wish to research it in more detail on their own prior to making a decision to have the new treatment. Therefore, it is likely that those who requested additional information would be less likely to choose the procedure.

The second basic specification of the probit model (See Table 7-21, Column 2) tests these assumptions by including the dummy variables *Heart Catheterization* (=1 if the respondent has had a heart catheterization procedure in the past) and *Special Information* (=1 if the respondent requested additional information before selecting a treatment option). As expected, the marginal effect on *Heart Catheterization* is positive and significant at the 5% level, and remains significant across specifications. The coefficient on *Special Information* has a negative sign and is significant at the 10% level; however, this result is not robust when additional explanatory variables are added to the model.

In specifying the remainder of the factors that would influence the decision to have the procedure, comments from focus group participants, as well as the open-ended responses were incredibly useful. Focus group participants for *Survey 2: Treatment* indicated that if they felt the new treatment procedure was valuable enough, they would utilize many different financial resources available to them in order to pay for it. Some focus group participants indicated that they would be willing to take out a second mortgage to access equity in their homes or sell an asset, such as a car or boat. Therefore, in addition to household income, other measures of wealth are included as explanatory variables in the probit equation for who chose to have the procedure. These additional wealth variables include a dummy variable for whether or not the individual owns their home, as well as a measure of how secure the respondent feels their family would be in the event that the respondent were to die suddenly. Respondents had the option of indicating that their families would be very secure, fairly secure, or not very secure, which were coded as a 3, 2, and 1 respectively. Therefore a higher value for *Secure* indicates a higher level security (presumably wealth) that would be available to the respondent's heirs. Although some of this financial security may be the death benefit from a life insurance policy, the model controls for life insurance, such that the variable *Secure* should provide a fairly good proxy for the individual's current level of wealth.

In choosing to have the procedure, focus group participants indicated that time away from work and family obligations were important considerations. The procedure described in *Survey 2: Treatment* is a surgical procedure. Although the procedure is considered minimally invasive, it could require a short stay in the hospital if complications arise. Therefore, individuals who work would need to plan for the possibility that he/she could miss several days of work in order to have the procedure. To account for the fact that some individuals may have more difficulty requesting time off due to the demands of their job, the variable *Stress* was included. In addition, individuals who do not work, but have dependent children to care for may be less likely to choose the procedure, unless a spouse is available. Therefore, dummy variables for *married* and having a dependent child (*Child under 18*) were also included in the model. In addition, the variable male was included to account for possible gender differences.

Finally, the open-ended responses indicated that physical limitations may prevent some individuals from choosing the procedure as their treatment option. Individuals who are disabled may have difficulty getting to the hospital; or as the open-ended responses suggest, other medical conditions may increase the risks associated with the procedure. Individuals who have a very high BMI may feel that the resulting benefit of the procedure will be less for them due to their weight, or they may be less likely to have the procedure because they may feel the risk to them of the procedure is actually higher than the stated risk for the average person. Likewise, individuals who have other chronic health conditions (as measured by the frequency of MD visits) may feel they will obtain a lower overall benefit from the procedure. Finally, those who are very old may feel that the benefit from the procedure is not worth the emotional, physical, and time cost involved for having the procedure and the associated recovery. To account for these potential physical limitations, dummy variables for overweight, obese, and very obese is included as well as a dummy variable to account for the possibility that the individual is disabled. In addition, frequency of MD visits is included as a proxy for chronic conditions and a continuous variable for age is included[128] to account for limitations that might arise from increased age.

In the detailed probit model (See 7-22, Column 1) household income, new information on risk, and having had a heart catheterization procedure are all positively related to choosing the procedure. Education tends to be negative and is significant for high school graduates and individuals with a graduate degree. Higher amounts of stress, being disabled, and increased age all decrease the probability of having the procedure. These variables suggest that limitations in the individual's ability to take time off from work and physical limitations may be factors that hinder individuals from choosing the procedure.

The sample for *Survey 2: Treatment* includes two observations for which WTP was $100,000 and $300,000. These values are considerably higher than the rest of the distribution, and therefore, may be considered outliers. Both of the respondents who indicated these amounts also indicated that were in the top savings category, with savings that exceeded $100,000. Therefore, it is certainly possible that these individuals are willing *and able* to pay these large amounts; however, to consider the effect these two observations have on the marginal effects of the explanatory variables, the same probit was performed without these potential outliers (See Table 7-22, Column 2). A comparison of the two regressions indicates that there is virtually no change in the factors that are significant or in their coefficients. Additionally, a comparison of the detailed probit models (Table 7-22) to the basic probit models (Table 7-21) indicate that income, graduate degree, change in perceived risk, and heart catheter are significant across all specifications. The predictive ability of the detailed models is higher, indicating that the marginal effects obtained from this model are likely to be more precise. However, there is very little change in the coefficient on *Change in Perceived Risk* across specifications, indicating that this result is very robust, as is the marginal effect for those who have had a heart catheterization, which is also very consistent across specifications.

[128] Using dummy variables for age (as was done in prior models) indicated that the marginal effect for each age category was essentially the same, therefore, a continuous variable for age was used.

The results of a likelihood ratio test (χ^2 = 37.45 and p-value of 0.039) suggest that men and women may be influenced by different factors in terms their decision to have the procedure. Therefore, regression results for these two subgroups are reported in Table 7-22. As the probit results in Table 7-22, Column 3 indicate, women with a graduate degree are less likely to get the procedure; however, as discussed previously, this result may simply indicate the desire to research the procedure further prior to committing to have it. In addition, an increase in perceived risk stemming from the new information tends to increase the probability of having the procedure, as does more frequent trips to the doctor. However, women who request additional information about the procedure, are already taking a cholesterol-lowering medication, or report that they are currently under a great deal of stress, are les likely to select the procedure. Interestingly enough, for men, the decision to have the procedure appears to be influenced by only a few factors. Advanced age, being very obese, and working are all highly significant and reduce the probability of men choosing to have the procedure.[129]

The final table presents the results of the OLS regression on WTP for the Procedure (See Table 7-23). The first model (Table 7-23, Column 1) includes all observations[130], and the second (Table 7-23, Column 2) omits the two potential outliers discussed above. A cursory glance reveals that the two models are very different, indicating that the two omitted observations do have a significant effect on the coefficients of the independent variables. Running the model again, indicates that excluding only the observation for which WTP=300,000, provides results that closely resembles those in Table 7-23, Column 2. Therefore, the second model (excluding the outliers) appears to be more accurate.

Looking at the WTP equation in Table 7-23, Column 2, there are several significant variables of interest. As expected, the higher the individual's wealth (as measured by household income and degree of financial security), the more the individual is willing to pay for the procedure. Using the coefficient on income, the income elasticity

[129] Work was interacted with years of education to create a variable to measure the opportunity cost of time. The models presented in Table 7-22 were also run with this interaction term replacing WORK. The overall results and individual coefficients were nearly identical in the two specifications. Including the variable WORK tended to provide a higher R-squared for the WTP models, therefore this was the variable included in the probit models.

[130] All observations for which the individual selected the procedure (Procedure=1).

of willingness to pay for the procedure is estimated to be 0.18.[131] Again, this value may diverge from the income elasticity of demand based on the degree of substitutability between the proposed treatment and other available goods, the cross-price elasticities, and the share of the budget devoted to each good (Flores and Carson 1997). The coefficients on *Change in Perceived Risk* and *Special Info* are negative and significant suggesting that when individuals are presented with new information and ask additional questions about the procedure, they are less confident in the value of the treatment; and are therefore willing to pay less for it. Finally, frequency of MD visits is negative and significant, offering evidence to suggest that those with chronic conditions are willing to pay less for the procedure, presumably because it will have less of an expected benefit to these individuals.

As before, the results of a likelihood ratio test (χ^2 = 95.88 and p-value of 0.000) strongly suggest that the factors influencing the WTP for the procedure vary across gender. For women, household income has a positive and significant effect on WTP, while those who have some college or ask additional questions about the procedure are WTP significantly less for the procedure. For men, new information that changes their perceived risk reduces their WTP, which, as discussed earlier, may result from the individual feeling less confident about the benefits associated with the procedure and therefore lower WTP. Men who are disabled are WTP more, which may suggest that men view the procedure and an alternative way to invest in their health. Men who live in a MSA are willing to pay more for the procedure, which is most likely due to individuals in urban areas being accustomed to paying more for services; and finally, the positive and highly significant (at the 1% level) coefficient on the variable *Secure* suggests that for men, wealth is a very important determinant in their WTP for treatment.

7.9 Correcting for Starting Point Bias

The empirical results on WTP for both screening and treatment suggest that starting point bias is present in the data sets. According to Boyle et al. (1985) starting point bias occurs in iterative bidding when the respondent's final valuation is influenced

[131] (.033 * 43,538)/7,821 = 0.18, where 43,538 is mean household income and 7,821 is the mean WTP for the procedure.

by the first bid the respondent receives. The economics literature has shown that iterative bidding techniques tend to be prone to starting point bias (Whitehead et al. 1995). Brookshire et al. (1981) provide two possible explanations for starting point bias. One possibility is that respondents become bored and terminate the bidding process before reaching their true WTP, especially if the respondent recognizes that the initial bid is considerably different from his/her true valuation. A second possible explanation is that due to lack of consumer markets for the good/service being valued in the survey, respondent's have little or no experience valuing the good; therefore, the initial bid may be viewed as providing market information regarding the value of the good on which the respondent anchors his/her own valuation (Boyle et al. 1985).

Although several iterative bidding studies have identified starting point bias in their data, Whitehead et al. (1995) offer two possible methods for adjusting for starting point bias such that unbiased estimates of WTP can be obtained. Whitehead et al. explain that the appropriate method to be used depends on the cause of the bias. If the starting point bias stems from boredom, then Whitehead et al. suggest using the corrective procedure presented by Farmer and Randall (1994), which includes identifying the starting point that has no marginal effect on stated WTP. However, if the starting point bias results from respondents anchoring their valuation on an initial bid that seems reasonable, then unbiased estimates of WTP can be obtained by subtracting out the marginal effect of the starting point bias (Whitehead et al. 1995). In fact, Whitehead et al. show mathematically that if the marginal effect of the starting point bias can be set equal to zero, that unbiased estimates of WTP can be obtained.

Comments from focus group participants and the completion of the bidding process for a large percentage of the sample suggests that respondent boredom was not a key issue for this study, rather it is more likely that respondents were unfamiliar with the good being valued (since it does not yet exist), and therefore, anchored their valuation on the initial bid presented to them. Since the set of bids from which the initial bid was randomly selected was based on the range of valuations provided by focus group participants in their open-ended surveys, these initial bids would most certainly provide reasonable values to the survey participants. If this is in fact the source of the starting point bias for the data collected in this study, then according to Whitehead et al. (1995), unbiased estimates of WTP can be obtained simply by subtracting out the marginal effect of the starting point bias.

The regression results provide a coefficient for the starting point bias, such that the marginal effect of starting point bias for screening and treatment can be calculated simply by multiplying the coefficient by the mean initial bid for each good. For example, the coefficient of starting point bias in the regression on WTP for screening in Table 7-19, Column 2 is + 0.480. The mean initial bid for *Survey 1: Screening* was $51.58; therefore, it follows that the marginal effect from starting point bias on WTP is an upward bias of $24.76. Therefore, adjusting the mean WTP of $94 down by $25 (in effect, setting the starting point bias=0), yields a mean WTP for screening equal to $69. The median WTP for screening was $50; therefore, adjusting for starting point bias would result in a median WTP of $25. The same procedure can be applied to the *Survey 2: Treatment* data. The coefficient on the starting bid in Table 7-23, Column 2 is .371. Multiplying by the mean starting bid for treatment ($5,404.76) indicates an upward bias of $2,005 due to the initial bid. Adjusting for this potential bias results in a mean WTP for treatment equal to $5,816 and a median WTP of $495.

7.10 Treatment Effectiveness and Value of Statistical Life

The mean reported WTP for the proposed treatment was $7,821. As part of the survey, respondents were told that this new treatment was 85% effective. Therefore, having the treatment would not reduce the individual's risk of heart attack to zero; however, it would diminish it considerably. To find the risk-dollar tradeoff, it is necessary to consider the total marginal costs and benefits of having the treatment. In addition to a monetary cost, the treatment also includes a small risk of death equal to 1/10,000.[132] Respondents indicated a mean level of perceived risk for a heart attack *for this year* to be 30/100,000 or 3/10,000. Since the procedure was stated to be 85% effective, having the procedure would presumably lower the mean risk by 2.55/10,000. However, it is expected that the procedure would be effective at reducing this risk for *several* years (not just one).

[132] This risk stems from the possibility of death from the anesthesia or infection resulting from the procedure.

The implied number of years the treatment is assumed to be effective can be estimated by using the value of a statistical life (VSL). As discussed in Chapter 2, Viscusi and Aldy's (2003) review article find the most reliable VSL estimates to be in the range of 5 million to 9 million dollars. Using this range of VSL estimates and the mean WTP for treatment of $7,821, it can be inferred that respondents expected the treatment to be effective for approximately 3.5 to 6 years.[133] If the mean WTP adjusted for starting point bias is used, then the implied expected duration of treatment is slightly lower at 2.5 to 4.5 years.[134] Therefore, although a VSL can not be calculated directly using the data obtained in the survey, the WTP for treatment obtained in the study is consistent with published VSL estimates assuming that the treatment is effective for an approximate average of 3.5 - 5 years. Since medically this is a very reasonable estimate given this type of procedure, the WTP for treatment obtained in this study appears consistent with estimates from VSL studies.

[133] 2.55/ 10,000 * number of years effective *VSL = $7,821 + 1/10,000
2.55/ 10,000 * number of years effective * 9 million = $7,821 + 1/10,000 = 3.4 years
2.55 /10,000 * number of years effective * 5 million = $7,821 + 1/10,000 = 6.1 years

[134] 2.55/ 10,000 * number of years effective *VSL = $5,816 + 1/10,000
2.55/ 10,000 * number of years effective * 9 million = $5,816 + 1/10,000 = 2.5 years
2.55 /10,000 * number of years effective * 5 million = $5,816 + 1/10,000 = 4.5 years

Table 7-1: Key Summary Statistics for Screening and Treatment Data

Demographics		Screening (n = 268)	Treatment (n=295)
Gender	Male	53%	51%
	Female	47%	49%
Age	Range	18-83	18-91
	Mean Age	48	64
Education	Less than High School	9%	13%
	High School Grad	37%	39%
	Some College	23%	19%
	Associate's Degree	5%	7%
	Bachelor's Degree	17%	15%
	Graduate Degree	9%	6%
Race	White	77%	88%
	Black	8%	7%
	Hispanic	9%	3%
	Other	6%	2%
Household	Married	60%	66%
	Household Size	2.6	2.3
	Head of Household	85%	87%
Work Status	Currently Working	65%	34%
	Retired	20%	47%
	Disabled	6%	10%
	Household Income	$48,223	$43,538
	MSA	83%	87%
Health			
	Self-Reported Health Status	3.4	2.8
	Heart Disease	12%	75%
	Heart Attack	5%	37%
	Taking Cholesterol Medication	17%	63%
	High Cholesterol	35%	59%
	High Blood Pressure	32%	40%
	Diabetes	8%	22%
	Live/Work -Smoking Environment	34%	*
	Family History of Heart Attack	40%	58%
Weight	BMI Range	16-62	16-77
	BMI Mean	28.3	29.2
	Overweight	30%	38%
	Obese	17%	23%
	Very Obese	19%	16%

* Data Not Available

Table 7-2: Summary Statistics for *Survey 1: Screening* (n=268)

Variable	Description	Frequency Distribution					
		5%	25%	Median	75%	95%	
WTP	Willingness To Pay (mean = 94.01, SD = 142.59, min = 0, max= 1000,	0	15	50	100	400	
		male	female				
Male	Respondent's Gender male = 1, female = 0 (mean = .534)	143 (53.36%)	125 (46.64%)				
		married	not married				
Married	Respondent's Marital Status married = 1, not married = 0 (mean = .604)	162 (60.45%)	106 (39.55%)				
		18-34	35-44	45-55	55-64	65+	
Age	Respondent's Age at Time of Joining Panel (mean age=47.85, SD=16.45, min=18, max=83)	68 (25.37%)	52 (19.40%)	48 (17.91%)	46 (17.16%)	54 (20.15%)	
		white	black	hisp	other		
Race	Respondent's Race (4 categories)	206 (76.87%)	22 (8.21%)	24 (8.96%)	16 (5.97%)		
		less HS	HS grad	college	assoc	bach	grad
Education	Respondent's Level of Education (6 categories)	24 (8.96%)	98 (36.57%)	61 (22.76%)	14 (5.22%)	46 (17.16%)	25 (9.33%)
		5%	25%	Median	75%	95%	
Household Income	Household Income (mean = 48,223, SD = 33,398, min = 2500, max= 200,000)	6,250	22,500	45,000	67,500	112,500	
		yes	no				
Life Insurance	Respondent has Life Insurance yes = 1, no = 0 (mean = .668)	179 (66.79%)	89 (33.21%)				
		yes	no				
MSA	Respondent resides in a Metropolitan Statistical Area yes = 1, no = 0 (mean = .825)	221 (82.46%)	47 (17.54%)				
		5%	25%	Median	75%	95%	
Medical Spending	Medical Spending (mean = 47.89, SD = 70.65, min = 10, max= 650, median=35)	10	10	35	48	150	
		normal	over	obese	v. obese		
Weight	Respondent's Weight (4 categories)	91 (33.96%)	80 (29.85%)	45 (16.79%)	52 (19.40%)		
		0%	30%	85%			
Treatment Effectiveness	0%=no treatment, 30%=treatment is 30% effective (drug therapy), 85%=treatment is 85% effective (new procedure)	43 (16.04%)	94 (35.07%)	131 (48.88%)			

Table 7-2 (continued)

Variable	Description	Frequency Distribution					
		1	2	3	4	5	
General Health	Self reported general health status (5 categories) 1=poor, 5=excellent (mean =3.44 SD=1.01 median=3.5)	8 (2.99%)	39 (14.55%)	87 (32.46%)	94 (35.07%)	40 (14.93%)	
		Yes	No				
Heart Disease	Self reported heart disease status yes = 1, no = 0 (mean = .116)	31 (11.57%)	237 (88.43%)				
		Yes	No				
Heart Attack	Has respondent had a heart attack yes = 1, no = 0 (mean = .045)	12 (4.48%)	256 (95.52%)				
		Yes	No				
Cholesterol Medication	Does respondent take cholesterol lowering medication yes = 1, no = 0 (mean = .172)	46 (17.16%)	222 (82.84%)				
		Yes	No				
Life Threatening Condition	Has respondent ever expereince a life threatening condition or illness yes = 1, no = 0 (mean = .243)	65 (24.25%)	203 (75.75%)				
		0	1	2	3	4	5
Stress	Respondent's Reported Level of Stress (6 categories) 0 = none, 5 = most (mean =2.70 SD=1.29)	12 (4.48%)	34 (12.69%)	76 (28.36%)	66 (24.62%)	57 (21.27%)	23 (8.58%)
		0	1	2	3	4	
Exercise	Respondent's Reported frequency of Exercise (5 categories) 0 = none, 4 = most (mean=1.74 SD=1.21)	12 (4.46%)	257 (95.54%)				
		5%	25%	Median	75%	95%	
Amount over Ideal BMI	Amount that Respondent's body mass index is >24.9 (high end of normal) (mean = 4.38, SD = 6.07, min = 0, max= 28.1)	0	0	2.6	6.1	18.1	
		5%	25%	Median	75%	95%	
Frequency of MD Visits	Frequency with which respondent goes to doctor's office for treatment (mean = 2.20, SD = 1.81, min = 0, max= 10)	0	1	2	3	5	
		5%	25%	Median	75%	95%	
Perceived Risk	Respondent's reported Perceived Risk after new information (mean = 17.92, SD = 16.0, min = 0, max= 100)	0	5	15	25	50	
		5%	25%	Median	75%	95%	
Initial Perceived Risk	Respondent's reported Perceived Risk prior to new information (mean = 15.07, SD = 14.16, min = 0, max= 80)	0	4.5	10	24	47	
		5%	25%	Median	75%	95%	
Change in Perceived Risk	Amount of change in perceived risk from initial value (mean = 2.84, SD = 8.76, min = -50, max= 80)	-2	0	0	5	19	

Table 7-2 (continued)

Variable	Description	Frequency Distribution				
		mean	std dev	min	max	
Strong Prior on Perceived Risk	Perceived risk if new information had no effect	9.4	12.89	0	50	
		mean	std dev	min	max	
Weak Prior on Perceived Risk	Perceived risk if new information had large effect	1.5	7.48	0	60	
		Yes	No			
Diabetes (Broad)	Respondent has diabetes[a] yes = 1, no = 0 (mean = .078)	21 (7.84%)	247 (92.16%)			
		Yes	No			
Hypertension (Broad)	Respondent has hypertension[a] yes = 1, no = 0 (mean = .321)	86 (32.09%)	182 (67.91%)			
		Yes	No			
High Cholesterol or Low HDL	Respondent has high cholestrol or low HDL yes = 1, no = 0 (mean = .302)	81 (30.22%)	187 (69.78%)			
		Yes	No			
Family History (Broad)	A member of respondent's family has had a heart attack[b] yes = 1, no = 0 (mean = .399)	107 (39.93%)	161 (60.07%)			
		10	40	50	60	100
Starting Bid	First bid in iterative bidding (mean = 51.68, SD = 28.53, min = 10, max = 100)	51 (19.03%)	58 (21.64%)	52 (19.40%)	57 (21.27%)	50 (18.66%)
		0	1 or 2	3	4	5
Certainty (Broad)	Certainty of initial WTP[c] (mean = 7.28, SD = 2.62, min = 0, max = 10)	8 (2.99%)	9 (3.36%)	9 (3.36%)	9 (3.36%)	33 (12.31%)
		6	7	8	9	10
Certainty (Broad)	(continued)	20 (7.46%)	33 (12.52%)	46 (17.16%)	23 (8.58%)	78 (29.10%)

[a] combines health data from Knowledge Networks with survey data

[b] combines questions from AHA risk quiz with other survey questions

[c] certainty of 10 assigned to observations with WTP=0

Table 7-2 (continued - Risk Factors on AHA Risk Assessment Quiz)

	Variable	Description	Mean	Std. Dev.	Min	Max
r1	Male over Age 45	Respondent is a male over the age of 45	0.295	0.457	0	1
r2	Female over Age 55	Respondent is a female over the age of 55	0.212	0.409	0	1
r3	Family history of Heart Attack	Repondent has a father/brother under age 55 OR mother/sister under age 65 who expereinced a heart attack	0.172	0.378	0	1
r4	Smoke or Live/Work witrh Smoker	Respondent smokes or lives/works with people who smoke everyday	0.34	0.474	0	1
r5	High Cholesterol	Respondent has a cholesterol level of 240 or higher OR has been told by doctor that he/she has high cholesterol	0.22	0.42	0	1
r6	Low HDL (Good Cholesterol)	Respondent's HDL ("good") cholesterol is less than 35	0.127	0.333	0	1
r7	Hypertension	Respondent's blood pressure is 140/90 or higher OR has been told by doctor that he/she has high blood pressure	0.25	0.434	0	1
r8	Less than 30 Min. Physical Activity	Respondent reports that he/she gets less than 30 minutes of physical activity on most days	0.381	0.486	0	1
r9	20 Pounds or more overweight	Respondent reports that he/she is is 20 pounds or more overweight for their height and build	0.496	0.501	0	1
r10	Diabetes	Respondent has diabetes OR a fasting blood sugar of 126 or higher OR takes medicine to control his/her blood sugar	0.075	0.263	0	1
r11	Heart Attack or Heart Disease	Respondent has coronoary heart disease or has a heart attack	0.045	0.207	0	1

Table 7-3: Summary Statistics for *Survey 2: Treatment* (n=295)

