Final Report

VALUATION OF REDUCTIONS IN HUMAN HEALTH SYMPTOMS AND RISKS

Volume 1

EXECUTIVE SUMMARY

George Tolley
Lyndon Babcock

and

Mark Berger
Anthony Bilotti
Glenn Blomquist
Michael Brien
Robert Fabian
Gideon Fishelson
Charles Kahn
Austin Kelly
Don Kenkel
Ronald Krumm
Tracy Miller
Robert Ohsfeldt
Sherwin Rosen
William Webb
Wallace Wilson
Martin Zelder

The University of Chicago

Cooperative agreement between the University of Chicago and the U.S. Environmental Protection Agency with participation by University of Illinois at Chicago, University of Kentucky and University of Wyoming.

USEPA Grant #CR-811053-01-0
PROJECT OFFICER: Dr. Alan Carlin
Office of Policy Analysis
Office of Policy, Planning and Evaluation
U.S. Environmental Protection Agency
Washington, D.C. 20460

January 1986

DISCLAIMER

Although funded by the United States Environmental Protection Agency under Cooperative Agreement No. CR811053-01, the views expressed in this report do not necessarily represent those of the Environmental Protection Agency. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

VALUATION OF REDUCTIONS IN HUMAN HEALTH SYMPTOMS AND RISKS

Abstract of Executive Summary

1. INTRODUCTION

The project undertakes an assessment and reconciliation of attempts to value reductions in human health risks, and it develops new methods and estimates for these values. The report on the project consists of four volumes. Volume 1 (this volume) contains the Executive Summary of project findings. The Executive Summary is abstracted here.

2. COMPARATIVE ANALYSIS OF APPROACHES TO VALUING HEALTH RISKS

Volume 2 contains a comparative assessment of work on valuing health risks. Based on the assessment, a set of interim morbidity and mortality values applicable to effects of criteria air pollutants is developed.

Following the introduction to Volume 2, section 2.2 presents a model for valuing health risk reductions which can be used to compare alternative approaches to valuing health risks. Plausible assumptions imply that cost of illness and preventive expenditures measures are lower bounds to willingness to pay for health risk reductions. Contingent valuation, hedonic measures and other valuation approaches are compared conceptually.

Section 2.3 gives a critique of econometric evidence on the effects of environmental quality on human health. One of several concerns with comparability and reliability is how estimates are affected by avoidance measures taken by individuals in response to adverse environmental conditions. The assessment considers in detail five major empirical studies of the effects of air pollutants on mortality.

Section 2.4 is concerned with the cost of illness approach to measuring health benefits. A contribution of the present project is to put estimates of the aggregate cost of illness (medical expenditures and foregone earnings) due to morbidity on an individual per case and per day spent ill basis. Section 2.4 includes an evaluation of previous cost of illness studies.

Section 2.5 is concerned with contingent valuation studies in which interview estimates are obtained of willingness to pay for health. The three major existing contingent valuation studies of morbidity are evaluated.

In section 2.6, a comparison is conducted of cost of illness

and contingent valuation benefit measures obtained for a group of individuals for a common set of symptoms. The results indicate that willingness to pay as revealed through contingent valuation greatly exceeds cost of illness. The two measures do not move together in any systematic fashion.

Section 2.7 considers the household production approach, in which the individual produces health by combining his own time and effort with purchased goods. Two studies are reviewed that use this framework to produce illustrative empirical estimates of willingness to pay for health improvements.

Section 2.8 reviews the housing market hedonic literature throwing light on housing price premiums for air quality. Estimates from this literature are used to obtain suggestive upper bound estimates of the value of mortality risks.

Section 2.9 brings together the foregoing results to arrive at a set of health risk values for use in environmental assessments. Interim values applicable to air pollution are developed. High, low and medium estimates are developed for morbidity conditions and mortality. Medium estimates of the value of reducing various types of acute or short term morbidity range from $25 to $125 per day. Medium estimates of the value of reduced aggravation of previously existing chronic morbidity conditions range from $60 to $150 per day. Medium estimates of the value of reduced new incidence of chronic morbidity conditions range from $800 per year for uncomplicated angina to $60,000 per year for non-fatal cancer. The medium estimates for mortality range from $2 million for an unforseen instant death to $4 million for a death due to lung cancer.