Variable	Description	Frequency Distribution					
		5%	25%	Median	75%	95%	
WTP	Willingness To Pay (mean = 7,821, SD = 21,084, min = 0, max= 300,000)	0	150	2,500	8,000	30,000	
		male	female				
Male	Respondent's Gender male = 1, female = 0 (mean = .505)	149 (50.51%)	146 (49.49%)				
		married	not married				
Married	Respondent's Marital Status married = 1, not married = 0 (mean = .661)	195 (66.10%)	100 (33.90%)				
		18-34	35-44	45-55	55-64	65-74	75+
Age	Respondent's Age at Time of Joining Panel (5 categories, mean = 63.71, SD = 13.77, min = 18, max = 91)	7 (2.37%)	23 (7.80%)	41 (13.90%)	67 (22.71%)	90 (30.51%)	67 (22.71%)
		white	black	hisp	other		
Race	Respondent's Race (4 categories)	259 (87.80%)	21 (7.12%)	9 (3.05%)	6 (2.03%)		
		less HS	HS grad	college	assoc	bach	grad
Education	Respondent's Level of Education (6 categories)	39 (13.22%)	116 (39.32%)	57 (19.32%)	20 (6.78%)	44 (14.92%)	19 (6.44%)
		5%	25%	Median	75%	95%	
Household Income	Household Income (mean = 43,538, SD = 30,057, min = 2500, max= 162,500)	8750	22500	37500	55000	112500	
		yes	no				
Life Insurance	Respondent has Life Insurance yes = 1, no = 0 (mean = .739)	218 (73.90%)	77 (26.10%)				
		yes	no				
MSA	Respondent resides in a Metropolitan Statistical Area yes = 1, no = 0	257 (87.12%)	38 (12.88%)				
		normal	over	obese	v obese		
Weight	Respondent's Weight (4 categories)	70 (23.37%)	111 (37.63%)	67 (22.71%)	47 (15.93%)		
		yes	no				
Procedure	Did Respondent choose the Procedure yes = 1; no = 0 (mean=.854)	252 (85.42%)	43 (14.58%)				
		procedure	meds	none			
Treatment	Treatment selected by Respondent Meds=Medication only; None=neither treatment option was chosen	252 (85.42%)	36 (12.20%)	7 (2.37%)			

Table 7-3 (continued)

Variable	Description	Frequency Distribution					
		1	2	3	4	5	
General Health	Self reported general health status (5 categories) 1=poor, 5=excellent (mean =2.78 SD=0.96 median=3.5)	27 (9.15%)	88 (29.83%)	109 (36.95%)	65 (22.03%)	6 (2.03%)	
		Yes	No				
Heart Attack	Has respondent had a heart attack yes = 1, no = 0 (mean = .373)	110 (37.29%)	185 (62.71%)				
		0	1	2	3	4	
Decrease in Quality of Life from heart attack	Amount a heart attack affects ability to work, perform daily activities, and overall quality of life (mean=2.12, SD=1.23)	39 (13.22%)	52 (17.63%)	78 (26.44%)	88 (29.83%)	38 (12.88%)	
		Yes	No				
Cholesterol Medication	Does respondent take cholesterol lowering medication yes = 1, no = 0 (mean = .627)	185 (62.71%)	110 (37.29%)				
		Yes	No				
Life Threatening Condition	Respondent has expereinced a life threatening condition or illness yes = 1, no = 0 (mean = .664)	196 (66.44%)	99 (33.56%)				
		0	1	2	3	4	5
Stress	Respondent's Reported Level of Stress (6 categories) 0 = none, 5 = most (mean =2.63 SD=1.33)	16 (5.42%)	45 (15.25%)	80 (27.12%)	72 (24.41%)	56 (18.98%)	26 (8.81%)
		0	1	2	3	4	
Exercise	Respondent's Reported frequency of Exercise (5 categories) 0 = none, 4 = most (mean=1.92 SD=1.33)	60 (20.34%)	57 (19.32%)	59 (20.00%)	83 (28.14%)	36 (12.2%)	
		5%	25%	Median	75%	95%	
Amount over BMI	Amount that Respondent's BMI > 24.9 (high end of normal) (mean = 4.92, SD = 6.58, min = 0, max= 52.1)	0	0.1	3.1	7.1	16.1	
		5%	25%	Median	75%	95%	
Frequency of MD Visits	Frequency with which respondent goes to doctor's office for treatment (mean = 2.20, SD = 1.81, min = 0, max= 10)	0	1	2	3	5	
		5%	25%	Median	75%	95%	
Perceived Risk	Respondent's reported Perceived Risk after new information (mean = 30.22, SD = 21.5, min = 0, max= 100)	2	15	25	45	74	
		5%	25%	Median	75%	95%	
Initial Perceived Risk	Respondent's reported Perceived Risk prior to new information (mean = 26.56, SD = 18.94, min = 0, max= 85)	2	10	23	40	60	
		5%	25%	Median	75%	95%	
Change in Perceived Risk	Amount of change in perceived risk from initial value (mean = 3.65, SD = 8.35, min = -20, max= 50)	-5	0	0	6	20	

Table 7-3 (continued)

Variable	Description	Frequency Distribution				
		yes	no			
Child Under 18	Respondent has child under 18 years old yes = 1, no = 0	37 (12.54%)	258 (87.46%)			
		yes	no			
Info Special	Respondent requested additional information about procedure yes = 1, no = 0	144 (48.81%)	151 (51.19%)			
		mean	std dev	min	max	
Strong Prior on Perceived Risk	Perceived risk if new information had no effect	15.26	18.74	0	85	
		mean	std dev	min	max	
Weak Prior on Perceived Risk	Perceived risk if new information had large effect	1.86	9.03	0	75	
		1	2	3		
Secure	How financially secure family would be if respondent died (not secure=1, fairly secure=2, very secure=3)	61 (20.68%)	155 (52.54%)	79 (26.78%)		
		yes	no			
Own Home	Respondent owns home yes = 1, no = 0	233 (78.98%)	62 (21.02%)			
		yes	no			
Work	Respondent works yes = 1, no = 0	100 (33.90%)	195 (66.10%)			
		yes	no			
Disabled	Respondent is disabled yes = 1, no = 0	30 (10.17%)	265 (89.83%)			
		1000	2000	5000	8000	10,000
Starting Bid	First bid in iterative bidding[a] mean = 5404.76, SD = 3415.87, min = 1000, max = 10000)	47 (18.65%)	46 (18.25%)	51 (20.24%)	56 (22.22%)	52 (20.63%)
		0	1 or 2	3	4	5
Certainty (Broad)	Certainty of initial WTP[b] (mean = 6.83, SD = 3.06, min = 0, max = 10)	19 (2.99%)	12 (4.07%)	17 (5.76%)	10 (3.39%)	43 (14.58%)
		6	7	8	9	10
Certainty (Broad)	(continued)	19 (6.44%)	27 (9.15%)	40 (13.56%)	15 (5.00%)	93 (31.53%)

[a] includes n = 252 (respondents who did not choose the procedure, did not participate in the interative bidding)

[b] certainty of 10 assigned to observations with WTP=0

Table 7-3 (continued)

Variable	Description	Mean	Std. Dev.	Min	Max	n
Family history of Heart Attack	Respondent has an immediate family member who has experienced a heart attack yes = 1; no = 0	0.576	0.495	0	1	295
High Cholesterol	Respondent has doctor-diagnosed high cholesterol (from KN health data) yes = 1; no = 0	0.593	0.492	0	1	295
Hypertension	Respondent has doctor-diagnosed high blood pressure (from KN - health data) yes = 1; no = 0	0.397	0.490	0	1	295
Diabetes	Respondent has doctor-diagnosed diabetes (from KN health data) yes = 1; no = 0	0.220	0.415	0	1	295
Heart Catheter	Respondent has had heart catheter procedure yes = 1, no = 0	0.505	0.501	0	1	295

Table 7-4: *Survey 1: Screening* OLS Regression on General Health

Independent Variable	Self-Reported General Health as Dependent Variable			
AGE 35-44	- 0.265* (0.164)	- 0.285* (0.159)	- 0.323** (0.157)	- 0.312* (0.161)
AGE 45-54	- 0.399** (0.169)	- 0.329** (0.164)	- 0.384** (0.162)	- 0.454*** (0.165)
AGE 55-64	- 0.461*** (0.173)	- 0.448*** (0.168)	- 0.495*** (0.165)	- 0.514*** (0.169)
AGE 65 and above	- 0.469*** (0.173)	- 0.332* (0.171)	- 0.303* (0.168)	- 0.417** (0.169)
High School Graduate	0.080 (0.201)	0.064 (0.195)	0.009 (0.191)	0.014 (0.196)
Some College	0.213 (0.216)	0.169 (0.209)	0.070 (0.207)	0.092 (0.212)
Associates Degree	0.267 (0.298)	0.283 (0.289)	0.187 (0.285)	0.157 (0.292)
Bachelors Degree	0.448** (0.223)	0.410* (0.216)	0.250 (0.218)	0.258 (0.223)
Graduate Degree	0.173 (0.255)	0.107 (0.248)	- 0.128 (0.253)	- 0.108 (0.259)
Life Threatening Condition	- 0.553*** (0.134)	- 0.437*** (0.133)	- 0.411*** (0.130)	- 0.507*** (0.131)
Amount of Stress	- 0.142*** (0.044)	- 0.117*** (0.043)	- 0.115*** (0.042)	- 0.137*** (0.043)
Frequency of Exercise	0.124*** (0.046)	0.106** (0.044)	0.104** (0.043)	0.119*** (0.044)
Amount Over Ideal BMI	- 0.039*** (0.009)	- 0.029*** (0.009)	- 0.029*** (0.009)	- 0.037*** (0.009)
Freqency of MD Visits		- 0.136*** (0.033)	- 0.121*** (0.032)	
Household Income			5.68e-06*** (1.70e-06)	6.60e-06*** (1.72e-06)
Constant	4.03*** (0.243)	4.21*** (0.239)	4.01*** (0.242)	3.82*** (0.243)
F	**7.62**	**8.79**	**9.28**	**8.51**
Prob > F	**0.0000**	**0.0000**	**0.0000**	**0.0000**
R^2	**0.2807**	**0.3272**	**0.3558**	**0.3202**
Adjusted R^2	**0.2439**	**0.2899**	**0.3175**	**0.2826**
Root MSE	**0.8779**	**0.8508**	**0.8341**	**0.8552**
N	**268**	**268**	**268**	**268**

***** significant at the 1% level**
**** significant at the 5% level**
*** significant at the 10% level**

Table 7-5: *Survey 1: Screening* OLS Regression on General Health with Overweight Variables

Independent Variable	**Self-Reported General Health as Dependent Variable**			
AGE 35-44	-0.299* (0.165)	-0.309* (0.159)	-0.345** (0.156)	-0.342** (0.161)
AGE 45-54	-0.437** (0.170)	-0.351** (0.165)	-0.400** (0.163)	-0.483*** (0.166)
AGE 55-64	-0.461*** (0.174)	-0.447*** (0.169)	-0.491*** (0.166)	-0.510*** (0.170)
AGE 65 and above	-0.471*** (0.177)	-0.329* (0.174)	-0.295* (0.171)	-0.412** (0.173)
High School Graduate	0.111 (0.203)	0.087 (0.196)	0.029 (0.193)	0.039 (0.198)
Some College	0.270 (0.219)	0.218 (0.212)	0.114 (0.210)	0.142 (0.216)
Associates Degree	0.406 (0.308)	0.401 (0.297)	0.291 (0.293)	0.277 (0.301)
Bachelors Degree	0.490** (0.225)	0.438** (0.217)	0.273 (0.219)	0.290 (0.225)
Graduate Degree	0.229 (0.257)	0.153 (0.249)	-0.086 (0.254)	-0.060 (0.262)
Life Threatening Condition	-0.556*** (0.135)	-0.434*** (0.133)	-0.406*** (0.137)	-0.508*** (0.132)
Amount of Stress	-0.150*** (0.044)	-0.122*** (0.043)	0.120*** (0.042)	-0.144*** (0.043)
Frequency of Exercise	0.121*** (0.046)	0.102** (0.045)	0.100** (0.044)	0.116*** (0.045)
Overweight	-0.155 (0.138)	-0.133 (0.134)	-0.163 (0.131)	-0.187 (0.135)
Obese	-0.468*** (0.168)	-0.368** (0.164)	-0.382** (0.161)	-0.473*** (0.164)
Very Obese	-0.606*** (0.164)	-0.492*** (0.161)	-0.482*** (0.158)	-0.579*** (0.160)
Freqency of MD Visits		-0.140*** (0.032)	-0.125*** (0.032)	
Household Income			5.70e-06*** 1.71e-06	6.67e-06*** (0.1.73e-06)
Constant	4.098*** (0.253)	4.281*** (0.248)	4.091*** (0.249)	3.899*** (0.251)
F	**6.56**	**7.77**	**8.27**	**7.41**
Prob > F	**0.0000**	**0.0000**	**0.0000**	**0.0000**
R^2	**0.2809**	**0.3313**	**0.3599**	**0.321**
Adjusted R^2	**0.2381**	**0.2886**	**0.3163**	**0.2777**
Root MSE	**0.8813**	**0.8515**	**0.8348**	**0.8581**
N	**268**	**268**	**268**	**268**

***** significant at the 1% level**
**** significant at the 5% level**
*** significant at the 10% level**

Table 7-6: *Survey 2: Treatment* OLS Regression on General Health

Independent Variable	**Self-Reported General Health as Dependent Variable**			
AGE 35-44	-0.144 (0.381)	-0.115 (0.370)	-0.111 (0.368)	-0.138 (0.379)
AGE 45-54	- 0.465 (0.361)	- 0.431 (0.351)	- 0.405 (0.350)	- 0.433 (0.360)
AGE 55-64	- 0.689** (0.352)	- 0.655* (0.342)	- 0.629* (0.341)	- 0.658** (0.350)
AGE 65-74	- 0.780** (0.348)	- 0.716** (0.339)	- 0.661* (0.339)	- 0.714** (0.348)
AGE 75 and above	- 0.919*** (0.353)	- 0.788** (0.344)	- 0.731** (0.344)	- 0.849** (0.353)
High School Grraduate	0.095 (0.167)	0.023 (0.163)	0.018 (0.163)	0.087 (0.166)
Some College	0.214 (0.189)	0.150 (0.184)	0.117 (0.184)	0.175 (0.189)
Associates Degree	0.617** (0.245)	0.575** (0.238)	0.545** (0.238)	0.580** (0.244)
Bachelors Degree	0.604*** (0.200)	0.557*** (0.195)	0.488** (0.198)	0.523** (0.203)
Graduate Degree	0.475* (0.253)	0.388 (0.247)	0.267 (0.255)	0.333 (0.262)
Life Threatening Condition	- 0.232** (0.118)	- 0.195* (0.109)	- 0.190** (0.108)	- 0.224** (0.111)
Amount of Stress	- 0.151*** (0.040)	- 0.126*** (0.040)	- 0.122*** (0.040)	- 0.146*** (0.040)
Frequency of Exercise	0.066* (0.041)	0.061 (0.041)	0.058 (0.040)	0.063 (0.041)
Amount Over Ideal BMI	- 0.027*** (0.008)	- 0.022*** (0.008)	- 0.021*** (0.008)	- 0.025*** (0.008)
Freqency of MD visits		- 0.131*** (0.031)	- 0.128*** (0.031)	
Household Income			3.23e-06** (1.81e-06)	3.73e-06** (1.86e-06)
Constant	3.77*** (0.410)	4.08*** (0.405)	3.91*** (0.416)	3.58*** (0.420)
F	**5.33**	**6.46**	**6.3**	**5.29**
Prob > F	**0.0000**	**0.0000**	**0.0000**	**0.0000**
R^2	**0.2103**	**0.2577**	**0.2661**	**0.2215**
Adjusted R^2	**0.1708**	**0.2178**	**0.2238**	**0.1796**
Root MSE	**0.8738**	**0.8486**	**0.8453**	**0.8691**
N	**295**	**295**	**295**	**295**

***** significant at the 1% level**
**** significant at the 5% level**
*** significant at the 10% level**

Table 7-7: *Survey 1: Screening* OLS Regression on Initial Perceived Risk of a Heart Attack

Category	Independent Variable	Initial Perceived Risk	Initial Perceived Risk	Initial Perceived Risk	Initial Perceived Risk
Risk Factors	male			1.175 (1.606)	1.529 (1.547)
	Age 35-44			3.267 (2.361)	2.119 (2.286)
	Age 45-54			5.415** (2.441)	4.163* (2.365)
	Age 55-64			8.064*** (2.631)	7.871*** (2.532)
	Age 65 or higher			6.226** (2.634)	6.484** (2.535)
r1	Male over Age 45	7.586*** (1.976)	7.704*** (1.883)		
r2	Female over Age 55	7.672*** (2.087)	7.671*** (1.989)		
r3	Family History of Heart Attack	2.676 (2.090)	1.484 (2.005)	3.192 (2.114)	1.778 (2.058)
r4	Smoke or Live / Work with Smokers	1.582 (1.663)	0.817 (1.591)	1.546 (1.704)	1.130 (1.642)
r5	High Cholesterol	5.784** (2.491)	5.422** (2.375)	6.725*** (2.466)	6.577*** (2.373
r6	Low HDL (Good Cholesterol)	-1.246 (2.329)	-2.108 (2.225)	-2.368 (2.348)	-3.058 (2.265)
r7	Hypertension	0.246 (1.939)	-1.107 (1.866)	0.186 (1.949)	-1.203 (1.900)
r8	Less than 30 Minutes Physical Activity / Day	1.463 (1.607)	0.164 (1.552)	0.956 (1.634)	-0.086 (1.589)
r9	20 Pounds or More Overweight	5.069*** (1.663)	3.360** (1.619)	5.194*** (1.707)	3.799** (2.270)
r10	Diabetes	4.281 (3.299)	2.475 (3.163)	3.372 (3.349)	2.125 (0.660)
r11	Heart Disease OR Heart Attack	12.833*** (4.198)	9.117** (4.064)		
	Heart Disease			7.629*** (2.883)	5.311* (2.821)
	Heart Attack			10.818** (4.260)	9.467** (4.110)
Medication	Taking Cholestrol Medication	-2.395 (2.932)	-3.170 (2.797)	-3.620 (3.044)	-4.577 (2.937)
General Health	General Health		-4.301*** (0.837)		-3.914*** (.861)
Education	High School Graduate	-7.169** (2.888)	-6.398** (2.756)	-6.334** (2.880)	-5.765** (2.774)
	Some College	-6.632** (3.056)	-5.433* (2.921)	-6.491** (3.054)	-5.500* (2.947)
	Associates Degree	-8.499** (4.226)	-7.616* (4.030)	-10.227** (4.218)	-9.045** (4.068)
	Bachelors Degree	-9.394*** (3.236)	-7.136** (3.114)	-8.565*** (3.237)	-6.567** (3.146)
	Graduate Degree	-9.223** (3.625)	-8.407** (3.457)	-9.378*** (3.623)	-8.680** (3.490)
	constant	12.816*** (2.858)	29.270*** (4.212)	10.682*** (3.180)	26.008*** (4.554)
	F	**5.88**	**7.59**	**5.09**	**6.19**
	Prob > F	**0.0000**	**0.0000**	**0.0000**	**0.0000**
	R^2	**0.2857**	**0.3543**	**0.3030**	**0.3572**
	Adjusted R^2	**0.2372**	**0.3076**	**0.2435**	**0.2994**
	Root MSE	**12.369**	**11.784**	**12.317**	**11.853**
	N	**268**	**268**	**268**	**268**

***** significant at the 1% level**
**** significant at the 5% level**

Table 7-8: *Survey 1: Screening* OLS Regression on Perceived Risk of a Heart Attack After New Information

Category	Independent Variable	Perceived Risk after New Info	Perceived Risk after New Info	Perceived Risk after New Info	Perceived Risk after New Info
Risk Factors	male			-.019 (1.878)	0.347 (1.826)
	Age 35-44			4.555* (2.760)	3.369 (2.697)
	Age 45-54			4.922* (2.853)	3.628 (2.790)
	Age 55-64			9.314*** (3.076)	9.114*** (2.988)
	Age 65 or higher			6.763** (3.079)	7.029** (2.991)
r1	Male over Age 45	7.012*** (2.275)	7.129*** (2.197)		
r2	Female over Age 55	8.945*** (2.403)	8.944*** (2.320)		
r3	Family History of Heart Attack	3.339 (2.406)	2.156 (2.339)	3.855 (2.472)	2.394 (2.428)
r4	Smoke or Live / Work with Smokers	3.980** (1.914)	3.220* (1.856)	3.839* (1.992)	3.410* (1.938)
r5	High Cholesterol	4.809* (2.868)	4.450 (2.771)	5.664* (2.883)	5.511** (2.800)
r6	Low HDL (Good Cholesterol)	1.178 (2.681)	0.322 (2.596)	0.061 (2.746)	-0.653 (2.672)
r7	Hypertension	-0.616 (2.232)	-.1959 (2.177)	-0.608 (2.278)	-2.045 (2.242)
r8	Less than 30 Minutes Physical Activity / Day	0.490 (1.850)	-0.800 (1.811)	0.168 (1.911)	-0.909 (1.875)
r9	20 Pounds or More Overweight	8.227*** (1.915)	6.531*** (1.889)	8.243*** (1.996)	6.800*** (1.971)
r10	Diabetes	1.346 (3.789)	-0.446 (3.691)	1.052 (3.916)	-0.236 (3.816)
r11	Heart Disease OR Heart Attack	13.688*** (4.833)	10.000** (4.742)		
	Heart Disease			4.931 (3.371)	2.535 (3.328)
	Heart Attack			11.320** (4.981)	9.924** (4.849)
Medication	Taking Cholestrol Medication	-2.179 (3.375)	-2.948 (3.264)	-2.846 (3.559)	-3.835 (3.465)
General Health	General Health		-4.269*** (0.976)		-4.045*** (1.016)
Education	High School Graduate	-6.856** (3.325)	-6.091* (3.215)	-6.135* (3.367)	-5.547* (3.274)
	Some College	-6.609* (3.518)	-5.419 (3.408)	-6.502* (3.570)	-5.478 (3.477)
	Associates Degree	-7.145 (4.865)	-6.269 (4.702)	-9.065* (4.932)	-7.844 (4.799)
	Bachelors Degree	-7.104* (3.725)	-4.862 (3.633)	-6.738* (3.785)	-4.673 (3.712)
	Graduate Degree	-9.093** (4.173)	-8.283** (4.034)	-9.381** (4.236)	-8.659** (4.118)
	constant	13.056*** (3.290)	29.387*** (4.903)	11.556*** (3.718)	27.397*** (5.373)
	F	**5.15**	**6.28**	**4.00**	**4.77**
	Prob > F	**0.0000**	**0.0000**	**0.0000**	**0.0000**
	R^2	**0.2594**	**0.3122**	**0.2545**	**0.2998**
	Adjusted R^2	**0.2090**	**0.2625**	**0.1909**	**0.2370**
	Root MSE	**14.239**	**13.749**	**14.401**	**13.985**
	N	**268**	**268**	**268**	**268**

***** significant at the 1% level**
**** significant at the 5% level**
*** significant at the 10% level**

Table 7-9: *Survey 1: Screening* OLS Regression on Perceived Risk of a Heart Attack

Category	Independent Variable	Initial Perceived Risk	Perceived Risk after New Info	Initial Perceived Risk	Perceived Risk after New Info
Risk Factors	male	-0.494 (1.593)	-1.486 (1.889)	-0.491 (1.599)	-1.434 (1.884)
	Age 35-44	3.275 (2.350)	5.178* (2.787)	3.121 (2.363)	4.756* (2.785)
	Age 45-54	5.154** (2.487)	5.179* (2.951)	4.995** (2.504)	4.827* (2.951)
	Age 55-64	7.891*** (2.675)	9.523*** (3.173)	7.860*** (2.709)	9.682*** (3.193)
	Age 65 or higher	6.542** (2.823)	7.168** (3.349)	6.264** (2.904)	6.782** (3.422)
	Family History⅄ (Broad)	2.665 (1.680)	3.240 (1.993)	2.639 (1.685)	3.172 (1.986)
	Smoke or Live / Work with Smokers	1.107 (1.707)	3.093 (2.024)	1.027 (1.722)	2.985 (2.030)
	High Cholesterol or Low HDL	2.680 (2.001)	3.965* (2.373)	2.621 (2.013)	3.712 (2.373)
	Hypertension✦ (Broad)	1.397 (1.859)	0.907 (2.206)	1.323 (1.867)	0.691 (2.200)
	Exercise	-0.720 (0.654)	-0.829 (0.776)	-0.701 (0.657)	-0.771 (0.774)
	Overweight	4.885** (2.003)	4.602* (2.376)	4.871** (2.009)	4.549* (2.368)
	Obese	5.693** (2.409)	5.883** (2.857)	5.700** (2.415)	5.890** (2.846)
	Very Obese	8.509*** (2.440)	8.781*** (2.894)	8.493*** (2.448)	8.785*** (2.885)
	Diabetes✦ (Broad)	1.976 (3.142)	0.406 (3.727)	1.615 (3.182)	-0.639 (3.751)
	Heart Disease	6.633** (2.906)	4.137 (3.448)	6.111** (2.981)	2.711 (3.513)
	Heart Attack	10.687** (4.312)	10.987** (5.116)	10.366** (4.341)	10.103** (5.116)
	White	-1.449 (1.914)	-0.404 (2.271)	-1.374 (1.928)	-0.309 (2.273)
	Life Threat			1.617 (2.011)	3.952* (2.370)
	Stress			0.064 (0.634)	0.573 (0.747)
Medication	Taking Cholestrol Medication	-0.726 (2.793)	-1.100 (3.314)	-0.690 (2.831)	-0.740 (3.337)
Education	High School Graduate	-6.076** (2.914)	-6.014* (3.457)	-6.180** (2.926)	-6.349* (3.449)
	Some College	-6.642** (3.095)	-6.130* (3.672)	-6.913** (3.126)	-6.976* (3.685)
	Associates Degree	-10.821** (4.326)	-10.097** (5.132)	-10.967** (4.342)	-10.544** (5.117)
	Bachelors Degree	-8.414*** (3.220)	-7.390* (3.820)	-8.498*** (3.239)	-7.771** (3.818)
	Graduate Degree	-10.651*** (3.631)	-10.945** (4.308)	-10.771*** (3.665)	-11.513*** (4.319)
	constant	12.167*** (3.731)	13.142*** (4.426)	11.945*** (4.074)	11.535** (4.801)
	F	**4.65**	**3.25**	**4.28**	**3.17**
	Prob > F	**0.0000**	**0.0000**	**0.0000**	**0.0000**
	R^2	**0.3047**	**0.2345**	**0.3068**	**0.2465**
	Adjusted R^2	**0.2392**	**0.1623**	**0.2351**	**0.1687**
	Root MSE	**12.352**	**14.653**	**12.385**	**14.597**
	N	**268**	**268**	**268**	**268**

***** significant at the 1% level**
**** significant at the 5% level**
*** significant at the 10% level**
✦ incorporates additional health data from Knowledge Networks
⅄ incorporates both the AHA risk questions and other survey questions on family history of heart attack

Table 7-10: *Survey 2: Treatment* OLS Regression on Perceived Risk of a Heart Attack

Category	Independent Variable	Initial Perceived Risk	Perceived Risk after New Info	Initial Perceived Risk	Perceived Risk after New Info
Risk Factors	Male	-1.054 (2.043)	0.076 (2.252)	-1.530 (2.044)	-0.454 (2.253)
	Age 35-44	3.714 (7.083)	6.512 (7.810)	5.124 (7.075)	8.082 (7.800)
	Age 45-54	6.696 (6.792)	9.548 (7.489)	7.681 (6.769)	10.644 (7.463)
	Age 55-64	11.262* (6.844)	15.954** (7.546)	11.878* (6.811)	16.641** (7.509)
	Age 65-74	8.405 (6.730)	12.050* (7.421)	8.919 (6.696)	12.622* (7.382)
	Age 75 and above	4.934 (6.777)	7.830 (7.473)	5.745 (6.749)	8.732 (7.441)
	Family History of Heart Attack	3.362* (2.018)	2.116 (2.225)	2.719 (2.031)	1.400 (2.239)
	High Cholesterol	4.210* (2.464)	4.722* (2.717)	4.102* (2.450)	4.601* (2.702)
	Hypertension	0.616 (2.235)	1.479 (2.465)	0.618 (2.222)	1.481 (2.450)
	Exercise	-0.115 (0.768)	0.019 (0.847)	-0.311 (0.769)	-0.199 (0.848)
	Amount over BMI	-0.023 (0.166)	0.153 (0.183)	-0.022 (0.165)	0.154 (0.182)
	Diabetes	2.903 (2.499)	4.766* (2.756)	2.798 (2.485)	4.648* (2.740)
	Heart Attack	5.357** (2.366)	6.266** (2.609)	4.559* (2.384)	5.377** (2.629)
	Decrease in Quality of Life from Heart Attack	3.215*** (0.968)	3.860*** (1.068)	2.961*** (0.971)	3.578*** (1.070)
Medication	Taking Cholestrol Medication	0.489 (2.541)	0.667 (2.802)	0.450 (2.526)	0.623 (2.785)
General Health	General Health	- 4.871*** (1.167)	- 5.620*** (1.287)	-4.750*** (1.162)	-5.485*** (1.281)
	Life Threating Condition			4.383** (2.139)	4.879** (2.358)
Education	High School Graduate	-2.650 (3.141)	-2.745 (3.463)	-2.634 (3.123)	-2.727 (3.443)
	Some College	-3.771 (3.582)	-5.458 (3.949)	-4.437 (3.576)	-6.200 (3.942)
	Associates Degree	-0.825 (4.648)	-2.690 (5.125)	-1.191 (4.624)	-3.097 (5.098)
	Bachelors Degree	- 7.031* (3.878)	- 7.603* (4.276)	-7.027* (3.855)	-7.598* (4.250)
	Graduate Degree	- 14.639*** (4.764)	- 14.837*** (5.253)	-15.124*** (4.742)	-15.377*** (5.228)
	constant	22.893*** (8.760)	21.916** (9.659)	21.026** (8.757)	19.838** (9.654)
	F	**6.35**	**7.46**	**6.32**	**7.4**
	Prob > F	**0.0000**	**0.0000**	**0.0000**	**0.0000**
	R^2	**0.328**	**0.3646**	**0.3382**	**0.3744**
	Adjusted R^2	**0.2763**	**0.3157**	**0.2847**	**0.3238**
	Root MSE	**16.113**	**17.766**	**16.019**	**17.661**
	N	**295**	**295**	**295**	**295**

***** significant at the 1% level**
**** significant at the 5% level**
*** significant at the 10% level**

Table 7-11*: Survey 1: Screening* Open Ended Responses

Treatment Effectiveness	Serial	Please tell us why you chose not to have the test even when it was offered for $0 (FREE).
85%	11	because i think it would be scarry to have someone tell you that you could have a heart attack even though it would be helpful in preventing an attack if there is a too stop it.
85%	176	leave well enough alone
85%	334	sometimes i dont beleive in medicine.. i hope i never have to take all kinds of pill to be healthy. also i am the type of person that i dont what to know i have something cuz i would just worry about it all the time..
85%	456	I don't want to have to worry about this type of condition
85%	547	IF IT WAS POSITIVE I WOULDN'T HAVE THE TREAMENTS.
30%	179	I do not go to the doctors, I do not give blood test. I'll die when I die, I put my faith in GOD, not man.
30%	236	I have already had two heart attacks. My heart is in bad shape I have a pace maker to help my heart funtion better. I probably wasn't the one to ask these queations.
30%	238	because I already know that I have a family history of heart problems and would not change my life style anyway
30%	283	when its your time its your time why try to prolong the eventual?
none	296	Your information said that there was no treatment available, so why would I want to know that I might have this problem. I'm ready to die when God is ready for me.
none	339	If there is no treatment or cure, thn I prefer NOT to know.
none	376	i consider that as the other factors that are analized in a standard blood test, this test must be included, after being completely determined that is accuratte, so, it must be completely and oabsolutely generalized for all the people having blood testings
none	412	You said earlier that there was nothing they could do for the this blood problem.So why have the test done?
none	466	yes I would have the teat done if it were free I hit the wrong botton.
none	502	In this situation, there is not a treatment for vulnaralbe plaque; therefore, if I have it, I do not want to change my life style or worry about something that cannot be fixed anyway. If there were a treatment for it, I would be willing to pay $15-$20 for such a test.
none	512	If I can't change the outcome, Id rather not know.

Table 7-12*: Survey 2: Treatment* Open Ended Responses

Treatment	Serial	Please tell us why you chose not to have the procedure.
Refuse	1015	I would like to consult my Dr's first. Ido not know if I am physically able to go thru the test. I had a Carotid artey surgery last year to prevent a stroke While in the hospital I had a bad heart attack.Since thenI have been very ill at times . My lifestyle has changed But I am content with that.Only I have a very bitter taste >all food. I think it is the medications..I am S.O.B.at times & have Gas pains & belching.At least I am able to sit here & answer surveys.
Refuse	1079	The procedure would be fine but I have a congenital muscle disease that rules out statins or any chloresteral lowering medication. Medication creates intolerable pain.
Refuse	1150	i would have to speak to my cardiologist first
Refuse	1186	I would wish to hear what my present Doctor would recommend since I trust his recommendations
Refuse	1247	I have normal cholesterol,low blood pressure,normal pulse.My heart problem is cardiac arythmia,one attack for this type of cardiac arrest has a survival rate of 5%.I now have an implanted defibulator.
Refuse	1380	This survey is ridiculous. There are many kinds of heart disease. Mine has nothing to do with plaque or cholesterol or heart damage from an attack, so I can't really answer these questions at all.
Refuse	1402	I did't answer the last question because I have other problems, which is complicating matters. I have lung disease also.Plus,I was diagnosed as having lymph atenitis,years ago.
Procedure	1262*	because of the risk
Drug	1021	have had all the test - it was only a mild heart attact. and am now on medication
Drug	1036	Because, before I have any medical procedure done, I would check other resourdes (other Drs., computer, other heart patients, etc.) to see if there are other options and procedures for me, and then decide what I wanted to do. And, if I found out there were other options, I would not appreciate this doctor making it sound like I ONLY had 2 choices in the world. I would feel like he took MY CHOICE away from me when he gave me only HIS TWO CHOICES. Then I would not go back to him. I would appreciate a doctor who would explain all the options I had(even bypass surgery, etc.), and give me time to check out every resource. Then, I would discuss MY CHOICE with him & TRUST him more - because, then I would feel as if he was workimg with me - not for himself, by only giving me his 2 choices.
Drug	1056	tell me the good it will do.
Drug	1058	I fear any type of operation. Unless I was on the brink of death, I would not choose to have this procedure. So many people come home from a hospital in worse shape than when they entered it, due to carelessness on the part of doctors and nurses and non-sterile conditions.
Drug	1087	THERE IS NO GUARANTEE THAT THIS PROCEDURE IS ABSOLUTELY CORRECT. I DO NOT LIKE TO THINK ABOUT ANY INVASIVE SURGERY WITHOUT KNOWING THAT IT IS CLOSE TO 100% ACCURATE. HAVING HAD A HEART CATHERIZATION I WOULD REALLY HAVE TO THINK VERY LONG AND HARD ABOUT DOING THIS PROCEDURE.
Drug	1090	I'm soon be 65 years old
Drug	1097	I am 85 years old right now - if I would be a younger man I would go for the procedure. I already had a heart catherization which told me that I have vein and artery blockages. I decided to go with just medication and no operating procedures. That was a year and a half ago and I have been doing good with this medication. The medication I am taking is - Zocor, Plavax, topal asperin and a nitro-dur patch every day.
Drug	1098	I have lymphedema and a history of DVT. I will never have an elective surgical procedure on my legs even a simply cather insertion. I take oumadin regularly and will not risk going off unless absoltely necessary. No MD knowing my history would advise it.
Drug	1103	_na_
Drug	1105	I HAVE BEEN TOLD I HAVE HAD AHEART ATTACT. BUT I NEVER FELT ANY THING. I DO HAVE AN ENLARGE HERAT, AND HAVE LOST ABOUT 25 PERCENT OF IT FUNTION, FROM PICTURE OF ECHCOGRAM
Drug	1113	Because I have extenuating circumstances. I went through hyperthyroidism, which caused a thyroid storm & some heart damage which makes me very susceptible to atrial fibrillation & I take medication for it, so it is an additional risk when considering surgery of this kind. I would need much more consultation with a cardiologist before doing such a procedure. At this time, I am much more apt to go into cardiac arrest than have a heart attack, I think.
Drug	1123	I have had test . I have no plaque.
Drug	1135	I fully recovered from my heart attack which was 32 years ago. I have not curtailed my activities, only my choice of foods and have always had my own cardiologist who I see 4 times a year and all my tests have been excellent.
Drug	1167	It is something my Doctor would have to order for me and also the answers I had given on this survey is not the best of my knowledge.I'm not very good at reading an understandng what I have read.
Drug	1171	unsure at this time need more time to think
Drug	1177	_na_
Drug	1199	_na_
Drug	1206	Do not want surgery as I have a great fear of it
Drug	1223	I have already a five way bypass and at my age and financial situation I do not think anything expencive is justified
Drug	1228	The type of heart problems I have is treated with medication. If it happens more often, then I would consider an invasive procedure to correct the problem. I believe the more surgery one subjects themselves to the more apt they are for infections, etc., and possible death unless it is a life and death situation.
Drug	1233	I am feeling fine now and I don,t want to go through any more pure Hell than I have already been through in my77 years on earth Thank you
Drug	1258	I would be afraid of this procedure unless I knew for sure that i had a problem I would only try the medication only
Drug	1275	Possibly I did not answer correctly.Although I have never had an attack I did have some problem..that could have caused an attack.Mtral valve prolapse..resulting in a valve replacement and replacing of the aortic valve with 5 by passes.I am on socor and have periotic echo cardiograms etc.I will discuss this procedure with my physician.it sounds interesting .Knowing the type of practice has surely he may now be aware of this
Drug	1279	_na_
Drug	1300	I would choose not to have this procdure done because of the following reasons: ...other medical conditions ... breast cancer, bladder removal with cancer ... very poor sight, prone to strokes, etc. ...advanced age ...very poor medical health
Drug	1317	i have a negative feeling about it
Drug	1321	I choose not te procedure because of the high risk it have to the patient maybe death
Drug	1334	i resist even taking medication, let alone having a invasive procedure. eating organic, exerciseing and living a stress reduced life makes most sence to me.
Drug	1350	have had five heart attacks. all were when i was still smoking. i quit smoking in 1997. am now overweight, but feel good. my father, 2 brothers, and only sister died of heart attacks. 2 siblings also had diabetes. after the last coded heart-attack, i sure am not ready for any other surgery. might be a minimal invasion, but i`m not ready yet. due to see heart Dr. soon. will then ask him what he thinks.
Drug	1355	i would not take the meds even. if it my time thats ok
Drug	1399	Because I am scared of any Procedure's that require surgery or being put under .....
Drug	1425	ionlyhavemiss in heartbeat
Drug	1439	I don't know how invasive the 'procedure' is. I am not interested in heart cath--etc.
Drug	1443	Don't want to be a ginea pig.
Drug	1454	Have no Ins.
Drug	1455	I am alreaedy under the care of physicians for my heart disease. I have had an angiogram with the resultant angioplasty. I have had follow-up angiograms showing no advancement of my disease. If my doctor felt that I should undergo this treatment then I would consider it.

* only one to have answered no to zero bid, all others chose medication or refused treatment

Table 7-13: *Survey 1: Screening* Censored Regression on WTP

Independent Variable	**WTP as Dependent Variable**			
Household Income	8.12e-04*** (2.91e-04)	8.01e-04*** (2.89e-04)	7.61e-04*** (2.89e-04)	7.62e-04*** (2.88e-04)
MSA	34.714 (23.132)	35.918 (23.042)	45.019* (23.246)	44.250* (23.219)
Life Insurance	17.103 (19.730)	18.313 (19.660)	14.365 (19.667)	12.638 (19.723)
Medical Spending	0.193 (0.123)	0.179 (0.123)	0.181 (0.123)	0.190 (0.123)
High School Graduate	-13.226 (32.909)	-11.659 (32.782)	-14.261 (32.596)	-14.232 (32.606)
Some College	-55.570 (34.972)	-53.529 (34.845)	-60.130* (34.630)	-59.803* (34.634)
Associates Degree	-56.032 (49.533)	-52.314 (49.375)	-53.909 (49.169)	-55.035 (49.055)
Bachelors Degree	-48.745 (37.873)	-43.698 (37.869)	-50.448 (37.390)	-50.415 (37.309)
Graduate Degree	-112.132*** (43.067)	-109.421** (42.909)	-118.914*** (42.576)	-118.152*** (42.474)
Perceived Risk	0.996* (0.551)			
Initial Perceived Risk		1.438** (0.629)		
Change in Perceived Risk		-0.182 (0.986)	0.570 (1.052)	0.516 (1.052)
Strong Prior on Perceived Risk			1.790** (0.714)	1.741** (0.715)
Weak Prior on Perceived Risk			-0.991 (1.255)	-1.007 (1.254)
Treatment Effectiveness 30%				-11.869 (26.443)
Treatment Effectiveness 85%				-22.069 (26.406)
Starting Bid	0.724** (0.307)	0.739** (0.306)	0.725** (0.305)	0.819** (0.329)
Certainty (Broad)	4.549 (3.403)	4.636 (3.387)	5.116 (3.380)	5.250 (3.375)
Constant	-49.184 (45.291)	-56.786 (45.398)	-53.784 (44.796)	-42.723 (48.291)
LR chi2	**30.16**	**32.22**	**34.17**	**34.9**
Prob > chi2	**0.0026**	**0.0022**	**0.0019**	**0.0041**
Pseudo R^2	**0.0092**	**0.0099**	**0.0105**	**0.0107**
N	**268**	**268**	**268**	**268**

***** significant at the 1% level**
**** significant at the 5% level**
*** significant at the 10% level**

Table 7-14: *Survey 1: Screening* Probit on Choosing the Screening Test

Independent Variable	**TEST (1=yes, 0=no) as Dependent Variable**			
Household Income	4.15e-06 (4.79e-06)	3.97e-06 (4.81e-06)	3.52e-06 (4.86e-06)	3.84e-06 (5.02e-06)
MSA	0.0523 (0.357)	0.028 (0.360)	0.137 (0.376)	0.129 (0.378)
Life Insurance	0.693** (0.310)	0.712** (0.315)	0.692** (0.327)	0.696** (0.328)
High School Graduate	0.115 (0.602)	0.097 (0.610)	0.105 (0.661)	0.102 (0.662)
Some College	-0.754 (0.570)	-0.826 (0.585)	-1.027 (0.635)	-1.037 (0.637)
Associates Degree	-1.075 (0696)	-1.180 (0.710)	-1.378 (0.747)	-1.398 (0.751)
Bachelors Degree	-0.352 (0.640)	-0.425 (0.653)	-0.592 (0.689)	-0.596 (0.690)
Graduate Degree	-0.981 (0.642)	-1.015 (0.652)	-1.212 (0.697)	-1.231 (0.703)
Perceived Risk	0.008 ((0.010)			
Initial Perceived Risk		0.005 (0.010)		
Change in Perceived Risk		0.030 (0.022)	0.037* (0.023)	0.037* (0.023)
Strong Prior on Perceived Risk			0.008 (0.013)	0.007 (0.014)
Weak Prior on Perceived Risk			-0.025* (0.015)	-0.027* (0.016)
Treatment Effectiveness 30%	0.946*** (0.372)	1.007*** (0.382)	1.172*** (0.417)	1.200*** (0.433)
Treatment Effectiveness 85%	1.066*** (0.353)	1.088*** (0.357)	1.103*** (0.359)	1.118*** (0.364)
General Health				-0.039 (0.151)
Constant	0.503 (0.650)	0.550 (0.663)	0.626 (0.659)	0.758 (0.835)
LR chi2	**22.16**	**23.4**	**26.72**	**26.79**
Prob > chi2	**0.0232**	**0.0245**	**0.0136**	**0.0205**
Pseudo R^2	**0.1828**	**0.1930**	**0.2205**	**0.2210**
N	**268**	**268**	**268**	**268**

***** significant at the 1% level**
**** significant at the 5% level**
*** significant at the 10% level**

Table 7-15: *Survey 1: Screening* Probit on Choosing the Screening Test, including Medical Spending✦

Independent Variable	**Screening TEST (1=yes, 0=no) as Dependent Variable**			
Household Income	4.85e-06 (5.11e-06)	4.68e-06 (5.14e-06)	4.47e-06 (5.23e-06)	4.72e-06 (5.48e-06)
MSA	0.045 (0.382)	0.019 (0.386)	0.133 (0.401)	0.129 (0.403)
Life Insurance	0.643** (0.326)	0.658** (0.332)	0.658* (0.348)	0.663* (0.350)
Medical Spending✦	0.014* (0.007)	0.015** (0.007)	0.015** (0.007)	0.015** (0.007)
High School Graduate	0.146 (0.628)	0.122 (0.635)	0.118 (0.697)	0.115 (0.698)
Some College	-0.825 (0.593)	-0.909 (0.607)	-1.200* (0.679)	-1.215* (0.688)
Associates Degree	-1.11 (0.739)	-1.221* (0.749)	-1.496* (0.796)	-1.515* (0.807)
Bachelors Degree	-0.453 (0.664)	-0.543 (0.676)	-0.776 (0.727)	-0.785 (0.731)
Graduate Degree	-1.081 (0.671)	-1.118* (0.678)	-1.376* 0.737	-1.395* (0.749)
Perceived Risk	0.005 (0.010)			
Initial Perceived Risk		0.002 (0.010)		
Change in Perceived Risk		0.030 (0.024)	0.041* (0.024)	0.041* (0.025)
Strong Prior on Perceived Risk			0.009 (0.013)	0.008 (0.014)
Weak Prior on Perceived Risk			-0.028* (0.016)	-0.029* (0.017)
Treatment Effectiveness 30%	0.973** (0.393)	1.035*** (0.403)	1.219*** (0.443)	1.244*** (0.473)
Treatment Effectiveness 85%	1.082*** (0.365)	1.092*** (0.369)	1.140*** (0.376)	1.158*** (0.394)
General Health				-0.027 (0.171)
Constant	0.188 (0.700)	0.240 (0.717)	0.280 (0.718)	0.368 (0.916)
LR chi2	**28.72**	**30.08**	**33.95**	**33.97**
Prob > chi2	**0.0043**	**0.0046**	**0.0021**	**0.0034**
Pseudo R^2	**0.2369**	**0.2482**	**0.2801**	**0.2803**
N	**268**	**268**	**268**	**268**

***** significant at the 1% level**
**** significant at the 5% level**
*** significant at the 10% level**

✦ data on medical spending was not available for individuals who did not choose the screening (TEST=0). The mean value of medical spending was assigned to these observations; therefore, this table is intended for comparison purposes only.