3. CONTINGENT VALUATION STUDY OF LIGHT SYMPTOMS AND ANGINA

Volume 3 reports on a contingent valuation study conducted as part of this project to estimate the benefits of light symptom reductions and angina relief. The approach is based on focus group experimentation followed by systematic household sampling.

Section 3.2 addresses the problem of quantifying reductions in symptoms. To cover the range of conditions encountered in environmental assessments, respondents needed to be asked about a variety of situations, but the variety had to be manageable. Four survey instruments were used. Two of the instruments were for relief from seven light symptoms, with one instrument pertaining to one day of relief and the other to thirty days of re1ief. Two of the instruments were for relief of angina, with one of these pertaining to ten days of relief and the other to twenty days.

Sections 3.3 and 3.4 explain the structure of the contingent valuation instrument. Section 3.5 explains the household sampling procedure, which was carried out in Chicago and Denver.

In Section 3.6 the empirical results are presented. A relationship was found between the number of days a symptom is experienced and the bid per day, indicating the existence of increasing marginal disutility of symptoms. Independent variables in regressions explaining bids included age, education and income, and these generally had postive coefficients.

Section 3.7 reports the results of an experimental mail survey where a response rate of 48 percent was achieved. Results were corroborative of the household surveys.

4. CONCEPTS AND APPROACHES TO THE VALUATION OF SERIOUS ILLNESES

Volume 4 extends the analysis of health valuation to serious or life threatening illness.

Section 4.2 considers alternative definitions of health and, for the study of serious illnesses resulting from environmental causes, concludes that a definition in terms of absence of symptoms should be used. The potential contributions of various pollutants to the risks of serious illnesses are reviewed, in order to choose which diseases should be studied and what ranges of risks are relevant. Specific measures of health status are evaluated including symptom description, self-assessment, health risk appraisal, health indexes and multi-attribute utility functions. The first three of these are recommended for contingent valuation studies.

Section 4.3 develops a life cycle explanatory framework for valuing reductions in life-threatening illness that guides the remainder of the study. Within this framework, longevity (i.e. mortality) and quality of life (as affected by morbidity) are considered together in a unified context. Young people, presented with improved prospects for greater health and longevity only after a long period of time, will heavily discount the benefits and will pay little, even though aware that their preferences many years hence will be different. Policies that promise a near-term benefit will be valued much more highly by people of any age. If people can easily substitute near term consumption for deferred consumption, they will place less value on additions to life expectancy. The capacity for consumption changes over the life cycle. An added year of life accompanied by high income or accumulated wealth, together with a high quality of leisure time, will be valued relatively highly. Latency is modelled within the life cycle framework.

Section 4.4 develops a model of choice under uncertain preferences, bringing utility theory to bear on the problem of valuing small changes in events that are thought of only infrequently and may involve low probabilities of occurrence. The model is applicable to contingent valuation approaches to serious illness. The model assumes environmental health risks are unfamiliar to most people, and that because people seldom have occasion to think carefully about them they are uncertain about

their preferences concerning them. The model leads to twelve theorems for stimulating people to obtain improved knowledge about their preferences and to state valid, consistent risk reduction values.

Section 4.5 applies the preceding sections to contingent valuation of life threatening illness. A structure for an intensive interviewing process is developed, based on techniques of in-depth interviewing.

The proposed interview structure contains four modules. The first module concerns the repsondent's health experiences. The defensive measures module is the second module. The third module pertains to risk perception and risk behavior. This module teaches respondents basic notions of probability and conveys information about probabilities involved in health. Information is obtained about repsondent perceptions and attitudes towards risks.

Contingent valuation questions form the fourth module. The module begins with simple questions involving certainty scenarios and mortality only, after which serious illnesses are introduced. Then life path scenarios are introduced that combine morbidity and mortality in a life cycle setting. Respondents are asked to choose among and value the scenarios, first in a certainty and then an uncertainty setting.