Table 7-16: *Survey 1: Screening* OLS Regression on WTP for TEST=1

Independent Variable	**WTP as Dependent Variable**			
Household Income	7.19e-04** 3.00e-04	6.99e-04** 2.99e-04	6.62e-04** 3.00e-04	6.75e-04** (2.99e-04)
MSA	36.078 (23.662)	37.369 (23.589)	45.699* (23.904)	42.793* (23.889)
Life Insurance	8.142 (20.348)	9.623 (20.290)	7.246 (20.346)	4.276 (20.349)
Medical Spending	0.130 (0.124)	0.113 (0.124)	0.114 (0.124)	0.135 (0.124)
High School Graduate	-18.169 (-33.500)	-15.733 (33.403)	-19.473 (33.268)	-19.524 (33.235)
Some College	-46.232 (35.839)	-43.522 (35.739)	-49.497 (35.624)	-48.124 (35.587)
Associates Degree	-33.48 (52.142)	-28.550 (52.026)	-29.782 (510939)	-32.683 (51.800)
Bachelors Degree	-49.097 (38.693)	-42.680 (38.733)	-49.965 (38.312)	-50.930 (38.204)
Graduate Degree	-99.677** (44.348)	-95.599** (44.245)	-104.346** (44.014)	-102.985** (43.884)
Perceived Risk	0.939* (0.565)			
Initial Perceived Risk		1.478** (0.648)		
Change in Perceived Risk		-0.438 (0.993)	0.191 (1.073)	0.029 (1.073)
Strong Prior on Perceived Risk			1.805** (0.727)	1.673** (0.728)
Weak Prior on Perceived Risk			-0.441 (1.394)	-0.417 (1.391)
Treatment Effectiveness 30%				-41.106 (27.953)
Treatment Effectiveness 85%				-52.289* (28.036)
Starting Bid	0.574* (0.311)	0.590* (0.310)	0.578* (0.310)	0.737** (0.335)
Certainty (Broad)	9.030*** (3.500)	9.176*** (3.488)	9.624*** (3.492)	10.108*** (3.491)
Constant	-51.889 (46.098)	-61.633 (46.285)	-58.555 (45.721)	-25.182 (48.708)
F	**2.34**	**2.39**	**2.31**	**2.25**
Prob > F	**0.0076**	**0.0049**	**0.0055**	**0.0047**
R^2	**0.1050**	**0.1155**	**0.1199**	**0.1328**
Adj R2	**0.0601**	**0.0672**	**0.0679**	**0.0138**
Root MSE	**140.59**	**140.05**	**140**	**139.56**
N	**252**	**252**	**252**	**252**

***** significant at the 1% level**
**** significant at the 5% level**
*** significant at the 10% level**

Table 7-17*: Survey 1: Screening* Heckman Selection Models

	Model 1		Model 2	
	Regression Equation	Selection Equation	Regression Equation	Selection Equation
Independent Variable	**WTP**	**TEST (1=yes, 0=no)**	**WTP**	**TEST (1=yes, 0=no)**
Household Income	7.77e-04*** (2.93e-04)	3.83e-06 (4.46e-06)	7.09e-04*** (2.90e-04)	3.88e-06 (2.70e-06)
MSA	36.661 (23.201)	0.122 (0.414)	45.206* (23.226)	0.233 (0.189)
Life Insurance	20.067 (19.588)	0.162 (0.296)	16.317 (19.631)	0.276 (0.210)
Medical Spending	0.106 (0.116)		0.104 (0.106)	
High School Graduate	-10.579 (32.705)	-0.125 (0.400)	-14.110 (32.488)	-0.004 (0.242)
Some College	-52.209 (34.882)	-0.500 (0.407)	-60.410* (34.579)	-0.382 (0.270)
Associates Degree	-43.222 (49.422)	-0.714* (0.381)	-44.313 (49.191)	-0.775** (0.386)
Bachelors Degree	-44.248 (37.755)	-0.453 (0.300)	-51.515 (37.247)	-0.492 (0.275)
Graduate Degree	-108.196*** (42.866)	-0.801*** (0.315)	-117.617*** (42.532)	-0.867*** (0.313)
Initial Perceived Risk	1.453** (0.630)	0.007 (0.006)		
Change in Perceived Risk	-0.212 (0.985)	0.004 (0.013)	0.517 (1.054)	0.010 (0.009)
Strong Prior on Perceived Risk			1.820*** (0.711)	0.002 (0.007)
Weak Prior on Perceived Risk			-0.885 (1.272)	-0.015 (0.011)
Treatment Effectiveness 30%		0.096 (0.222)		0.226 (0.183)
Treatment Effectiveness 85%		0.324* (0.171)		0.341** (0.160)
Starting Bid	0.477 (0.303)		0.467 (0.298)	
Certainty (Broad)	5.730* (3.358)		7.294** (3.339)	
Constant	-49.251 (45.189)	0.402 (0.818)	-51.622 (44.669)	0.283 (0.283)
Wald chi2	**31.10**		**34.12**	
Prob > chi2	**0.0033**		**0.0020**	
rho (ρ)	**1**		**1**	
lambda (λ)	**139.66**		**139.11**	
LR chi2	**56.50**		**54.33**	
Prob > chi2	**0.0000**		**0.0000**	
Censored observations	**16**		**16**	
N	**268**		**268**	

***** significant at the 1% level**
**** significant at the 5% level**
*** significant at the 10% level**

Table 7-18*: Survey 1: Screening* Probit on Choosing the Screening TEST (detailed)

Category	Independent Variable	Test (1= yes, 0 = no) as Dependent Variable			
Income	Household Income	1.27e-05* (7.35e-06)	1.40e-05* (7.67e-06)	1.11e-05* (6.89e-06)	1.13e-05* (7.02e-06)
	MSA	0.406 (0.549)	0.353 (0.584)	0.426 (0.500)	0.412 (0.510)
Risk Aversion	Life Insurance	1.508** (0.600)	1.797*** (0.689)	1.391*** (0.512)	1.533*** (0.550)
Medical Expeditures	Medical Spending	0.025* (0.012)	0.030** (0.014)		
Education	High School Graduate	0.447 (0.833)	0.217 (0.884)	0.293 (0.787)	0.089 (0.828)
	Some College	-1.721** (0.807)	-2.002** (0.859)	-1.520** (0.728)	-1.667** (0.762)
	Associates Degree	-2.407** (1.109)	-2.964** (1.197)	-2.139** (0.973)	-2.500** (1.022)
	Bachelors Degree	-1.203 (0.922)	-1.403 (1.004)	-1.001 (0.836)	-1.165 (0.904)
	Graduate Degree	-1.476 (0.956)	-1.411 (0.987)	-1.385 (0.871)	-1.377 (0.909)
Treatment Effectiveness	Effectiveness 30%	2.047* (0.746)	2.334*** (0.801)	1.674*** (0.632)	1.744*** (0.639)
	Effectiveness 85%	1.757* (0.594)	1.923*** (0.617)	1.529*** (0.520)	1.621*** (0.526)
Risk Factors	Male	-0.928** (0.484)	-0.837* (0.515)	-0.960** (0.445)	-0.901** (0.453)
	AGE 35 - 44	0.493 (0.706)	0.566 (0.760)	0.272 (0.610)	0.261 (0.630)
	AGE 45 - 54	-0.636 (0.657)	-0.671 (0.696)	-0.427 (0.571)	-0.473 (0.588)
	AGE 55 - 64	-1.050 (0.720)	-1.423* (0.812)	-0.929 (0.659)	-1.143* (0.702)
	AGE 65 and above	1.442 (1.176)	1.603 (1.258)	1.404 (0.984)	1.332 (1.013)
	Family History (Broad)	-0.035 (0.483)	-0.104 (0.502)	-0.056 (0.427)	-0.106 (0.439)
	Smoking Environment	-0.786* (0.488)	-0.911* (0.511)	-0.639 (0.429)	-0.683 (0.436)
	High Cholesterol or Low HDL	-0.970 (0.615)	-1.118* (0.658)	-0.669 (0.493)	-0.686 (0.504)
	Hypertension (Broad)	2.088** (0.903)	2.093** (0.893)	1.784** (0.759)	1.680** (0.725)
	Exercise	-0.338* (0.202)	-0.274 (0.201)	-0.359** (0.185)	-0.315* (0.184)
	Overweight	-0.474 (0.575)	-0.529 (0.604)	-0.497 (0.492)	-0.496 (0.503)
	Obese	1.550 (1.037)	1.906* (1.118)	1.221 (0.896)	1.365 (0.904)
	Very obese	0.085 (0.664)	0.089 (0.694)	-0.062 (0.578)	-0.019 (0.583)
	Diabetes (Broad)	-0.546 (0.801)	-0.479 (0.855)	-0.719 (0.710)	-0.630 (0.722)
	Heart disease	0.882 (1.041)	1.734 (1.167)	0.956 (0.844)	1.359 (0.933)
	Heart attack	-2.977** (1.401)	-3.267** (1.421)	-2.769** (1.194)	-2.745** (1.179)
	White	0.002 (0.470)	0.173 (0.507)	-0.070 (0.420)	0.056 (0.444)
	Cholesterol Medication	0.266 (0.904)	-0.032 (0.955)	0.419 (0.732)	0.288 (0.782)
	Change in Perceived Risk		0.078* (0.044)		0.051 (0.035)
	constant	0.678 (1.178)	0.221 (1.249)	1.473 (0.979)	1.257 (1.011)
	LR chi2	**55.17**	**58.65**	**47.96**	**50.3**
	Prob > chi2	**0.0024**	**0.0013**	**0.0108**	**0.0084**
	Pseudo R^2	**0.4552**	**0.4838**	**0.3957**	**0.4150**
	N	**268**	**268**	**268**	**268**

***** significant at the 1% level**
**** significant at the 5% level**
*** significant at the 10% level**

Table 7-19: *Survey 1: Screening* OLS Regression on WTP for TEST=1 (detailed)

Category	Independent Variable	WTP	WTP	WTP (Females)	WTP (Males)
Income	Household Income	9.46e-04*** (3.07e-04)	9.33e-04*** (3.08e-04)	1.20e-02*** (4.21e-04)	6.72e-04 (4.85e-04)
	MSA	31.947 (24.263)	32.368 (24.305)	30.606 (32.389)	28.252 (45.900)
Risk Aversion	Life Insurance	11.228 (20.983)	11.353 (21.012)	-6.297 (29.456)	24.824 (31.391)
Medical Expeditures	Medical Spending	0.023 (0.131)	0.0219 (0.131)	-0.109 (0.180)	0.147 (0.249)
Education	High School Graduate	-19.623 (33.870)	-19.639 (33.915)	-27.392 (51.068)	25.283 (49.912)
	Some College	-61.379* (36.642)	-60.755* (36.705)	-70.246 (53.005)	-15.789 (55.803)
	Associates Degree	-63.455 (52.633)	-63.302 (52.704)	-107.171 (74.687)	-17.369 (80.731)
	Bachelors Degree	-61.156 (38.588)	-60.417 (38.657)	-94.664* (57.712)	-14.061 (59.722)
	Graduate Degree	-125.781*** (44.411)	-125.353*** (44.476)	-136.029** (66.764)	-78.925 (66.532)
Treatment Effectiveness	Effectiveness 30%	-24.930 (29.872)	-26.153 (29.974)	27.828 (46.226)	-84.749* (44.606)
	Effectiveness 85%	-27.798 (29.145)	-28.664 (29.216)	25.634 (43.142)	-88.699* (45.832)
Risk Factors	Male	7.583 (18.829)	7.059 (18.873)		
	AGE 35 - 44	2.825 (27.539)	3.801 (27.619)	14.510 (40.958)	-22.542 (39.978)
	AGE 45 - 54	10.587 (29.582)	10.516 (29.623)	-6.070 (43.651)	14.035 (42.801)
	AGE 55 - 64	14.687 (31.296)	15.737 (31.382)	-23.528 (44.178)	63.943 (52.742)
	AGE 65 and above	61.309* (33.273)	61.519* (33.320)	45.620 (49.584)	66.110 (49.980)
	Family History (Broad)	21.350 (19.448)	21.918 (19.495)	13.179 (30.171)	47.852* (28.414)
	Smoking Environment	14.331 (19.604)	15.764 (19.759)	-31.987 (30.387)	43.290 (29.899)
	High Cholesterol or Low HDL	56.776** (23.067)	57.743** (23.147)	33.963 (35.996)	89.128*** (33.758)
	Hypertension (Broad)	-11.007 (21.503)	-11.465 (21.544)	-26.686 (33.320)	-0.343 (34.984)
	Exercise	10.189 (7.666)	10.198 (7.676)	19.317* (11.696)	8.999 (11.404)
	Overweight	-18.768 (23.383)	-18.727 (23.414)	-81.058** (35.982)	44.138 (35.235)
	Obese	-15.308 (27.602)	-15.113 (27.641)	-38.867 (43.516)	1.580 (39.779)
	Very obese	28.565 (28.403)	28.632 (28.441)	-33.878 (38.246)	87.855** (44.939)
	Diabetes (Broad)	55.395 (38.611)	54.217 (38.707)	128.876** (52.852)	-23.867 (70.339)
	Heart disease	48.652 (33.728)	46.798 (33.899)	22.847 (50.030)	50.819 (55.859)
	Heart attack	-14.931 (50.826)	-14.678 (50.896)	-57.302 (101.640)	13.990 (63.190)
	White	-43.511* (23.061)	-42.269* (23.174)	-58.499* (33.831)	-17.256 (34.628)
	Cholesterol Medication	-35.523 (32.960)	-35.770 (33.006)	40.178 (49.640)	-82.775* (49.729)
	Change in Perceived Risk		-0.634 (0.993)	-1.180 (1.909)	-0.210 (1.273)
	Starting Bid	0.483 (0.339)	0.480 (0.339)	0.344 (0.464)	0.615 (0.546)
	Certainty (Broad)	8.941** (3.586)	9.009** (3.592)	9.047 (5.902)	7.372 (5.087)
	constant	-33.906 (58.014)	-33.252 (58.102)	8.098 (98.603)	-87.210 (79.205)
	F	**2.01**	**1.95**	**1.66**	**1.61**
	Prob > F	**0.0021**	**0.0028**	**0.0345**	**0.0408**
	R^2	**0.2205**	**0.2219**	**0.3719**	**0.3303**
	Adj R2	**0.1106**	**0.1082**	**0.1481**	**0.1247**
	Root MSE	**136.75**	**136.94**	**131.45**	**138.3**
	N	**252**	**252**	**119**	**133**

***** significant at the 1% level**
**** significant at the 5% level**
*** significant at the 10% level**

Table 7-20: *Survey 1: Screening* Censored Regression on WTP (detailed)

Category	Independent Variable	WTP (TEST = 1)	cnreg(cens: TEST = 1)	tobit (cens = 0)	OLS (WTP>0)
Income	Household Income	9.33e-04*** (3.08e-04)	1.04e-03*** (2.87e-04)	1.11e-03*** (3.00e-04)	8.86e-04*** (3.21e-04)
	MSA	32.368 (24.305)	34.297 (22.867)	35.220 (24.014)	33.514 (25.490)
Risk Aversion	Life Insurance	11.353 (21.012)	23.715 (19.769)	36.745* (21.001)	5.658 (22.963)
Medical Expenditures	Medical Spending	0.0219 (0.131)	0.062 (0.125)	0.065 (0.131)	0.035 (0.134)
Education	High School Graduate	-19.639 (33.915)	-19.424 (32.339)	-24.922 (34.084)	-27.443 (36.620)
	Some College	-60.755* (36.705)	-73.475** (34.590)	-83.033** (36.529)	-68.540* (39.439)
	Associates Degree	-63.302 (52.704)	-89.027* (48.867)	-96.746* (51.196)	-74.061 (55.140)
	Bachelors Degree	-60.417 (38.657)	-62.096* (36.777)	-70.633* (38.776)	-70.931* (41.745)
	Graduate Degree	-125.353*** (44.476)	-142.559*** (41.868)	-165.628*** (44.589)	-126.571** (48.879)
	Effectiveness 30%	-26.153 (29.974)	5.884 (27.419)	19.809 (29.039)	-47.613 (32.676)
	Effectiveness 85%	-28.664 (29.216)	3.317 (26.799)	15.344 (28.469)	-51.139 (32.216)
Risk Factors	Male	7.059 (18.873)	-1.772 (17.794)	-2.178 (18.649)	8.410 (19.715)
	AGE 35 - 44	3.801 (27.619)	2.319 (26.243)	-3.840 (27.470)	10.979 (28.811)
	AGE 45 - 54	10.516 (29.623)	8.212 (27.680)	-4.455 (29.255)	13.723 (31.818)
	AGE 55 - 64	15.737 (31.382)	4.719 (29.870)	-5.718 (31.582)	14.402 (33.720)
	AGE 65 plus	61.519* (33.320)	63.122** (31.350)	57.036* (32.873)	61.719* (34.753)
	Family History	21.918 (19.495)	21.780 (18.476)	27.09 (19.447)	19.582 (20.579)
	Smoking Environment	15.764 (19.759)	13.274 (18.660)	13.206 (19.684)	14.875 (20.952)
	High Cholesterol or Low HDL	57.743** (23.147)	51.171** (21.849)	58.443** (22.867)	58.401** (24.171)
	Bhypertension	-11.465 (21.544)	5.044 (20.393)	8.770 (21.349)	-16.039 (22.429)
	Exercise	10.198 (7.676)	6.631 (7.200)	7.389 (7.643)	12.145 (8.382)
	Overweight	-18.727 (23.414)	-21.601 (22.128)	-19.517 (23.373)	-24.134 (25.053)
	Obese	-15.113 (27.641)	-12.078 (26.452)	-2.066 (27.742)	-22.161 (28.958)
	Very obese	28.632 (28.441)	24.005 (26.912)	31.244 (28.338)	20.896 (30.097)
	Diabetes (Broad)	54.217 (38.707)	47.721 (35.492)	52.135 (37.278)	49.895 (40.180)
	Heart disease	46.798 (33.899)	64.445** (32.426)	69.528* (34.114)	44.224 (35.791)
	Heart attack	-14.678 (50.896)	-48.299 (47.430)	-62.377 (50.079)	-15.105 (53.722)
	White	-42.269* (23.174)	-41.574* (21.619)	-38.739* (22.720)	-42.559* (24.598)
	Cholesterol Medication	-35.770 (33.006)	-38.178 (31.117)	-43.503 (32.575)	-37.920 (34.100)
	Change in Perceived Risk	-0.634 (0.993)	-0.255 (0.953)	-0.199 (0.995)	-0.706 (1.027)
Controls	Initial Bid	0.480 (0.339)	0.527 (0.323)	0.526 (0.338)	0.554 (0.354)
	Certainty (Broad)	9.009** (3.592)	4.088 (3.362)	5.536 (3.597)	10.590*** (3.984)
	constant	-33.252 (58.102)	-39.236 (55.159)	-77.872 (58.881)	-10.650 (64.265)
	LR chi2	**1.95**	**59.4**	**64.06**	
	Prob > chi2	**0.0028**	**0.0023**	**0.0006**	
	Pseudo R^2	**0.2219**	**0.0182**	**0.0205**	
	F	**0.1082**			**1.87**
	Prob > F	**136.94**			**0.0053**
	R2	**252**			**0.2264**
	Adjusted R2	**0.1075**			**0.1051**
	N	**252**	**268**	**268**	**237**

***** significant at the 1% level**
**** significant at the 5% level**
*** significant at the 10% level**

Table 7-21: *Survey 2: Treatment* Probit on Choosing the Procedure

Independent Variable	**Procedure (1=yes, 0=no) as Dependent Variable**	
Household Income	1.35e-05*** (4.39e-06)	1.28e-05*** (4.59e-06)
MSA	-0.176 (0.299)	-0.291 (0.315)
Life Insurance	0.231 (0.213)	0.234 (0.219)
High School Graduate	-0.445 (0.335)	-0.427 (0.344)
Some College	-0.298 (0.374)	-0.337 (0.386)
Associates Degree	-0.367 (0.468)	-0.259 (0.494)
Bachelors Degree	-0.274 (0.419)	-0.180 (0.435)
Graduate Degree	-1.061** (0.494)	-0.985* (0.505)
Change in Perceived Risk	0.034** (0.015)	0.035** (0.015)
Strong Prior on Perceived Risk	0.005 (0.005)	0.005 (0.006)
Weak Prior on Perceived Risk	0.008 (0.012)	0.010 (0.014)
Cholesterol Medication	-0.133 (0.204)	-0.240 (0.216)
Heart Catherization		0.458** (0.209)
Special Information		-0.350* (0.202)
Constant	0.816** (0.467)	0.967* (0.499)
LR chi2	**23.03**	**31.75**
Prob > chi2	**0.0275**	**0.0043**
Pseudo R^2	**0.094**	**0.1296**
N	**295**	**295**

***** significant at the 1% level**
**** significant at the 5% level**
*** significant at the 10% level**

Table 7-22: *Survey 2: Treatment* Probit on Choosing the Procedure (detailed)

Category	Independent Variable	Procedure (1=yes, 0=no)	Procedure (w/o outliers)	Procedure (females)	Procedure (males)
Wealth	Household Income	1.14e-05** (5.34e-06)	1.12e-05** (5.35e-06)	9.13e-06 (6.96e-06)	1.80e-05 (1.36e-05)
	MSA	-0.218 (0.341)	-0.216 (0.340)	-0.394 (0.548)	0.505 (0.748)
	Secure	-0.217 (0.179)	-0.222 (0.179)	-0.344 (0.252)	-0.332 (0.432)
	Own Home	0.253 (0.263)	0.256 (0.263)	0.214 (0.351)	0.769 (0.698)
Risk Aversion	Life Insurance	0.230 (0.246)	0.230 (0.245)	0.233 (0.334)	0.333 (0.549)
Education	High School Graduate	-0.734* (0.402)	-0.733* (0.402)	-0.718 (0.587)	-0.609 (0.878)
	Some College	-0.622 (0.438)	-0.617 (0.438)	-0.593 (0.653)	0.184 (1.026)
	Associates Degree	-0.784 (0.557)	-0.784 (0.557)	-0.595 (0.906)	-0.280 (1.097)
	Bachelors Degree	-0.381 (0.493)	-0.376 (0.493)	-0.343 (0.743)	0.358 (1.041)
	Graduate Degree	-1.238** (0.579)	-1.282** (0.582)	-2.501*** (1.004)	-1.076 (1.249)
Risk	Change in Perceived Risk	0.037** (0.016)	0.037* (0.016)	0.046* (0.027)	0.049 (0.035)
	Strong Prior on Perceived Risk	0.005 (0.006)	0.005 (0.006)	0.005 (0.010)	0.005 (0.014)
	Weak Prior on Perceived Risk	0.017 (0.016)	0.017 (0.016)	0.012 (0.019)	✦
Medication	Cholesterol Medication	-0.416* (0.258)	-0.400 (0.259)	-0.865** (0.396)	0.524 (0.581)
Familiarity	Heart Catherization	0.413* (0.239)	0.402* (0.240)	0.167 (0.363)	0.243 (0.465)
	Special Info	-0.309 (0.223)	-0.301 (0.223)	-0.546* (0.327)	0.240 (0.519)
Responsibility	Work	-0.214 (0.296)	-0.203 (0.297)	0.349 (0.453)	-1.603*** (0.665)
	Stress	-0.224** (0.089)	-0.228*** (0.090)	-0.421*** (0.142)	-3.29e-04 (0.215)
	Married	0.092 (0.246)	0.089 (0.246)	0.453 (0.352)	-0.519 (0.681)
	Child Under 18	0.169 (0.413)	0.163 (0.411)	0.013 (0.560)	✦
Physical Limiations	Overweight	-0.203 (0.287)	-0.214 (0.288)	-0.277 (0.408)	-0.232 (0.713)
	Obese	0.391 (0.360)	0.374 (0.361)	0.487 (0.494)	-0.284 (0.847)
	Very obese	-0.192 (0.350)	-0.200 (0.351)	0.450 (0.519)	-1.743** (0.882)
	Disabled	-0.723* (0.375)	-0.720* (0.374)	-0.448 (0.507)	-1.294 (1.084)
	Age	-0.022* (0.012)	-0.022* (0.012)	-0.004 (0.017)	-0.094*** (0.035)
	Frequency of MD Visits	0.067 (0.071)	0.069 (0.071)	0.199* (0.105)	-0.138 (0.145)
Gender	Male	0.367 (0.240)	0.360 (0.240)		
	constant	3.396*** (1.123)	3.411*** (1.122)	2.512 (1.614)	8.015*** (2.984)
	LR chi2	**52.79**	**52.63**	**44.98**	**33.47**
	Prob > chi2	**0.0021**	**0.0022**	**0.0118**	**0.0946**
	Pseudo R^2	**0.2154**	**0.2154**	**0.3090**	**0.3838**
	N	**295**	**293**	**146**	**123**

***** significant at the 1% level**
**** significant at the 5% level**
*** significant at the 10% level**

✦ Variable dropped by Stata due to insufficient variation

Table 7-23: *Survey 2: Treatment* OLS Regression on WTP for Procedure = 1

Category	Independent Variable	WTP	WTP (w/o outliers)	WTP (females)	WTP (males)
Wealth	Household Income	0.109** (0.053)	0.033** (0.029)	0.077* (0.043)	-0.043 (0.049)
	MSA	4928.354 (4035.789)	2284.069 (2192.194)	-2005.946 (3786.757)	7209.448** (3223.649)
	Secure	4109.028* (2184.794)	3564.700*** (1188.434)	2674.341 (1903.600)	5333.224*** (1766.389)
	Own Home	-1466.485 (3836.191)	-513.044 (2081.369)	-2811.786 (2958.094)	2998.222 (3426.934)
Risk Aversion	Life Insurance	-3198.99 (3534.656)	-2794.225 (1917.513)	-1851.460 (2784.271)	-2858.137 (3120.109)
Education	High School Graduate	-1989.560 (4372.609)	-337.581 (2374.326)	-3968.481 (3698.874)	4386.075 (3438.510)
	Some College	-4689.519 (4969.982)	-2497.080 (2697.980)	-7984.829* (4106.417)	1669.639 (4020.062)
	Associates Degree	-72.099 (6488.626)	595.552 (3520.707)	-9666.696 (6916.234)	6987.623 (4717.818)
	Bachelors Degree	-4836.537 (5262.481)	-2790.105 (2857.239)	-5888.573 (4520.946)	1714.373 (4094.976)
	Graduate Degree	19720.280*** (7112.78)	-602.035 (4009.845)	-3753.547 (13,665.87)	4467.372 (4997.631)
Risk	Change in Perceived Risk	-456.302*** (175.032)	-174.710* (95.728)	-136.912 (167.009)	-237.012* (125.4868)
	Strong Prior on Perceived Risk	-51.282 (78.378)	6.819 (42.591)	22.365 (65.144)	-12.357 (60.668)
	Weak Prior on Perceived Risk	213.866 (155.183)	-10.362 (84.804)	-9.784 (121.414)	66.064 (149.354)
Medication	Cholesterol Medication	-441.288 (3299.370)	193.514 (1805.763)	-678.573 (2781.216)	-135.999 (2609.523)
Familiarity	Heart Catherization	-2211.117 (3081.394)	158.622 (1689.928)	2229.917 (2890.720)	249.393 (2365.540)
	Special Info	-5974.020** (2875.915)	-3599.107** (1563.618)	-4208.203* (2452.495)	-2957.343 (2212.747)
Responsibility	Work	-1832.511 (3811.188)	771.701 (2075.798)	354.464 (3072.692)	363.458 (3175.670)
	Stress	93.881 (1184.701)	936.109 (651.036)	921.855 (1007.738)	146.502 (993.301)
	Married	4128.444 (3382.664)	2885.645 (1836.506)	2676.920 (2494.228)	5089.970 (3281.424)
	Child Under 18	-7061.518 (4437.608)	-3273.953 (2413.759)	-693.851 (3929.575)	-5202.266 (3546.365)
Physical Limiations	Overweight	-2608.203 (3652.386)	-1838.732 (1983.329)	-4569.191 (3150.075)	-1359.294 (2989.931)
	Obese	5937.888 (4005.719)	651.206 (2185.424)	1543.381 (3498.963)	430.263 (3166.646)
	Very obese	-412.275 (4686.081)	-1676.393 (2543.341)	-935.609 (3488.426)	-7131.897 (4564.376)
	Disabled	1642.73 (5209.144)	1345.658 (2825.726)	-2494.662 (4144.381)	8861.012** (4459.687)
	Frequency of MD Visits	-1629.798* (868.825)	-886.218* (472.477)	-1106.354 (697.425)	-326.008 (744.064)
	Age	126.413 (141.643)	71.965 (76.87)	104.172 (107.310)	-86.992 (127.409)
Controls	Male	-1117.570 (3048.717)	-261.545 (1654.785)		
	Starting Bid	0.739* (0.407)	0.371* (0.221)	0.357 (0.365)	0.650** (0.322)
	Certainty (Broad)	706.029 (466.701)	60.368 (255.354)	343.120 (420.831)	-69.350 (362.837)
	constant	-9967.795 (13,509.030)	-4970.592 (7347.943)	1021.727 (11,043.29)	-7926.283 (12,080.18)
	F	**2.53**	**1.68**	**1.19**	**1.33**
	Prob > F	**0.0001**	**0.0197**	**0.2626**	**0.1502**
	R^2	**0.2480**	**0.1817**	**0.2752**	**0.2642**
	Adjusted R^2	**0.1498**	**0.0739**	**0.0446**	**0.0661**
	Root MSE	**20792**	**11278**	**11845**	**10998**
	N	**252**	**252**	**117**	**133**

***** significant at the 1% level**
**** significant at the 5% level**
*** significant at the 10% level**

Figure 7-1: Distribution of WTP for Screening

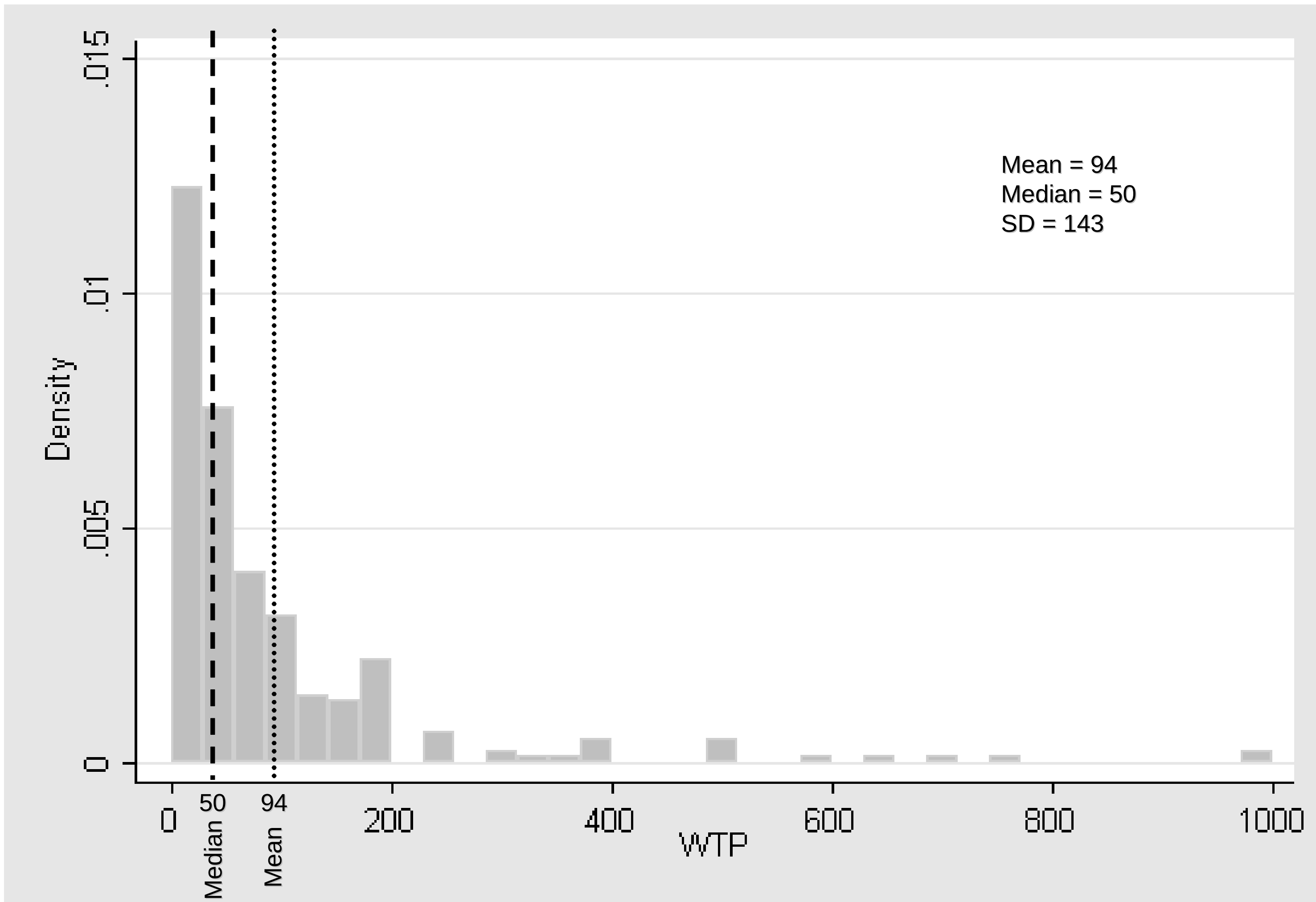
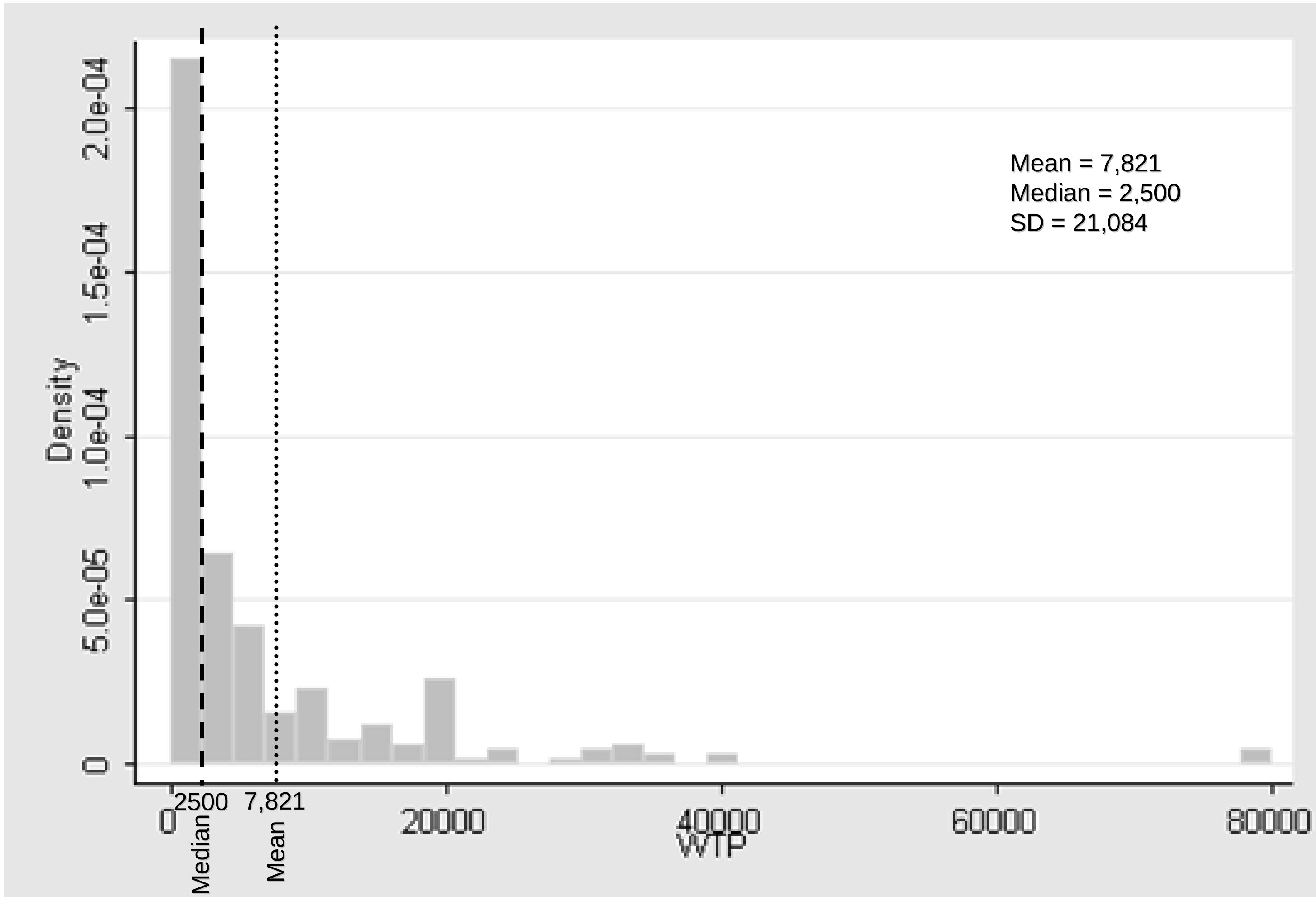


Figure 7-2: Distribution of WTP for Treatment



*2 observations (WTP=100,000 and 300,000) are omitted from graph to maintain horizontal scale in order to view distribution more clearly

Chapter VIII: Discussion and Conclusion

8.1 Restatement of Motivation and Purpose

Despite significant advances in coronary care in the last two decades, national fatality rates from heart attacks have remained predominantly unchanged (Muller 1999). Recently, it was discovered that treatment was aimed at reducing the *amount* of plaque in the coronary vessels, while the cause of heart attacks was dependent on the *composition* of the plaque. In particular, cardiologists now believe that 75% of all heart attacks are caused by a "vulnerable" plaque which creates a blockage in the vessel when it erupts into the bloodstream causing a clot to form. This new theory explains why traditional risk factors for heart disease have failed to identify many people who are risk for heart attack and is evidenced by the fact that over half of the individuals who die suddenly from coronary heart disease (CHD) had no previous warnings prior to the attack (American Heart Association 2003). Therefore, many individuals at risk for a heart attack are not receiving treatment and may not even be aware that they are at risk. As a result, medical researchers are working to develop a screening method that is inexpensive and non-invasive enough to administer to the general public to better identify those at risk for a heart attack. Once an individual is identified as being at high risk, treatment can be started. Unfortunately, the only treatment currently available is drug therapy, which is only about 30% effective at reducing heart attacks. Again, the problem being that cholesterol lowering drugs were developed to reduce the *total* amount of plaque, which does not necessarily reduce vulnerable plaque. Therefore now that the cause of heart attacks is better understood, medical device companies are researching ways to find the hidden plaque and treat it. Once this is accomplished, it is likely that many individuals will be eligible for this procedure; however, choosing who receives it will most likely be based on public policy decisions administered by Medicare.

Because most individuals who are at risk for heart attack are 65 and over, much of the expenditures for managing heart disease and treating heart attack patients are covered by Medicare. Therefore, in many heart-related medical cases, public policy determines who receives care and the level of care that is given. In addition, a large portion of disability allowances stem from disabilities resulting from CHD and heart attack.

Therefore, the screening and treatment of vulnerable plaque is certainly an issue that affects the allocation of public funds. Thus, it is important to understand the underlying preferences of individuals who are likely to receive these services, such that efficient decisions can be made regarding who is eligible to receive care and the level of care that will be provided when these new health options become available.

To obtain a valuation for these services, and better understand the factors affecting demand, two contingent valuation surveys were conducted to elicit the underlying preferences of individuals by having them state their WTP for either screening or treatment. The surveys were developed using decision trees that reflected the medical options available in both the current and desired states of the world. After receiving valuable information from focus groups, both surveys were converted into web-based surveys and administered online. Because Internet surveys are often prone to coverage bias, Knowledge Networks (KN) was selected to administer the web-based surveys using their nationally representative panel. Therefore, *Survey 1: Screening* was administered to adults representing the general population, and resulted in a sample size of 268 observations. Using health data obtained from KN panel members, *Survey 2: Treatment* was administered to adults with doctor-diagnosed heart conditions. This resulted in a sample of 295 individuals who had a greater level of familiar with heart issues, and as result, are expected to provide more reliable valuations for the WTP for treatment.

8.2 Comparisons to Earlier Work and Theoretical Expectations

To help establish the validity of the data sets and better understand the factors affecting the WTP for screening and treatment, models of general health and perceived risk were developed. The results of these models are consistent with economic theory and therefore, lend credibility to the data sets used to analyze WTP.

8.2.1 General Health

The general health models for both data sets are consistent with Grossman's (1972) model of health production. As expected, age has a negative and often significant effect on general health, especially for individuals 55 years of age and over. Consistent with Grossman's theory, education has a positive effect on general health, and is statistically significant for those individuals holding a college degree. Also as expected, individuals who have experienced a life threatening condition or illness report a lower level of general health, *ceteris paribus*, which is consistent with Grossman's theory of an accident or injury reducing the health stock. In addition, high levels of stress or being significantly overweight reduces general health. Investments in health, such as exercise, improve general health; however, frequent visits to the doctor have a negative effect on general health, suggesting that this variable is acting as a proxy for chronic conditions which negatively affect health. Finally, as Grossman predicts, individuals with higher levels of household income report higher levels of general health, *ceteris paribus*. Therefore, the results of the regression on general health support Grossman's theory of household health production and lend credibility to the data sets used for this study.

8.2.2 Perceived Risk

Regression models including the American Heart Association (AHA) risk factors, and controls for cholesterol lowering medication, and education, indicate that several of the risk factors are significant in determining perceived risk. These include (1) being a male over the age of 45, (2) being a female over the age of 55, (3) having high cholesterol, (4) being 20 pounds or more overweight, and (5) having coronary heart disease or having had a prior heart attack. Education was highly significant and negative at all levels, suggesting that those with more education have lower levels of perceived risk. Separating out risk factors that included more than one variable indicated that age, rather than gender, had more of an effect on perceived risk. In particular, the coefficients on the "55 to 64" age group is positive and significant across all specifications. This is not a surprising given that physicians start treating heart disease more aggressively at age 55. Not unexpectedly, individuals who had experienced a heart attack had a higher perceived risk, and the greater the severity of the attack (as measured by the degree to which the heart attack affected the individual's ability to work, engage in their daily activities, provide for their family, and their overall quality of life), the greater the individual's perceived risk. Finally, individuals who reported a lower general health status or who have experienced a life threatening condition or illness also tended to indicate higher levels of perceived risk, *ceteris paribus*.

Comparing regressions using the individual's self-reported perceived risk obtained *after* the new information was presented versus perceived risk *prior* to the new information suggests that individuals understood the new information and responded accordingly. In fact, even though the information presented in the survey was brief and to the point, much like the information that would be provided to a patient by a physician, the regression results support the fact that respondents were able to process this information correctly. Therefore, as Hoehn and Randall (2002) find in their study, a small amount of information is enough for respondents to "fill in" the gaps using prior information. This was evident in this study by the fact that perceived risk (after the new information) was not well explained by traditional risk factors. In fact, it appears the new information caused individuals to base their risk perceptions less on traditional risk factors and "fill in" using prior information, such that they relied more on factors that are commonly known to affect heart disease, including being overweight and smoking.

Interestingly enough, taking cholesterol lowering medication does not significantly reduce perceived risk in any of the specifications, for either the *Survey 1: Screening* data or the *Survey 2: Treatment* data. Currently, statin (cholesterol lowering) medications are only about 30% effective and take a long time to work; therefore, the findings from the perceived risk models suggest that individuals recognize the shortcoming of the drug therapy treatment currently available, and lends support to the need for a new, more effective treatment method.

8.3 Key Results – WTP for Screening and Treatment

The data obtained from *Survey 1: Screening* indicates that the mean WTP for screening is $94, with a median of $50 and standard deviation of $143. The regression results suggest an upward bias of $25 due to the initial bid; therefore, following Whitehead et al (1995) this value is subtracted in order to obtain unbiased estimates. Thus, after adjusting for starting point bias, the mean WTP for screening is equal to $69 and the median is $25. These WTP estimates include some individuals who chose not to have the screening and others who would only receive screening if it were offered at no out-of-pocket cost. However, most individuals appear to value the screening and would be willing to spend some of their financial resources to receive it. Even when no treatment is available, many individuals have a positive value for the screening. This is consistent with the finding by Berwick and Weinstein (1985) and suggests that information obtained from screening does have value for its own sake; namely, that it is likely to increase the individual's expected utility by allowing for better planning and allocation of the individual's time.

The results of *Survey 2: Treatment* data indicate that the mean WTP for a treatment that is 85% effective at reducing the risk of heart attack is $7,821 with a median of $2,500 and standard deviation of $21,084. The regression results suggest that setting the starting point bias equal to zero requires a downward adjustment of $2,005. Therefore, the unbiased mean WTP for treatment is $5,816 and median of $495. This valuation includes some individuals in the general population who preferred drug therapy as a treatment option and some individuals who elected to have no treatment at all. Again, some individuals would only have the treatment if it were offered at no out-of-pocket cost to them; however, as the mean and median indicate, most individuals valued the procedure and were willing to spend some of their financial resources to receive it.

8.4 Factors that Influence the Demand for Screening and Treatment

In analyzing the factors that influence WTP for the screening and treatment of vulnerable plaque, the data analysis suggests that some factors appear to influence whether the individual will *choose* to have the screening/procedure, while other factors affect *how much* the individual is willing to pay for it. A common issue in analyzing health data is how to handle the large number of zeros that are typically present in the data. It is often suggested that a two-part model be used, such that a probit/logit equation is used to model the decision to have the screening/treatment, and then an OLS regression is used to model WTP, but only using those observations for which participation occurs. The data analysis for the *Survey 1: Screening* data and the *Survey 2: Treatment* data support the use of a two-part model in estimating marginal effects for factors influencing WTP.

8.3.1 The Decision to Have Screening

The decision to have screening was modeled using two specifications of a probit model. The basic model includes general measures of perceived risk as obtained from the respondent assessing his/her risk using a computerized visual analog scale. The detailed model includes specific risk factors as measured by a risk assessment quiz published by the American Heart Association (AHA) and from health data obtained from KN which included past diagnoses and other health behaviors of the individuals in the sample.

The results of the basic probit regression indicate that the new information received by the respondent (as measured by their change in perceived risk) was an important factor in the individual choosing to have the screening. In addition, individuals were more likely to have the test if treatment was available (although the level of treatment effectiveness was not necessarily important). And finally, those who are more risk averse (as measured by having life insurance) are more likely to choose the screening. The results of the detailed probit model support these broad conclusions. In addition, it appears that males, individuals who exercise, and those who have already experienced a heart attack are less likely to get the screening. However, the base likelihood of getting the screening is significantly increased for individuals with high blood pressure.

Although the lack of a significant difference between WTP for screening when treatment is 30% effective versus when treatment is 85% effective may suggest an insensitivity to scope, it is important to remember that individuals are being asked to value *screening*; therefore, the effectiveness of the treatment is one step removed from the treatment decision. Although respondents may not distinguish very much between a treatment that is 30% effective and one that is 85% effective when determining their WTP for screening; it is clear they do differentiate between screening in which treatment is available versus screening in which no treatment is available in their decision to get the screening test. Since screening with the possibility of treatment is clearly larger in scope (offering a higher level of quality), the results of this study do suggest that individuals completing the CV survey did respond to variations in scope.

8.3.2 WTP for Screening

The factors influencing the WTP for screening were determined using an OLS regression for those individuals who chose to have the screening (including those who would only receive the screening when it involved no out-of-pocket cost). The data indicates construct validity in that, as theory would predict, higher levels of household income increases the WTP for screening. This model also suggests that those with higher perceived risk who have strong priors regarding their risk assessment, will have a higher WTP for screening. Race appears to matters in that whites (compared to non-whites) will tend to have a lower WTP for screening, all else constant. And finally, (not surprisingly) those who are risk averse and have high cholesterol levels are willing to pay more.