(End of Abstract of Executive Summary)

PREFACE TO STUDY

One of the chief reasons for concern with the environment is to protect and improve human health. Yet health effects remain among the most difficult of all effects of environmental measures with which to deal. Evaluating health effects calls for answers on two questions: 1) What is the contribution of environmental improvements to better health? and 2) How much is improved health valued? The latter question--how much is health valued, or how much is it worth in terms of other goods and services to obtain a better state of health--is the focus of the present study. National environmental legislation requires estimation of benefits of proposed environmental measures. This mandate cannot be fulfilled without consideration of the second question.

Values attached to improved health in turn break down into two components--mortality and morbidity. The estimation of both mortality and morbidity benefits has remained fragmentary. From an early misplaced emphasis on foregone earnings as a measure of the value of reducing mortality, progress has been made on approaches recognizing satisfactions people enjoy over and above those from earnings in the market place. Meanwhile, values attached to reduced morbidity have been based for the most part on medical expenses and foregone earnings. Methods of valuing morbidity have lagged behind mortality.

For both mortality and morbidity, benefits are affected by risk considerations including risk perceptions and behavior toward risk, and by actions taken by people to avoid exposure to pollutants. Empirical work has been hindered by lack of an adequate conceptual framework, data shortcomings and econometric estimation problems.

A broad assessment and reconcilation of approaches to valuing mortality and morbidity is needed. The close but often unrecognized relation between the two phenomena makes it important to carry out the assessment for mortality and morbidity within a common framework.

Building on the assessment, contributions are needed to provide a more adequate framework for valuing health benefits. A common framework for mortality and morbidity will recognize the inter-temporal nature of benefits, leading to a life cycle approach that gives attention to the quantity and quality of life over time. The effects of risk behavior, imperfect knowledge of risks and averting behavior need to be brought in.

New empirical methods need to be tried. The contingent valuation method, which has been applied to aesthetic benefits, is a contender for throwing light on mortality and morbidity benefits which other methods either measure imperfectly or do not measure at all.

The present report gives the results of the first phase of a study concerned with contributing to the estimation of mortality and morbidity benefits. The purposes of this phase have been to carry out a comparative assessment of previous work, to help meet the needs for a more adequate framework revealed by the assessment, and to apply the contingent valuation method to health benefits. A field study of light symptoms has been carried out, and an approach of 1ife threatening i11ne*sse*s has been developed.

Direction of this study was shared by George Tolley of the University of Chicago and Lyndon Babcock of the University of Illinois at Chicago. William Schulze, formerly at the University of Wyoming and now at the University of Colorado, shared in the early formulations and directed a related wage hedonic study not presently included in this report. The affiliations of the authors are as follows:

Name	Department or School	Institution
George Tolley	Economics	University of Chicago
Lyndon Babcock	Public Health	University of Illinois at Chicago
Mark Berger	Economics	University of Kentucky
Anthony Bilotti	Public Health	University of Illinois at Chicago
Glenn Blomquist	Economics	University of Kentucky
Michael Brien	Economics	University of Chicago
Robert Fabian	Economics	University of Chicago
Gideon Fishelson	Economics	Tel Aviv University
Charles Kahn	Economics	University of Chicago
Austin Kelly	Economics	University of Chicago
Don Kenkel	Economics	University of Chicago
Ronald Krumm	Public Policy	University of Chicago
Tracy Miller	Economics	University of Chicago
Robert Ohsfldt	Economics	Ball State University
Sherwin Rosen	Economics	University of Chicago

William Webb	Economics	University of Chicago
Wallace Wilson	Public Health	University of Illinois at Chicago
Martin Zelder	Economics	University of Chicago

CONTENTS OF EXECUTIVE SUMMARY

Introduction		1-1
Volume 2 Summary:	Comparative Analysis of Approaches to Valuing Health Risks	1-1
Volume 3 Summary:	Contingent Valuation Study of Light Symptoms and Angina	1-14
Volume 4 Summary:	Concepts and Approaches to the Valuation of Serious Illness	1-21

List of Tables

Table 1-1:	Framework for Health Values	1-9
Table 1-2:	Interim Values for Morbidity and Mortality Effects of Air Pollution	1-12
Table 1-3:	Seven Light Symptom One Day Regression Results	1-18

EXECUTIVE SUMMARY

INTRODUCTION

Health effects are among the most difficult effects of environmental measures with which to deal. National legislation requires that estimates of the benefits of environmental measures be made. This mandate cannot be carried out without addressing the question of how much improved health is valued.