8.3.3 Choosing a More Effective Treatment

The results of the probit model indicate that the decision to have treatment is largely affected by household income as well as the change in perceived risk brought about by the new information. In addition, familiarity plays an important role in that having experience with a heart catheter procedure increases the base probability of choosing the procedure by 0.45, indicating that those individuals who have had a heart catheterization procedure in the past are significantly more likely to have the procedure. However, requesting additional information about the procedure decreases the base probability of choosing the procedure by 0.31, indicating that those who are unfamiliar with the procedure and ask additional questions are significantly less likely to have the procedure, even if their perceived risk of a heart attack is high. These results suggest that providing information about the risks associated with vulnerable plaque is important, but perhaps even more important is providing information that makes the patient feel more comfortable with the procedure. Clearly the information provided by the specialist did not improve the likelihood that the patient would receive the recommended treatment; however, those who had undergone a heart catheterization procedure in the past were far more likely to have the procedure. Therefore, if the objective is to encourage patients to receive the recommended treatment, it may be helpful to conduct a focus group of patients who have had a heart catheterization in the past to better understand their apprehensions prior to the procedure and how those views changed following the procedure. This information could then be used to create a user-friendly brochure to help patients unfamiliar with the procedure feel more at ease.

The extended probit model indicates that those individuals with physical limitations resulting from disability and advanced age may also be less likely to choose the procedure. Certainly the physician would recognize medical conditions that would increase the risk associated with the procedure and share those with the patient as part of the discussion of treatment options. However, being aware that this may be a particular issue for disabled and elderly patients, care can be taken to ensure the patient is accurately assessing these risks, such that he/she can make an informed decision based on actual risks, as opposed to perceived risks that may be unfounded.

8.3.4 WTP for Treatment

As expected, one of the largest determinants of WTP for treatment is consumer wealth. As theory would predict, individuals with higher levels of household income are willing to pay more, as are individuals who have greater financial security. Individuals with chronic conditions (as measured by frequent visits to the doctor) are willing to pay less for the procedure. This is not unexpected since individuals with chronic medical problems would be anticipated to have a lower expected utility gain from the procedure. Finally, information plays a role. Those who request additional information about the procedure are willing to pay about $3600 less on average compared to those who do not request additional information. In addition, those who feel their risk increases from the new information about vulnerable plaque are willing to pay less. These results suggest that those who are uncertain about the procedure and the risk reduction associated with it may have significant questions. As a result, these individuals may feel less confident about the value of the procedure, which translates into a lower WTP.

8.5 Contributions to the Literature

8.5.1 Valuing Heart-Related Health

In determining the reliability of results from a CV study, comparisons can be made to other studies. Kartman et al. (1996) and Chestnut et al. (1996) estimate WTP to reduce the occurrence of angina (chest pain). Since angina is only one symptom of heart disease, it is expected that the WTP to reduce angina would be significantly less than the WTP to reduce the probability of a heart attack. However, since angina can have a significant effect on quality of life, reducing the individual's ability to work and engage in daily activities, the WTP for a reduction in angina is expected to be higher than the WTP for screening. Kartman et al. (1996) find the mean WTP to reduce the number of chest pain occurrences by 25%-75% is between $290 and $345 (about $380-$450 in today's dollars). In order to avoid 8 additional episodes of chest pain, Chestnut et al. (1996) find a mean WTP of $218 (approximately $290 in today's dollars). Therefore, the results from this study seem reasonable in that mean WTP for screening is below reported estimates of mean WTP for reducing the occurrence of chest pain, yet the WTP for treatment (which would reduce the risk of heart attack) is significantly greater than the mean WTP for reducing the occurrence of angina.

A study by Johannesson, et al. (1993) found that individuals in Sweden with elevated cholesterol levels had a mean WTP of SEK 344 (about $61 in current U.S. dollars[135]) per month to achieve a normal cholesterol level. This equates to $732 per year. Therefore, for the mean WTP for treatment ($7,821), respondents in Sweden could receive 10 years of normal cholesterol. Given that the effectiveness of the treatment was estimated to be a maximum of 6.5 years using VSL estimates (See Section 7.9 Treatment Effectiveness and Value of a Statistical Life), this suggests that individuals in the Swedish study were not willing to pay as much.[136] Of course, the goods being valued are not exactly the same – the good in the Swedish study reduces one potential cause of heart attack completely, but leaves other potential risk factors unchanged. Therefore, the new procedure valued in this study may offer more benefit in that it directly reduces the risk of heart attack by 85%. In addition, it is possible that differences in WTP could arise from the different health care systems in the two countries creating cultural differences regarding consumer WTP for medical treatment.

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[135] The exchange rate for August 2, 1993 (the month the study was published) was 1 SEK (Swedish Krona) = .123487 USD. Exchange rate obtained from http://www.x-rates.com/cgi-bin/hlookup.cgi
Therefore, 344 SEK = $42.48 (1993). Using the "inflation calculation" on the Bureau of Labor Statistics website (http://www.bls.gov/) to adjust by the CPI indicates that $42.48 in 1993 is equivalent to $60.76 in current (2007) dollars.

[136] The results are similar if the mean WTP adjusted for starting point bias is used. A mean WTP of $5,816 would equate to approximately 8 years of normal cholesterol, compared to the maximum implied effectiveness of 4.5 years using VSL estimates.

8.5.2 Iterative Bidding with Cheap Talk and Follow-up Certainty Question

The iterative bidding technique used for the web-based surveys worked well in that a review of individual observations revealed that respondents seemed to take the bidding seriously, and in many cases, switched responses several times during the bidding process. Unfortunately, as the empirical results illustrate, starting point bias was still an issue. However, given the greater efficiency of using a multiple-bounded DC choice question in eliciting WTP and the power of the Internet to use real-time interface to generate questions based on past responses, it is likely that this new format will yield other variations of iterative bidding that may not be prone to starting point bias. In addition, the computer capabilities of a web-based survey offer greater opportunities for internal checks that may help reduce the possibility of hypothetical bias.

As mentioned previously, hypothetical bias currently poses one of the greatest problems for CV. As a result, researchers have attempted to eliminate hypothetical bias *ex ante* using a cheap talk script or *ex post* using calibrations based on a certainty follow-up question. Blumenschein et al. (forthcoming 2007) find that the cheap talk script is not effective in removing hypothetical bias, but that recalibrating using only individuals who are "definitely sure" of their responses can successfully remove hypothetical bias such that stated intentions correspond with actual purchase decisions. The purpose of this study was not to test the reliability of these methods; however, because WTP estimates were obtained following the cheap talk script, as well as the follow-up certainty question, some limited information as to the reliability of these methods can be offered by this study.

For the *Survey 1: Screening* data, the mean initial WTP for screening (following the cheap talk) was $108; however, it was only $94 following the certainty question. Likewise, for the *Survey 2: Treatment* data, the mean initial WTP for treatment (following the cheap talk script) was $9,928; however, it dropped to $7,821 following the certainty question. A final certainty question used in the focus groups indicated that most respondents were "definitely sure" of their WTP following the cheap talk script *and* the certainty scale question. Therefore, from these differences, it appears that the cheap talk script does not sufficiently reduce hypothetical bias, but the combination of the cheap talk script with a certainty follow-up question may eliminate hypothetical bias (with no *ex* *post* calibration required). To test whether the cheap talk script *with* a follow-up certainty scale question can effectively eliminate hypothetical bias, a study could be conducted using this method in such a way that stated intentions could be compared to actual purchase decisions. Because the elimination of hypothetical bias is such an important issue confronting the ability of CV to provide accurate measures of valuation, this is certainty a possible topic for future research.

8.5.3 The Role of Information on Consumer Demand for Health-Related Goods

The concepts proposed by Hoehn and Randall (2002) are particularly relevant to this study. Presumably "new" information on who is at risk for a heart attack is presented and measures of individual risk perception are obtained both before and after respondents are made aware of this new information. As Hoehn and Randall suggest, new information may have different effects on respondents' perception of risk, depending on their priors. The CV surveys used in this study allow for this possible heterogeneity. In particular, data is collected to determine the direction and magnitude that the new information has on each respondent's perception of heart attack risk.

Although the new information presented in the survey was expected to increase perceived risk; as Hoehn and Randall (2002) suggest, new information does not necessarily have that effect. In fact, 65% of the sample who completed *Survey 1:Screening* indicate that their risk perception did <u>not</u> change after reading the new information, and 5% indicated that the new information *lowered* their perception of heart attack risk. For the *Survey 2: Treatment* sample the results were similar. Sixty percent indicated that their perceived risk did not change and almost 5% indicated their risk decreased after reading the new information. Therefore, in both samples, a majority of the individuals had strong priors regarding their perceived risk of a heart attack. As the results of this study indicate, this strength of prior risk perception is an important factor in the decision to get screening, as well as in determining WTP for the procedure.

8.5.4 Does Information have Value for its own Merit?

Berwick and Weinstein (1985) find that information that has no bearing on medical decisions comprises about 25% of the WTP for ultrasound for women with normal pregnancy. In this study, those who were most certain of their stated WTP (certainty=10), indicated a mean WTP of $52 for screening when no treatment is available, a mean WTP of $93 for screening when treatment is 30% effective, and a mean WTP of $135 for screening when treatment is 85% effective. These results suggest that the value of information (that does not affect medical decision making) from screening is approximately 38% of the value of screening when the more effective treatment is available. It should be noted that the number of respondents who received a version of *Survey 1: Screening* in which there was no treatment was fairly small; therefore the numerical results should be used cautiously; however, the results do suggest that information from screening (in the absence of treatment) clearly has some value for individuals. Due to the fact that it is highly likely medical researchers will develop a screening for vulnerable plaque before they develop a treatment, a more in depth study focusing on the WTP for screening in the absence of treatment could be a topic for future research. In addition, Berwick and Weinstein point out a potential shortcoming of clinical decision analysis in that it does not include the value of information from a non-clinical standpoint in selecting the best treatment option. This was evidence by Scenario 2 in Chapter 4 in which screening is available, but treatment is not. In this case, screening would have no bearing on the medical outcomes (as illustrated by the same branches in Figure 2 for both the *screening* and *no screening* options); therefore, clinical decision analysis would not indicate a preference for screening. Yet the results of this study, and that of Berwick and Weinstein (1985), both suggest that information clearly has value for its own merit that should be considered in clinical decision analysis as well as in decisions affecting public policy.

Appendix A: Survey Instruments

{Survey 1: Screening}

{Notes appearing in {brackets} provide information for programming and do not appear in the online version of the survey. Screen breaks are indicated by either a page break, dashed line or solid line, the circles represent radio buttons, and navigational buttons appearing in the bottom right-hand corner of each screen are indicated by square brackets [ ]}

{I. Welcome Screen}

{1} How important do you feel it is for your doctor to include you in making decisions regarding *your* health?

Select one answer only

- ○ Very important
- ○ Somewhat important
- ○ Not important

[Next Question]

{II. General Questions}

Medical advances are occurring at a rapid rate; however, this can increase the cost of providing health care. Because of these rising costs, it becomes important to focus on how society should allocate its health care resources. The following questions will assist us in determining what is important to you. Specifically, we would like to ask how *you* would spend your *own* money for a medical test that could better identify who is at risk for a heart attack.

[Continue]

{2} Have you ever been told by a doctor that you have heart disease?

Select one answer only

- ○ Yes
- ○ No
- ○ I don't know

[Next Question]

{3} Have you ever taken medicine to reduce your cholesterol (Some examples include: Lipitor, Zocor, Mevacor, Pravachol)?

Select one answer only

- ○ Yes
- ○ No
- ○ I don't know

[Next Question]

{4} Have you ever experienced a heart attack?

Select one answer only

- ○ Yes
- ○ No

[Next Question]

{5} Do you have a relative in your *immediate* family (spouse, parent, sibling, or child) who has experienced a heart attack?

Select one answer only

- ○ Yes
- ○ No

[Next Question]

{If respondent answers “Yes” to question 5, then ask question 5b}

{5b} Were you involved in making decisions regarding the treatment of this family member’s heart condition?

Select one answer only

- ○ Yes
- ○ No

[Next Question]

{6} Have you ever undergone a heart catheterization procedure?

Select one answer only

- ○ Yes
- ○ No
- ○ I don't know

[Next Question]

{7} Are you a cardiologist or other health care professional who has received specific training in the treatment of heart disease?

Select one answer only

- ○ Yes
- ○ No

[Next Question]

{8} Have you ever had a life-threatening condition or illness?

Select one answer only

- ○ Yes
- ○ No

[Next Question]

{III. Perceived Risk Questions}

According to the American Heart Association, the following are factors that *could* increase your risk for a heart attack.

Please click Yes or No to indicate which risk factors *apply to you*

	YES	NO	DON"T KNOW
Are you a man over *45* years old.	○	○	○
Are you a woman over *55* years old, **OR** Are you a woman less than 55, who has passed *menopause* **OR** Are you a woman less than 55, who has had her *ovaries* removed, but is **not** taking estrogen.	○	○	○
Did your father or brother had a *heart attack* before age *55* **OR** Did your mother or sister have a *heart attack* before age *65*.	○	○	○
Do you *smoke*, or *live or work with* people who smoke every day.	○	○	○

	YES	NO	DON"T KNOW
Is your total cholesterol level *240 mg/dL or higher* **OR** Have you ever been told by your doctor that you have high cholesterol	○	○	○
Is your HDL ("good") cholesterol level *less than 35 mg/dL*.	○	○	○
Is your blood pressure *140/90* mm Hg or higher, **OR** have you been told that your blood pressure is *too high*.	○	○	○
Do you get *less* than a total of *30 minutes* of physical activity on most days.	○	○	○

	YES	NO	DON"T KNOW
Are you *20 pounds* or more overweight for your height and build.	○	○	○
Do you have *diabetes* **OR** a fasting blood sugar of 126 mg/dL or higher), **OR** do you need *medicine* to control your blood sugar.	○	○	○
Do you have *coronary heart disease*, or have you had a *heart attack*.	○	○	○

[Next Question]

Annual Risk of Fatality (Deaths per 100,000 persons)

No Risk	**Auto Accident**	High Risk	
|-----------------|-------------------------------|------------------------//------------>			
0	**19**	50	100,000

By identifying your own risk factors on the previous screen, you probably have a better awareness of your own risk for having a heart attack. Suppose you were asked to rate your risk of having a heart attack within the next year using the scale above (0 being NO risk and 50 being HIGH risk). If your risk of dying in a car accident within the next year is placed at 19, where would you place your risk of having a heart attack?

Although most people will have a risk in the range of 0 to 50, some people (including those who have already experienced a heart attack), may have a risk higher than 50

Using the above scale as a guide, enter the number that best describes your risk of having a heart attack in the next year. ______ {response will be inserted in follow-up certainty question on page 8}

Enter an answer from 0 to 100000 [_______]

{If response is not between 0 and 100,000, an error message is shown}

[Next Question]

New Information on Who is at Risk for Heart Attacks

Most of us learned that a build up of plaque within our arteries puts us at higher risk for heart attack, yet at some point you have probably heard of a very healthy, young man or woman who died suddenly of a heart attack. In fact, over 100,000 Americans die each year without ever having experienced any symptoms of heart disease. A news report that aired in January 2001 on the television show 20/20 explained how this can occur. The reporter stated that doctors have discovered that it is not atherosclerosis, or what many of us know as "hardening of the arteries," that causes most heart attacks. Instead, researchers now believe that most heart attacks are caused by something called "vulnerable plaque."

[Continue]

What is vulnerable plaque?

Vulnerable plaque is a type of plaque that lies hidden beneath the surface of an artery, much like lava within a volcano. Because this plaque is only covered by a thin cap, exercise or stress can "trigger" this plaque to erupt. When this occurs, it causes a blood clot to form instantaneously within the vessel. This blood clot can block the artery and prevent blood from traveling to the heart, which results in a heart attack.

[Continue]

Who is at risk for vulnerable plaque and heart attack?

Although those with high cholesterol and other known risk factors (like those mentioned earlier in this survey) are more at risk, apparently healthy individuals with NO prior symptoms of heart problems can have vulnerable plaques waiting to erupt. Unfortunately there is currently no way to determine who has vulnerable plaque and who does not. <u>Therefore, you may have vulnerable plaque, but be completely unaware that you are at increased risk of a heart attack.</u>

[Continue]

After reading this new information, I feel my *own* risk of having a heart attack within the next year is now

Select one answer only

- ○ much higher
- ○ somewhat higher
- ○ the same
- ○ somewhat lower
- ○ much lower

[Next Question]

Annual Risk of Fatality (Deaths per 100,000 persons)

No Risk　　**Auto Accident**　　High Risk

|----------------|------------------------------|------------------------//------------>

0　　**19**　　50　　100,000

Earlier you rated your own risk of having a heart attack as ______ on the scale above.

{insert respondent's answer from earlier perceived risk question on page 6}

Now that you have learned this new information, where would you place your risk of having a heart attack within the next year on this scale? ________

Enter an answer from 0 to 100000 [_______]

{If response is not between 0 and 100,000, an error message is shown}

[Next Question]

{**IV. Willingness to Pay Questions}**

Suppose you go to your regular physician for a routine exam. During the exam, your doctor says the following:

As part of your exam I am going to order some routine lab work. The results from these tests will tell us your cholesterol level; however, I would also like to order a new test to see if you have vulnerable plaque. Studies have shown that people who have LOW cholesterol levels and NO other risk factors CAN STILL have a heart attack due to vulnerable plaque. In fact, people who have heart attacks due to vulnerable plaque often have no warning and show no symptoms of heart problems prior to the attack.

Nearly 50% of all heart attacks result in death. Therefore, it is very important to identify those at risk, so that treatment can be given.

[Continue]

{Option 1: Treatment Version}

If this test indicates you have vulnerable plaque, then we can do further testing to determine if treatment is necessary. If this test indicates you do not have vulnerable plaque, then you will have the peace of mind from knowing that you are at significantly lower risk of having a heart attack

{Randomize the following such that of those respondents who receive a "treatment" version of the survey, half will be told that the treatment is 30% effective, while the other half will be told that the treatment is 85% effective}

Currently, the standard treatment for vulnerable plaque is drug therapy, which is 30% effective at reducing the occurrence of a heart attack.
{OR}
There is a new treatment available specifically for vulnerable plaque, which is 85% effective at reducing the occurrence of a heart attack.

I recommend that you strongly consider having this test. In fact, I recommend that everyone consider having this test as part of their annual exam or every time they have their cholesterol checked.

Take a moment to think about what the information from this test would be *worth to you*. Is there a benefit from finding out that you are NOT at high risk for a heart attack? On the other hand, would you benefit from knowing that you ARE at increased risk of a heart attack and could receive treatment?

[Continue]

{Option 2: Non-Treatment Version}

Although there is currently NO TREATMENT for vulnerable plaque, the results of this test would provide you with INFORMATION regarding your risk of having a heart attack.

I recommend that you strongly consider having this test. In fact, I recommend that everyone consider having this test as part of their annual exam or every time they have their cholesterol checked.

Take a moment to think about what the information from this test would be *worth to you*. Is there a benefit from finding out that you are NOT at high risk for a heart attack, such as peace of mind? On the other hand, would you benefit from knowing that you ARE at increased risk of a heart attack? Although TREATMENT IS NOT AVAILABLE, it would provide information that may lead you to make different life decisions and allow you to plan accordingly.

[Continue]

As you consider how much you would value knowing whether or not you are at increased risk for a heart attack, we would like to make you aware of a problem that occurs in surveys of this nature called "**hypothetical bias**."

Hypothetical bias occurs when people *say* they will pay more for a particular good or service than they *actually* do when paying for it out of their own pocket. For example, someone may say in a survey that they would buy a pair of sunglasses, but then when given the opportunity to buy the sunglasses, decide not to. That difference is what leads to hypothetical bias.

[Continue]

Studies have shown that "hypothetical bias" exists and that it can be quite large. In one study, people were asked how much they would pay for therapy to manage a chronic condition. The results of the study revealed that when the decision was hypothetical, people *said* they would pay *three times more* than they actually chose to pay when the decision was real. That's quite a difference, isn't it?

So, in considering what this blood test is worth to you in terms of the information it will provide, please also consider that due to hypothetical bias you might be *tempted* to say that it is worth more than you would *actually* pay if the decision to get this test were real.

Do you understand hypothetical bias?

Select on answer only

- ○ Yes
- ○ No, I would like further clarification

[Next Question]

{If respondent selects "No, I would like further clarification, then display the following as the next screen, otherwise continue with the survey}

Suppose as part of a marketing survey you were shown a pair of sunglasses and asked whether you would purchase the sunglasses if they were priced at $12. After thinking about it, you indicated on the survey that yes, you would purchase the sunglasses if they cost $12.

Later the same day you are in a store and see the exact same sunglasses for sale. They cost $12; however, you decided NOT to buy them. In this example, what you *said* you would purchase was different from you *actually* chose to purchase. This is a very common tendency and is called "hypothetical bias." It occurs what when people say they will purchase under *hypothetical* conditions differs from what they actually choose to purchase under *real* circumstances.

Do you understand hypothetical bias?

Select one answer only

- ○ Yes
- ○ No {Even if they answer no, move on to next question}

[Next Question]

Suppose you go to your doctor tomorrow and he/she tells you that a test for vulnerable plaque is now available to you. It is a simple, but accurate blood test that will tell you whether you are at increased risk for a heart attack. If you have to pay for it *out of your own pocket*, how much would you be willing to spend? What is it worth to you?

Before you answer, please consider the following:

Approximately how many dollars per month do you already spend on medical care (not including insurance premiums)?

Select one answer only

- ○ Less than $20.00 per month
- ○ $20.00 to $49.99 per month
- ○ $50.00 to $99.99 per month
- ○ $100.00 to $199.99 per month
- ○ $200.00 to $500.00 per month
- ○ More than $500.00 per month
- ○ Don't know

[Next Question]

So ask yourself these two questions:

> Based on what I am already spending for medical care, how much do I have *available* to spend on this test?
>
> If I were *really* faced with making this decision, would I *actually* pay <u>out of my own pocket</u> to have this test? Would I really spend *my* money in this way?

[Continue]

{*Iterative bidding process – computer will generate up to 5 bids based on the respondent's answers. See "Programming Notes on Iterative Bidding" on following pages for algorithm and examples ***}**

{First bid}

Now that you have considered all of these things,

If this blood test cost $______, would you choose to have it done?

Select one answer only

- ○ Yes
- ○ No

[Next Question]

{Bids 2-5}

If this blood test cost $______, would you choose to have it done?

Select one answer only

- ○ Yes
- ○ No

[Next Question]

{When presenting a $0 bid, add the word "FREE" so that it appears as "$0 (FREE)"}

{Programming Notes on Iterative Bidding}

{The bidding question will be asked up to 5 times inserting "bids" according to the following algorithm}

{The initial bid should vary randomly between $10, $40, $50, $60, and $100.}

{If the respondent says "Yes" to the initial bid, the second bid should be DOUBLE the initial bid (if initial bid is $60, then second bid should be $120). As long as the respondent says "yes", continue to double the bid. If the respondent says "No" to the initial bid, then HALF the initial bid to generate the next bid. Continue to reduce the bids by HALF as long as the respondent answers "No". }

{Once the respondent changes their response (from "yes" to "no" OR "no" to "yes"), subsequent bids should be generated by splitting the difference between the highest "yes" bid and lowest "no" bid.. For example, if the respondent says "Yes" to $50, but "No" to $100, then the next bid should be $75 (100+50 divided by 2).}

{If this process does not lead to a number that is an increment of $5, then it should be rounded DOWN. For example, if the respondent's highest "yes" bid is $50 and their lowest "no" bid is $75, then dividing the difference by 2 (50+75 = 125 /2) would yield $62.50. This should be rounded down, so that the next bid is $60. (Because this survey is asking about the respondent's willingness to pay for a good, it seemed rounding down the bids would be a more conservative approach). Since the computer program will most likely not have a function to round down, this can be accomplished in the following way: Divide the bid by 5 (62.5 / 5 = 12.5), truncate the result (to yield 12), and then re-multiply by 5 (12*5=60). This method should work for all cases in which the bid does not end in 5 or 0 (zero).

{The bidding process should stop once the response is within a $5 interval or a maximum of 5 bids have been generated}

{Examples}

Example 1:

$50 Y (double bid from $50 to $100)
$100 Y (double bid from $100 to $200)
$200 N (split difference between $100 and $200)
$150 Y (split difference between $150 and $200)
$175 N
(go to option 3 on page 16 and report range of $150 to $175)

Example 2:

$50 Y (double bid from $50 to $100)
$100 N (split difference between $50 and $100)
$75 Y (split difference between $75 and $100 and round down)
$85 Y (split difference between $85 and $100 and round down)
$90 N
(record WTP as $85 and go to page 17)

Example 3:

$40 N (divide $40 in half)
$20 Y (split difference between $20 and $40
$30 Y (split difference between $30 and $40)
$35 N
(STOP after 4 bids – record WTP as $30 and go to page 17)

{Extreme cases}

Example 4:

$60 N (divide bid in half)
$30 N (divide bid in half)
$15 N (divide bid in half and round down)
$5 N (divide bid in half and round down)
$0 Y
(record WTP as $0 and go to page 17)

Example 5:

$10 N (divide bid in half)
$5 N (divide bid in half and round down)
$0 N
(record as protest and go to page 16, option 1)

Example 6:

$50 Y (double bid)
$100 Y (double bid)
$200 Y (double bid)
$400 Y (double bid)
$800 Y
(For extremes with no upper bound, go to page 16, option 2)

{Option 1}

{If a respondent answers “no” to a zero bid, then ask the following open-ended question}

Please tell us why you chose not to have the test even when it was offered for $0 (FREE)

[Continue]

{Direct respondent to Thank You screen and end survey}

{Option 2}

{If a respondent answers “yes” to all 5 bids, then ask the following:}

You indicated that you would pay more than $_____ {insert highest “yes” bid} for this test. What is the most you would be willing to spend *out of pocket* for this test to find out if you are at increased risk for a heart attack?

Enter dollar amount here [_________]

[Next Question]

{this response will be inserted into certainty question on page 17}

{Option 3}

{If the bidding process does not sufficiently converge the respondent’s WTP value to within a $5 margin of error, then ask the following:}

You indicated that you would pay at least $______ {insert highest “yes” bid}, but less than $_______{insert lowest “no” bid}.

What is the most you would be willing to spend *out of pocket* for this test to find out if you are increased risk for a heart attack?

Enter dollar amount here [________]

[Next Question]

{this response will be inserted into certainty question on page 17}

If you yourself have never experienced a heart problem, then this is probably the first time that you have thought about how much you would value this type of test.

Therefore, it is reasonable to assume that you may not be entirely sure how much you would *really* be willing to pay out of your own pocket to have it done.

On a scale of 0 to 10, where 0 is "not sure at all" and 10 is "definitely sure" please indicate how sure you are that you would choose to get this potentially life saving[137] test if it cost $________ {insert respondent's previously stated WTP}

Not Sure At All	|---|											Definitely Sure
	0	1	2	3	4	5	6	7	8	9	10	

Enter your answer here [________]

[Next Question]

Earlier you said that you would pay $ _____ for this test. {insert previously stated WTP}

Now that you have had a chance to consider how sure you are about this decision, please enter the amount you would *definitely* (beyond any doubt) pay for this test. $________

[Next Question]

How many times would you expect to have this test over the course of your lifetime?

Enter number here [______]

[Next Question]

[137] "potentially life saving" was changed to "informative" in the non-treatment version of this survey

{V. Demographic Questions}

To complete the survey, please answer a few questions about your background to help us better understand which characteristics are important in making these kinds of health care decisions.

In general would you say your health is:

Select one answer only

- ○ Excellent
- ○ Very Good
- ○ Good
- ○ Fair
- ○ Poor

[Next Question]

Is there anyone NOT living with you who is financially or otherwise dependent on you (for example: child, elderly parent)

Select one answer only

- ○ Yes
- ○ No

[Next Question]

Do you have life insurance?

Select only one answer

- ○ Yes
- ○ No
- ○ I don't know

[Next Question]

Which of the following best describes how financially secure you feel your family would be in the untimely event of your death?

Select one answer only

- ○ very secure
- ○ fairly secure
- ○ not very secure

[Next Question]

Thank you for taking this survey on willingness to pay for a testing method to better determine who is at risk for heart attack. As you may have noticed, the proposed blood test you were asked about is hypothetical; however, clinical research is currently being done such that this type of test could become available in the near future. In fact, the November 25, 2002 issue of *U.S. News and World Report* describes a blood test that some researchers now believe can provide additional information on who is at risk for a heart attack. Therefore, the results from this study could provide valuable information to decision makers regarding the value that society would place on this blood test.

Thanks again for your participation in this important research.

[Continue]

Thinking about this topic, do you have any comments you would like to share?

Any comments welcome!

[Continue]

{Survey 2: Treatment}

{Notes appearing in {brackets} provide information for programming and do not appear in the online version of the survey. Screen breaks are indicated by either a page break, dashed line or solid line, the circles represent radio buttons, and navigational buttons appearing in the bottom right-hand corner of each screen are indicated by square brackets [ ]}

{I. Welcome Screen}

{1} How important do you feel it is for your doctor to include you in making decisions regarding *your* health?

Select one answer only

- ○ Very important
- ○ Somewhat important
- ○ Not important

[Next Question]

{II. General Questions}

Medical advances are occurring at a rapid rate; however, this can increase the cost of providing health care. Because of these rising costs, it becomes important to focus on how society should allocate its health care resources. The following questions will assist us in determining what is important to you. Specifically, we would like to ask how *you* would spend your *own* money for a medical procedure that could possibly reduce your risk of having a heart attack.

[Continue]

{2} Have you ever been told by a doctor that you have heart disease?

Select one answer only

○ Yes

○ No

○ I don't know

[Next Question]

{3} Have you ever taken medicine to reduce your cholesterol (Some examples include: Lipitor, Zocor, Mevacor, Pravachol)?

Select one answer only

○ Yes

○ No

○ I don't know

[Next Question]

{4} Have you ever experienced a heart attack?

Select one answer only

- ○ Yes
- ○ No

[Next Question]

{5} Do you have a relative in your *immediate* family (spouse, parent, sibling, or child) who has experienced a heart attack?

Select one answer only

- ○ Yes
- ○ No

[Next Question]

{If respondent answers "Yes" to question 5, then ask question 5b}

{5b} Were you involved in making decisions regarding the treatment of this family member's heart condition?

Select one answer only

- ○ Yes
- ○ No

[Next Question]

{6} Have you ever undergone a heart catheterization procedure?

Select one answer only

- ○ Yes
- ○ No
- ○ I don’t know

[Next Question]

{7} Are you a cardiologist or other health care professional who has received specific training in the treatment of heart disease?

Select one answer only

- ○ Yes
- ○ No

[Next Question]

{8} Have you ever had a life-threatening condition or illness?

Select one answer only

- ○ Yes
- ○ No

[Next Question]

{III. Quality of Life}

About half of the people who experience a heart attack die as a result. For those who survive, the results can vary substantially – from "no difference" for some, to others who are left permanently disabled to the point of being completely dependent on others. Because a heart attack permanently damages the heart muscle, a majority of people who survive a heart attack experience chronic symptoms such as chest pain, fatigue, and shortness of breath. If you have experienced a heart attack or have a close friend or relative who has, then you are probably already aware of how much these symptoms can affect your everyday life.

[Continue]

The following table describes how a heart attack may affect your quality of life.

Chronic Symptoms:	Symptoms such as chest pain, fatigue, and/or shortness of breath can occur *anytime* for no apparent reason, but are especially likely during times of exertion or stress.
Ability to Exercise:	Symptoms may become more severe during exercise
Ability to Lift or engage in any type of Physical Exertion:	Symptoms may become more severe as a result of any type of physical exertion (walking up stairs, carrying groceries, etc.)
Ability to Handle Stress:	Symptoms may become more severe during times of stress
Potential Hospitalization:	Severe symptoms may lead to hospitalization and possibly a heart catheterization procedure
Work Attendance and Performance:	Work attendance may be affected, and symptoms may affect your ability to perform your job duties
Probability of Disability:	Two-thirds of the people who experience a heart attack do not make a full recovery
Probability of Recurrent Heart Attack	Individuals who experience a heart attack are at a much greater risk of having another heart attack
Probability of Death:	About half of all heart attacks are fatal

As you can see, experiencing a heart attack can greatly affect your everyday life.

Please review this table carefully. In a moment we are going to ask you how these symptoms might affect *your* life.

[Continue]

{Option 1}

{If answer to question #4 is "No" then ask following}

Imagine that you experience a heart attack and survive. Take a moment to think about how this could affect *your* quality of life. How much physical exertion is required by your daily life and work? How would your condition affect your ability to handle the stress you encounter during a typical day?

In the table below, please indicate to what extent each area of your life would be affected by these symptoms.

{Option 2}

{If answer to question #4 is "Yes" then ask the following}

Earlier in this survey, you indicated that you had experienced a heart attack. Therefore, you know first hand the effect it can have. Please use the table below to indicate how having a heart attack has affected your quality of life

---

{Table below should appear for all respondents}

	Not at all	**Slightly**	**Moderately**	**Quite a bit**	**Extremely**
Ability to perform daily functions	○	○	○	○	○
Ability to effectively complete work duties	○	○	○	○	○
Ability to provide for family	○	○	○	○	○
Overall quality of life	○	○	○	○	○

[Next Question]

As someone familiar with heart problems, you are probably already aware of several factors that place could place you at risk for a heart attack, including high blood pressure, high cholesterol, obesity, diabetes, family history, or having had a prior heart attack yourself.

[Continue]

Annual Risk of Fatality (Deaths per 100,000 persons)

```
No              Auto                  High
Risk            Accident              Risk
 |---------------|---------------------------|----------------------//------------>
 0               19                          50                          100,000
```

Suppose you were asked to rate your risk of having a heart attack within the next year using the scale above (0 being NO risk and 50 being HIGH risk). If your risk of dying in a car accident within the next year is placed at 19, where would you place your risk of having a heart attack?

Everybody's individual risk is different. Although most people will have a risk in the range of 0 to 50 some people (including those who have already experienced a heart attack), may have a risk higher than 50

Using the above scale as a guide, enter the number that you believe best describes your risk of having a heart attack in the next year. ______ {response will be inserted in follow-up certainty question on page 28}

Enter an answer from 0 to 100000 [_______]

{If response is not between 0 and 100,000, an error message is shown}

[Next Question]

New Information on the Primary Cause of Heart Attacks

At some point your doctor probably told you that having high cholesterol and a build up of plaque within your arteries put you at higher risk for a heart attack; but what you may not know is that recent medical research has revealed that this is not the whole story. Researchers have discovered that atherosclerosis or what many of us know as "hardening of the arteries" is NOT the primary cause of heart attacks. Instead, doctors now believe that most heart attacks are caused by a certain *type* of plaque, called "vulnerable plaque."

What is vulnerable plaque?

Vulnerable plaque is a "soft" plaque that lies hidden beneath the wall of the artery, much like lava within a volcano. A trigger, such as stress, can cause the plaque to rupture. When this happens the plaque enters the blood stream and causes a blood clot to form. This clot can block the artery and prevent blood from flowing to the heart, which causes a heart attack. Because this process happens so quickly, a person may not experience chest pain or any other warning signs prior to the attack. Therefore, it is very important to identify who has vulnerable plaque in order to prevent these heart attacks from occurring.

[Continue]

Identifying and Treating those with Vulnerable Plaque

It is hard to determine who has vulnerable plaque because it lies hidden *within* the walls of the arteries. Even laboratory tests, such as those that measure good (HDL) and bad (LDL) cholesterol cannot identify who has vulnerable plaque. The good news is that medical research is currently being done to develop a way to detect and treat vulnerable plaque. In the meantime, patients are typically treated using cholesterol lowering medication. However, medication alone is only 30% effective at preventing heart attacks.

Doctors now believe that vulnerable plaque causes 75% of all heart attacks. That is why developing a new, more effective treatment is so important.

Who is at risk for a heart attack due to vulnerable plaque?

Anyone can have vulnerable plaque, but those who have coronary artery disease or other risk factors like those mentioned earlier in this survey are thought to be at increased risk. Because vulnerable plaques tend to be located in *several* places within the heart vessels, those who have already experienced a heart attack are thought to be at even greater risk. In fact, research suggests that over half of the people who have already experienced a heart attack have at least one other vulnerable plaque that could erupt.

[Continue]

After reading this new information, I feel my *own* risk of having a heart attack within the next year is now

Select one answer only

- ○ much higher
- ○ somewhat higher
- ○ the same
- ○ somewhat lower
- ○ much lower

[Next Question]

Annual Risk of Fatality (Deaths per 100,000 persons)

```
No          Auto              High
Risk        Accident          Risk
 |-----------|-----------------|--------------//---------->
 0          19                 50                    100,000
```

Earlier you rated your own risk of having a heart attack as ______ on the scale above.

{insert respondent's answer from earlier perceived risk question on page 26}

Now that you have learned this new information, where would you place your risk of having a heart attack within the next year on this scale? ________

Enter an answer from 0 to 100000 [_______]

{If response is not between 0 and 100,000, an error message is shown}

[Next Question]

{IV. Selecting a Treatment }

Suppose you begin to experience chest pain. You immediately go see your regular doctor.

Now suppose after some preliminary tests, your doctor tells you the following:

> "Your tests indicate that **you are at high risk for a heart attack**. There are two possible treatment options. The standard treatment for patients with your condition has been to prescribe a cholesterol lowering medication that you would take daily. However, medication alone is only 30% effective at reducing the occurrence of a heart attack.
>
> "Recently, a new treatment has been developed that is more effective. This treatment involves taking the medication I just described *and* having a minimally invasive procedure. Having this procedure *in addition to* taking the medication will reduce your risk of having a heart attack by 85%. The procedure does have a very small risk of death associated with it – about 10 people out of 100,000 who have this procedure die from medical complications. To put this in perspective, your risk of dying in a car accident each year is about twice this high or 19 out of 100,000.
>
> [Continue]

> "Even though your tests indicate that you are at high risk for having a heart attack, these tests are not perfect. Performing this procedure would give us *additional information* regarding your *actual* risk. If, during the procedure, we determine that you are at risk, we can treat you as part of the same procedure. This procedure could require an overnight stay at the hospital, but if we determine you are not at risk, you will most likely go home the same day. Beyond this, no additional recovery time is necessary. Therefore, once you return home, you should be able to return to work and your regular routine right away.
>
> "About 50% of heart attacks are fatal. For those who do survive, a heart attack can greatly reduce an individual's quality of life. Chest pain, fatigue, and shortness of breath can greatly diminish your ability to perform your work duties and can greatly affect your daily routine. **Your tests have indicated that you are at high risk for a heart attack.** Having this procedure would allow us to determine your actual risk with much more certainty (my typo) and permit us to treat you if necessary. Therefore, performing this procedure could dramatically increase your chances of avoiding a fatal or disabling heart attack."

[Continue]

You seek a second opinion and another trusted physician recommends the same procedure. So, two physicians, including your regular doctor, agree that you should strongly consider having BOTH the procedure and medication

Medication Only	30% effective
Procedure and Medication	85% effective additional risk of death: 10/100,000

Based on the risk and effectiveness of each treatment option, which would you choose?

Select one answer only

○ Procedure and Medication {Go to page 33}

○ Medication Only {Go to demographic questions}

○ Not sure, I would like more information before deciding {Go to next page}

[Next Question]

{If respondent chooses "Not sure, I would like more information before deciding" then show the information on the this page and the next as the next two screens}

Because you requested additional information, the doctor who would be performing the procedure comes in to provide you with more detailed information.

Suppose the doctor tells you the following:

> "This is a *minimally* invasive procedure that involves making a small incision in your upper thigh so that a very thin flexible tube, called a heart catheter, can be threaded through the vessel up to the coronary arteries. This tube will allow me to "see" into the vessel to determine if you have vulnerable plaque. If vulnerable plaque is found, then I can go ahead and treat the area as part of the same procedure using a heart catheter designed specifically for treatment.
>
> "This procedure is very similar to the procedure used to place a stent or to perform angioplasty. As with those procedures, you will be given a light sedative to relax you, although you will remain awake throughout the procedure. However, you will NOT experience any "chest tightness" that is often experienced with angioplasty or placing a stent. In fact, during this procedure <u>you should not experience any pain</u>, although you may feel a little discomfort at times. Following this procedure, you may have to stay overnight in the hospital for observation. However, if there are no complications, this will be done on an outpatient basis and you will be able to return to work and your normal routine the next day.

[Continue]

{continued from the previous page – screen should only be shown if the respondent chooses "Not sure, I would like more information before deciding" to the treatment question on page 30}

> "I agree with your regular doctor that given your previous tests which indicate you are at high risk for a future heart attack, this is the best course of treatment. Having this procedure in addition to taking medication reduces your risk of a future heart attack by 85%, compared to a 30% reduction from taking medication alone. This procedure does have a small risk of death. About 10 people out of 100,000 who have this procedure die from medical complications. However, because your test results indicate that you are at high risk for a heart attack, you are probably at a greater risk of dying if we do not perform this procedure.

Medication Only	30% effective
Procedure and Medication	85% effective additional risk of death: 10/100,000

Based on the risk and effectiveness of each treatment option, which would you choose?

Select one answer only

- ○ Procedure and Medication {Go to next page}
- ○ Medication Only {Go to demographic questions}

Again, take a moment to think about how having a disabling or fatal heart attack might affect your life and that of your family. This procedure can greatly reduce your chances of having a heart attack. Think about what that is worth to you and how much you would value this procedure.

As you consider how much this procedure would benefit you by reducing your chances of having a heart attack, we would like to make you aware of a problem that occurs in surveys of this nature called "**hypothetical bias**."

Hypothetical bias occurs when people *say* they will pay more for a particular good or service than they *actually* do when paying for it out of their own pocket. For example, someone may say in a survey that they would buy a pair of sunglasses, but then when given the opportunity to buy the sunglasses, decide not to. That difference is what leads to hypothetical bias.

[Continue]

Studies have shown that “hypothetical bias” exists and that it can be quite large. In one study, people were asked how much they would pay for therapy to manage a chronic condition. The results of the study revealed that when the decision was hypothetical, people *said* they would pay *three times more* than they actually chose to pay when the decision was real. That’s quite a difference, isn’t it?

So, in considering what this procedure is worth to you in terms of the reduction in the risk of heart attack, please also consider that due to hypothetical bias you might be *tempted* to say that it is worth more than you would *actually* pay if the decision to have this procedure were real.

Do you feel you understand hypothetical bias?

Select on answer only

- ○ Yes
- ○ No, I would like further clarification

{If they respond with “No, I would like further clarification, then display the following as the next screen, otherwise continue with the survey}

Suppose as part of a marketing survey you were shown a pair of sunglasses and asked whether you would purchase the sunglasses if they were priced at $12. After thinking about it, you indicated on the survey that yes, you would purchase the sunglasses if they cost $12.

Later the same day you are in a store and see the exact same sunglasses for sale. They cost $12; however, you decided NOT to buy them. In this example, what you *said* you would purchase was different from you *actually* chose to purchase. This is a very common tendency and is called “hypothetical bias.” It occurs what when people say they will purchase under *hypothetical* conditions differs from what they actually choose to purchase under *real* circumstances.

Do you understand hypothetical bias?

Select one answer only

- ○ Yes
- ○ No {Even if they answer no, move on to next question}

Suppose you experience chest pain tomorrow. You go to your doctor and he/she tells you about your treatment options. You choose to have the new procedure because it could reduce your risk of having a heart attack. If you have to pay for it out of your own pocket, how much would you be willing to spend? What is it worth to you?

Before you answer, please consider the following:

Approximately how many dollars per month do you already spend on medical care (not including insurance premiums)?

Select one answer only

- ○ Less than $20.00 per month
- ○ $20.00 to $49.99 per month
- ○ $50.00 to $99.99 per month
- ○ $100.00 to $199.99 per month
- ○ $200.00 to $500.00 per month
- ○ More than $500.00 per month
- ○ Don't know

[Next Question]

Which category best describes how much you currently have in savings?

Select one answer only

- ○ Less than $2,500
- ○ $2,500 – $10,000
- ○ $10,000 - $24,999
- ○ $25,000 - $50,000
- ○ $50,000 - $100,000
- ○ more than $100,000

[Next Question]

So ask yourself these two questions:

> Based on what I am already spending for medical care, how much do I have *available* to spend on this procedure?
>
> If I were *really* faced with making this decision, would I *actually* pay out of my own pocket to have this procedure? Would I really spend *my* money in this way?

[Continue]

{*Iterative bidding process – computer will generate up to 5 bids based on the respondent's answers. Follows same "Programming Notes on Iterative Bidding" as used in *Survey 1: Screening* with the following exceptions: }**

{<u>The initial bid should vary randomly between $1,000; $2,000; $5,000; $8,000; and $10,000}</u>

{<u>The bidding process should stop once the response is within a $100 interval or a maximum of 5 bids have been generated</u>}

{First bid}

Now that you have considered all of these things,

If the procedure costs $______, would you choose to have it done?

Select one answer only

- ○ Yes
- ○ No

[Next Question]

{Bids 2-5}

If the procedure costs $______, would you choose to have it done?

Select one answer only

- ○ Yes
- ○ No

[Next Question]

{When presenting a $0 bid, add the word "FREE" so that it appears as "$0 (FREE)

{Examples}

Example 1:

$1,000 – N (divide bid in half)
$500 – Y (split difference between $500 and $1,000 and round down to nearest $100)
$700 – N (split difference between $500 and $600)
$600 – Y
(STOP after 4 bids – record WTP as $600 and go to page 40)

Example 2:

$2,000 – N (divide bid in half)
$1,000 – Y (split difference between $1,000 and $2,000)
$1,500 – Y (split difference between $1,500 and $2,000 and round down)
$1,700 – N (split difference between $1,500 and $1,700)
$1,600 – Y
(record WTP as 1,600 and go to page 40)

Example 3:

$5,000 – Y (double bid)
$10,000 – Y (double bid)
$20,000 – N (split difference between $10,000 and $20,000)
$15,000 – N (split difference between $10,000 and $15,000)
$12,500 – N
(go to option 2 on page 39 and report range of $10,000 to $12,500)

{Option 1}

{If respondent answers "no" to a zero bid, then ask the following open-ended questions}

Please tell us why you chose not to have the procedure even if it were offered for $0 (FREE)

{Direct respondent to Thank you screen and end of survey}

{Option 2}

{If the bidding process does not sufficiently converge the respondent's WTP value to within a $100 margin of error, then ask the following:}

You indicated that you would pay at least $______ {insert highest "yes" bid}, but less than $_______{insert lowest "no" bid}.

What is the most you would be willing to spend *out of pocket* for this new procedure that could significantly reduce your risk of a future heart attack?

Enter dollar amount here [________]

[Next Question]

{Option 3}

{If a respondent answers "yes" to all 5 bids, then ask the following:}

You indicated that you would pay more than $_____ {insert highest "yes" bid} for this procedure.

What is the most you would be willing to spend *out of pocket* for this new procedure that could significantly reduce your risk of a future heart attack?

Enter dollar amount here [_________]

[Next Question]

{Option 4}

{If a respondent answers "no" to all 5 bids, then ask the following:}

You indicated that you would NOT be willing to pay $_____ {insert lowest "no" bid} for this procedure.

How much would you be willing to spend *out of pocket* for this new procedure that could significantly reduce your risk of a future heart attack?

Enter dollar amount here [_________]

[Next Question]

If you yourself have never experienced a heart problem, then this is probably the first time that you have thought about how much you would value this type of procedure.

Therefore, it is reasonable to assume that you may not be entirely sure how much you would *really* be willing to pay out of your own pocket to have it done.

On a scale of 0 to 10, where 0 is "not sure at all" and 10 is "definitely sure" please indicate how sure you are that you would choose to get this potentially life saving procedure if it cost $________ {insert respondent's previously stated WTP}

Not Sure At All |--| Definitely Sure

0 1 2 3 4 5 6 7 8 9 10

Enter your answer here [________]

[Next Question]

Earlier you said that you would pay $ _____ for this procedure. {insert respondent's previously stated WTP}

Now that you have had a chance to consider how sure you are about this decision, please enter the amount you would *definitely* (beyond any doubt) pay for this procedure.
$________

[Next Question]

{V. Demographic Questions}

To complete the survey, please answer a few questions about your background to help us better understand which characteristics are important in making these kinds of health care decisions.

In general would you say your health is:

Select one answer only

- ○ Excellent
- ○ Very Good
- ○ Good
- ○ Fair
- ○ Poor

[Next Question]

Is there anyone NOT living with you who is financially or otherwise dependent on you (for example: child, elderly parent)

Select one answer only

- ○ Yes
- ○ No

[Next Question]

Do you have life insurance?

Select only one answer

- ○ Yes
- ○ No
- ○ I don't know

[Next Question]

Which of the following best describes how financially secure you feel your family would be in the untimely event of your death?

Select one answer only

- ○ very secure
- ○ fairly secure
- ○ not very secure

[Next Question]

Thank you for taking this survey on willingness to pay for a more effective treatment method. As you may have noticed, the proposed treatment method you were asked about is hypothetical; however, clinical research is currently being done such that this type of procedure could become available in the near future. Therefore, the results from this study could provide valuable information to decision makers regarding the value that society would place on a procedure that would reduce the occurrence of heart attacks.

Thanks again for your participation in this important research.

[Continue]

Thinking about this topic, do you have any comments you would like to share?

Any comments welcome!

[Continue]

Appendix B: Key Statistics from Focus Groups

Focus Group #1 Screening / Paper version

This focus group included 6 individuals between the ages of 31-47.

	# Risk Factors	Perceived Risk (initial)	Perceived Risk (w/ new info)	Initial WTP	Certainty (scale 0-10)	Final WTP	Certainty
1	2	40	60	500	8	350	Yes, definitely
2	5	10	10	0	10	0	Yes, probably
3	3	12	15	100	6	25	Yes, definitely
4	2	5	15	200	10	200	Yes, definitely
5	2	5	7	50	3	50	Yes, probably
6	2	2	18	30	9	30	Yes, probably

Mean Initial WTP = $146.67 Median = $75 Max = $500 Min = $0
Mean Final WTP = $109.17 Median = $40 Max = $350 Min = $0

Change in mean WTP (after certainty question) = - $37.50 (25.6% decrease)

The mean for the Initial WTP for the screening was $146.67. However, after participants had an opportunity to assess the certainty of their initial WTP amount and then revise their stated WTP, the mean (Final WTP) for screening fell to $109.17. Therefore, the certainty question led to a $37.50 (25.6%) decrease in the mean WTP for the screening test.

The responses given by the focus group to the open-format WTP question in this survey helped establish the starting bids that were used in the online version of *Survey 1: Screening*. Since the mean was more likely to be influenced by a single response, the median was used as a guide in establishing the starting bids of $10, $40, $50, $60, $100.

The computer algorithm used to generate the bids would either double the previous bid or half it (depending on the answer given by the respondent); therefore, these starting points also allowed the 5 possible bids to cover a range of values from $0-$1600, which more than covers the range of values ($0-$500) given by the focus group participants.

Focus Group #2 Treatment / Paper Version

This focus group included 4 individuals between the ages of 36-49.

	Perceived Risk (initial)	Perceived Risk (w/ new info)	Initial WTP	Certainty (scale 0-10)	Final WTP	Certainty
1	40	60	2,000	10	2,000	Yes, definitely
2	10	10	10,000	10	25,000	Yes, definitely
3	12	15	1,000	10	1,000	Yes, definitely
4	5	15	25,000	5	25,000+	Yes, definitely

Mean WTP1 = $9,500 Median = $6,000 Min = $1,000 Max = $25,000
Mean WTP2 = $13,250 Median = $13,500 Min = $1,000 Max = $25,000

Change in mean WTP (after certainty question) = $3,750 (28.3% increase)

The mean for the Initial WTP for the procedure was $9,500. However, after participants had an opportunity to assess the certainty of their initial WTP amount and then revise their stated WTP, the mean (Final WTP) for the procedure increased to $13,250. Although the certainty question was originally designed to help prevent the possibility of hypothetical bias (and therefore was expected to lead to a reduction in the mean WTP); the certainty question in this case had the opposite effect. Although this may at first glance seem problematic; when the participant's reasoning (which was given during the focus group) is considered, it actually lends credibility not only to the validity of their final stated WTP, but also to the inclusion of the certainty question.

The participant who increased their maximum WTP from $10,000 to $25,000 indicated that answering the certainty question gave her an opportunity to reflect and compare this purchase decision to other large purchases she has made, such as buying a car. She said "while I was thinking about how certain I was of the value I put down, I began to consider how much would I pay for a car, or a mortgage payment? My life is worth more than those things, so I realized I would sell my car or take out a second mortgage to pay for this." The other participant who stated they would pay $25,000 said "I've had a life threatening disease and when it comes down to it, your life is worth everything. When it comes down to your life, raising your children, and seeing your children grow up, wouldn't you take out a mortgage? You'd do almost anything to live." Therefore, these comments suggest that the inclusion of the certainty question gave the individuals an opportunity to compare this decision to other large purchase decisions they have made in the past, such as the purchase of a car. By asking them about their certainty level, it also gave them an opportunity to consider additional sources of income that could be used to finance the cost of the procedure, such as refinancing their home or asking family members for help.

In addition, the focus group discussion indicated that participants thought about quality of life. Many participants said the warm-up questions made them think about how a heart attack would affect their life. Their comments also clearly indicated that they were considering their budget constraint. One participants made the comparison of "What is my life worth? Versus what can I afford?" and all the participants seemed to know exactly where they were going to get the money they said they would spend for the procedure. As one participant said "your part on hypothetical bias really made me think about that more seriously. Because you put that information in there it made you say 'o.k. I'm not just going to throw down a number.'"

Appendix C: Informed Consent

{Informed Consent Screen for *Survey 1: Screening***}**

You are invited to participate in an important study concerning a potential new screening test to better identify who is at risk for a heart attack. Researchers at the University of Kentucky are conducting it. It will take about 10-15 minutes to complete.

If you agree to participate in the University of Kentucky study, we think that you will find the study interesting.

> Part one contains questions about your perceived risk of having a heart attack and what you might be willing to pay for a screening test that would provide more information about your risk
>
> Part two contains background questions about you and your feelings.

You have the right to skip any questions you don't want to answer. You also have the right to withdraw from the study at any time without penalty. The potential risk to respondents from completing the survey is minimal. The benefit from completing this survey is that you will be contributing to research on how people value a potential new screening test that could help identify individuals at risk for a heart attack.

Participation is completely voluntary. As always, your identity will be unknown to anyone looking at the data from the study. All of the conditions and terms described in the "Knowledge Networks, Inc. Privacy & Terms of Use Policy" document that you received when you got your WebTV equipment apply to the University of Kentucky study. If you have questions about the study you may contact the investigator, Patricia Ryan at 508-740-9941. She is being guided in this research by Dr. Glenn Blomquist. If you have questions about your rights as a participant in the University of Kentucky study, or are dissatisfied with any aspect of it, you may contact the Office of Research Integrity at the University of Kentucky at 859-257-9428 or toll free at 1-866-400-9428.

Would you like to participate in the University of Kentucky's survey? (If you say "No" you will be directed to a different survey.)

Select one answer only

○ Yes

○ No

{Informed Consent Screen for *Survey 2: Treatment***}**

You are invited to participate in an important study concerning a potential new medical treatment for patients with heart disease. You have been chosen for this study because you indicated in a previous survey that you have a doctor-diagnosed heart problem. Researchers at the University of Kentucky are conducting it. It will take about 10-15 minutes to complete.

If you agree to participate in the University of Kentucky study, we think that you will find the study interesting.

> Part one contains questions about how you feel having a heart attack would affect your quality of life and then asks what you would be willing to pay for a potential new medical procedure that could reduce your risk of having a heart attack.
>
> Part two contains background questions about you and your feelings.

You have the right to skip any questions you don't want to answer. You also have the right to withdraw from the study at any time without penalty. The potential risk to respondents from completing the survey is minimal. The benefit from completing this survey is that you will be contributing to research on the value people place on a potential new medical procedure that could reduce the occurrence of heart attacks.

Participation is completely voluntary. As always, your identity will be unknown to anyone looking at the data from the study. All of the conditions and terms described in the "Knowledge Networks, Inc. Privacy & Terms of Use Policy" document that you received when you got your WebTV equipment apply to the University of Kentucky study. If you have questions about the study you may contact the investigator, Patricia Ryan at 508-740-9941. She is being guided in this research by Dr. Glenn Blomquist. If you have questions about your rights as a participant in the University of Kentucky study, or are dissatisfied with any aspect of it, you may contact the Office of Research Integrity at the University of Kentucky at 859-257-9428 or toll free at 1-866-400-9428.

Would you like to participate in the University of Kentucky's survey? (If you say "No" you will be directed to a different survey.)

Select one answer only

○ Yes

○ No

Appendix D: Survey Variables and Data Assignment

Survey 1: Screening Data

General health assigned for item non-response (data obtained from KN health data): serial #88 = 1 (poor) serial #227=2 (fair); designated by genHEALTHassign==1

Stress missing for serial #116, 541, 545, 384, 552, 464, 243, 548, 496, 424, 368. All assigned mean =2.700389; Identified by Stressassign=1 (0 otherwise)

Serial #431 originally had 10 for number of risk factors. Since 2 risk factors are mutually exclusive, this would have meant that this individual said "yes" to every possible item that applied to them. A check of the data file revealed that this respondent selected yes for everything except r6 (low HDL). The respondent is a 25 year old female; therefore r1 (male over 55) and r2 (female over55) were changed to =0. Other information about the respondent's medical history was checked and changes were made accordingly. Family history of heart problem was confirmed, smoking environment could not be confirmed or denied, so it was left as r4=1, health data indicated that individual did not have diabetes or high cholesterol, so r5, r6, and r7 changed to =0. Health data on frequency of exercise indicates that individual exercises on a regular basis, so r8 (less than 20 minutes physical activity per day) changed to =0; individual has not had a heart attack (q4) and does not have coronary heart disease (q2), so r10 changed =0. Amount over BMI = 7.1, so r9 left as=1. In the end, r1, r2, r5, r6, r7, r8, r10, r11=0 and r3, r4, r9 =1 for this observation.

Changes to serial #431 prompted an internal check that revealed others had marked both r1 (male over 45) and r2 (female over 55). All were women, many of whom were elderly, so it is likely that they just saw "over 45" and checked the first box even though they are not "*males* over 45" After confirming their gender with panel data from KN, r1 was changed to =0 for serial #230 (66 year old female), 342 (50 year old female)*, 237 (63 year old female), 530 (65 year old female), and 458 (58 year old female). Number of risk factors was also adjusted accordingly.

Two additional observations selected "are you a man over 45" when they are actually women and answered "no" to "are you a woman over 55." Both are females in their 70's, who again, may not have read very carefully. Since information on their actual gender and age was available from KN, these risk factors were adjusted to match, such that for serial #249 (71 year old female) and #277 (72 year old female), r1 was changed to =0 and r2 was changed to =1. Number of risk factors was also adjusted accordingly.

Serial #234 did not answer either perceived risk question; however, the respondent did indicate that the new information did not change their risk of having a heart attack. Therefore, initial perceive risk was assigned the sample mean = 15.07491. Since the individual indicated their risk did not change, perceived risk was also set equal to 15.07490, such that no change occurred between these two measures, as the respondent indicated.

Survey 2: Treatment Data

General health assigned for item non-response (data obtained from KN health data): serial #1245 = 2 (fair); designated by genHEALTHassign==1 (=0 otherwise)

Exercise missing for serial #1038 and 1360. Both assigned mean =1.924915; designated by ExerciseassignMEAN=1 (0 otherwise)

BMI and amount over BMI (AMToverBMI) missing for serial #1244, 1430, 1410, 1036, 1206. All assigned mean BMI = 29.21379 and mean AMToverBMI=4.917241; Identified by BMIassignMEAN=1 and AMToverBMIassignMEAN=1 (0 otherwise)

Frequency of MD visits (freqMDvisits) missing for serial #1023 and 1022. Both assigned mean = 3.204778; Identified by freqMDvisitsassignMEAN=1 (0 otherwise)

Perceived risk (perRISK) missing for serial #1233 and 1317. Both assigned mean = 30.21502; Identified by perRISKassignMEAN=1 (0 otherwise)

Quality of life after MI (QUALpostMI) missing for serial #1219, 1214, 1129, and 1334. All assigned mean = 2.116838. Designated by QUALpostMIassignMEAN=1 (0 otherwise)

SECURE missing for serial #1364, 1308, 1466, 1299, 1245, and 1439. All assigned mean= 2.062284; Identified by SECUREassignMEAN=1 (0 otherwise)

WTP for serial # 1220 changed from $65,000 to $6,500. While looking at some observations that were potential outliers (top 95%), it was discovered that this individual answered “yes” to a bid of $6,000 and “no” to both a bid of both $7,000 and $8,000. Therefore, based on the responses to the bidding, it is highly likely that when this individual was asked to enter the amount they were WTP, they accidentally hit an extra zero and entered $65,000 instead of the intended amount of $6,500. Given that this individual has a household income of $25,000 with savings of $6,250 and is over the age of 75 (and may have poor eyesight or not be as familiar using the computer), it seems much more reasonable that this respondent was attempting to enter 6500 and not 65000 as their WTP. Therefore, the WTP for this observation was changed to correct for this likely data entry error.

Assigned mean (78.12351) for medical spending to 28 observations (27 “I don’t know” and 1 skipped/refused)

RESPOND	Indicates if panel member replied to the survey invitation
RESUME	Indicates if this was a resumed interview (100 minutes or more) 0=no, 1=yes
CONSENT2	Indicates if panel member agreed to the consent screen 0=no, 1=yes
DT_START	Date interview started
TM_START	Time interview started
DT_END	Date interview ended
TM_END	Time interview ended
DURATION	Duration of interview in minutes
WEIGHT	Final post-stratification weight

GENERAL QUESTIONS FOR BOTH SURVEYS

Q1	How important do you feel it is for your doctor to include you in making decisions regarding your health?
Q2	Have you ever been told by a doctor that you have heart disease?
Q3	Have you ever taken medicine to reduce your cholesterol?
Q4	Have you ever experienced a heart attack?
Q5	Do you have a relative in your immediate family who has experienced a heart attack?
Q5B	Were you involved in making decisions regarding the treatment of this family member's heart condition?
Q6	Have you ever undergone a heart catheterization procedure?
Q7	Are you a cardiologist or other health care professional who has received specific training in the treatment of heart disease?
Q8	Have you ever had a life-threatening condition or illness?

SURVEY 1

VER	Indicates which version (regular or alternate text) that was randomly selected for respondent to receive
REGVER	Indicates which version of the regular text (30% or 85% effectiveness rate for treatment) that was randomly selected

RISK FACTORS

Q9_1	Are you a man over 45 years old?
Q9_2	Are you a woman over 55 years old, OR Are you a woman less than 55, who has passed menopause OR Are you a woman less than 55, who has had her ovaries removed, but is not taking estrogen?
Q9_3	Did your father or brother have a heart attack before age 55 OR Did your mother or sister have a heart attack before age 65?
Q9_4	Do you smoke, or live or work with people who smoke every day?
Q9_5	Is your total cholesterol level 240mg/dL or higher, OR Have you ever been told by your doctor that you have high cholesterol?
Q9_6	Is your HDL ("good") cholesterol level less than 35mg/dL?
Q9_7	Is your blood pressure 140/90 mm Hg or higher, OR have your been told that your blood pressure is too high?
Q9_8	Do you get less than a total of 30 minutes of physical activity on most days?
Q9_9	Are you 20 pounds or more overweight for your height and build?
Q9_10	Do you have diabetes OR a fasting blood sugar of 126mg/dL or higher, OR do you need medicine to control your blood sugar?
Q9_11	Do you have coronary heart disease, or have you had a heart attack?

Q10	Using the above scale as a guide, enter the number that best describes your risk of having a heart attack in the next year.
Q11	After reading this new information, I feel my own risk of having a heart attack within the next year is now…
Q12	Now that you have learned this new information, where would you place your risk of having a heart attack within the next year on this scale?
Q13	Do you understand hypothetical bias?
Q14	Do you understand hypothetical bias? (after additional information with example)
Q15	Approximately how many dollars per month do you already spend on medical care (not including insurance premiums)?

ITERATIVE BIDDING

	If this blood test cost $_____, would you choose to have it done?
BID1	Randomly generated first bid (10, 40, 50, 60, 100)
BID1RESP	Response to Bid 1
BID2	Bid 2 based on response to first bid (doubles or halves)
BID2RESP	Response to Bid 2
BID3	Bid 3 based on previous responses to bids 1 and 2
BID3RESP	Response to Bid 3
BID4	Bid 4 based on previous responses to bids 1-3
BID4RESP	Response to Bid 4
BID5	Bid 5 based on previous responses to bids 1-4
BID5RESP	Response to Bid 5

LOWNO	lowest no bid
HIGHYES	highest yes bid

Q17	You indicated that you would pay more than $_____ {insert highest yes bid} for this test. What is the most you would be willing to spend out of pocket for this test to find out if you are at increased risk for a heart attack? What is the most you would be willing to spend out of pocket for this test to find out if you are at increased risk for a heart attack?
Q18	You indicated you would pay at least $_____, but less than $_____. What is the most you would be willing to spend out of pocket for this test to find out if you are at increased risk for a heart attack?

HIGHEST	highest bid - includes all bids and questions 17 and 18

Q19	On a scale of 0 to 10, where 0 is "not sure at all" and 10 is "definitely sure" please indicate how sure you are that you would choose to get this potentially life saving test if it cost $______ {insert highest bid}
Q20	Now that you have had a chance to consider how sure you are about this decision, please enter the amount you would definitely (beyond any doubt) pay for this test.
Q21	How many times would you expect to have this test over the course of your lifetime?
Q22	In general would you say your health is
Q23	Is there anyone NOT living with you who is financially or otherwise dependent on you?
Q24	Do you have life insurance?
Q25	Which of the following best describes how financially secure you feel your family would be in the untimely event of your death?

SURVEY 2

QUALITY OF LIFE

	Imagine that you experience a heart attack and survive. Take a moment to think about how this could affect your quality of life…
Q9a_1	Ability to perform daily functions
Q9a_2	Ability to effectively complete work duties
Q9a_3	Ability to provide for family
Q9a_4	Overall quality of life

	Please use the table below to indicate how having a heart attack has affected your quality of life
Q9b_1	Ability to perform daily functions
Q9b_2	Ability to effectively complete work duties
Q9b_3	Ability to provide for family
Q9b_4	Overall quality of life

Q10	Using the above scale as a guide, enter the number that you believe best describes your risk of having a heart attack in the next year

Q11	After reading this new information, I feel my own risk of having a heart attack within the next year is now
Q12	Now that you have learned this new information, where would you place your risk of having a heart attack within the next year on this scale?
Q13	Based on the risk and effectiveness of each treatment option, which would you choose?
Q14	Based on the risk and effectiveness of each treatment option, which would you choose? (after additional information)
Q15	Do you feel you understand hypothetical bias?
Q16	Do you understand hypothetical bias? (after additional information)
Q17	Approximately how many dollars per month do you already spend on medical care (not including insurance premiums)
Q18	What category best describes how much you currently have in savings?

ITERATIVE BIDDING

	If the procedure cost $_____, would you choose to have it done?
BID1	Randomly generated first bid (1000, 2000, 5000, 8000, 10000)
BID1RESP	Response to Bid 1
BID2	Bid 2 based on response to first bid (doubles or halves)
BID2RESP	Response to Bid 2
BID3	Bid 3 based on previous responses to bids 1 and 2
BID3RESP	Response to Bid 3
BID4	Bid 4 based on previous responses to bids 1-3
BID4RESP	Response to Bid 4
BID5	Bid 5 based on previous responses to bids 1-4
BID5RESP	Response to Bid 5

LOWNO	lowest no bid
HIGHYES	high yes bid

Q21	You indicate that you would pay at least $_____, but less than $_____. What is the most you would be willing to spend out of pocket for this new procedure that could significantly reduce your risk of a future heart attack?
Q22	You indicated that you would be willing to pay more than $____ for this procedure {highest bid}. What is the most you would be willing to spend out of pocket for this new procedure that could significantly reduce your risk of a future heart attack
Q23	You indicated you would NOT be willing to pay $ ____ {lowest bid} for this procedure. How much would you be willing to spend out of pocket for this new procedure that could significantly reduce your risk of a future heart attack?

HIGHEST	Highest bid - includes questions 21-23

Q24	On a scale of 0 to 10, where 0 is "not sure at all" and 10 is "definitely sure" please indicate how sure you are that you would
	choose to get this potentially life saving procedure if it cost $
Q25	Now that you have had a chance to consider how sure you are about this decision, please enter that amount that you would
	definitely (beyond any doubt) pay for this procedure
Q27	In general would you say your health is
Q28	Is there anyone NOT living with you who is financially or otherwise dependent on you
Q29	Do you have insurance
Q30	Which of the following best describes how financially secure you feel your family would be in the untimely event of your death?

PPAGE	Age
PPAGECT4	Age - 4 categories
PPAGECAT	Age - 7 categories
PPDUALIN	Dual income hh
PPEDUC	Education (highest degree received)
PPEDUCAT	Education (categorical)
PPETH	Race / ethnicity
PPGENDER	Gender
PPHHHEAD	Household head
PPHHSIZE	Household size
PPHOUSE	Housing type
PPINCIMP	Household income
PPMARIT	Marital status
PPMSACAT	MSA status
PPREG4	Region 4 - based on state of residence
PPREG9	Region 9 - based on state of residence
PPRENT	Ownership status of living quarters
PPSTATEN	State
PPT01	Presence of household members - children under 2
PPT1317	Presence of household members - children 13-17
PPT18OV	Presence of household members - adults 18+
PPT25	Presence of household members - children 2-5
PPT612	Presence of household members - children 6-12
PPWORK	Current employment status
PPHE0003	In general, would you say your health is …
PPHE0004	Height 1 (feet)
PPHE0005	Height 2 (inches)
PPHE0006	How much do you weight without shoes?
PPHE0007	During an average week, how often do you exercise?
PPHE0014	How much stress, strain, or pressure have you been under during the past few months?
PPHE0015	Compared to the last few years, would you say that your stress level is better?
PPHE0088	How often do you go to a doctor's office or medical clinical for treatment of any ...
PPHE0149	What kind of medicine are you taking? - heart problem or disease
PPHE0151	What kind of medicine are you taking? - high cholesterol
PPHE0153	What kind of medicine are you taking? - hypertension
PPHECHOL	Derived: has r ever had high cholesterol? (doctor-diagnosed only)
PPHEDIAB	Derived: has r ever had diabetes? (doctor-diagnosed only)
PPHEHPRB	Derived: has r ever had heart problems or disease? (doctor-diagnosed only)
PPHEHYPE	Derived: has r ever had hypertension? (doctor-diagnosed only?
PPHE_BMI	Body mass index (bmi; weight x 704.5 in numerator)

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