The estimation of mortality and morbidity benefits has remained fragmentary. Benefits are affected by risk and by actions taken by people to avoid exposure. Empirical work has been hindered by lack of an adequate framework, data shortcomings and econometric estimation problems. A broad assessment and reconciliation of approaches to valuing morbidity and mortality is needed, followed by new efforts to estimate benefits.

This report gives results on the first phase of a larger study. The purposes of this phase are to contribute to a comparative assessment of previous work on mortality and morbidity, to help meet the conceptual needs revealed by the assessment -- taking into account averting behavior, life cycle, risk and health measurement considerations -- and to undertake new measurements by applying the contingent valuation method to health benefits. Contingent valuation work has included a field study of light symptoms and development of approaches for life threatening illnesses.

COMPARATIVE ANALYSIS OF APPROACHES TO VALUING HEALTH RISKS (Volume 2)

A wide variety of approaches to valuing health risk reductions have been proposed. While valuing mortality risks has received a good deal of attention, the problems of valuing morbidity risks and -- of even greater importance -- valuing combinations of morbidity and mortality risks have received less attention. The goal of Volume 2 is to provide a comparative review of approaches to valuing changes in health and a synthesis of the empirical results of the various approaches. A set of interim morbidity and mortality values is developed for use in environmental assessment.

Framework For Valuing Health Risks (Section 2.2)

A comparative model for valuing health risk reductions incorporates cost of illness, partly endogenous health reflecting preventive expenditures, uncertainty, mortality and morbidity. The willingness to pay measure from this model can be used to compare alterntive approaches to valuing health risks.

In the general case, an adequate willingness to pay measure for reductions in health risks consists of two terms: a utility term, which reflects the cost of illness as well as other factors; and a term reflecting preventive expenditures. It does not follow, however, that benefit measures involving the cost of illness alone or preventive expenditures alone are special cases of the general willingness to pay measure. Even the weaker result that the alternative benefit measures are lower bounds to the willingness to pay measure does not necessarily hold. Without additional assumptions, we cannot establish any general comparisons between the measures. We do find a set of plausible assumptions under which some comparisons of the alternative benefit measures can be made. If these assumptions are made, for the special cases of pure mortality and pure morbidity, both the cost of illness and the preventive expenditures measures will be lower bounds to willingness to pay. The theoretical model thus implies that meaningful comparisons may plausibly be made between these measures and an exact measure of willingness to pay for a reduction in health risks as revealed either in implicit markets, or discovered through contingent valuation experiments.

Health Econometrics: An Assessment (Section 2.3)

As part of the present study, a critique was undertaken of econometric evidence on the effects of environmental quality on human health. The focus is on mortality effects. A primary concern is whether or not the studies can shed light on the structure of demand for health, not just net responses to changes in environmental characteristics on health. A fundamental concern is with the role of avoidance measures taken by individuals in response to adverse health conditions. A reason for this concern is that impacts on health of differences in environmental quality can be inferred only as net effects after avoidance has taken place. The question is the extent to which specification and estimation in econometric models of past studies allow valid inferences of the net effects.

If avoidance procedures are perfect substitutes for the outside influences, very little if any net impact results from differences in outside conditions. Even in this case, the benefits of environmental improvements are not zero but equal to the costs of the avoidance procedures. More generally, differences in environmental conditions will be reflected in differences in health status even after avoidance procdures. The resulting calculation of benefits due to improvement in environmental conditions needs to consider not only cost savings from a reduction in avoidance expenditures but also the value of the increased health that results.

The assessment considers five empirical studies of the effects of environmental pollutants on mortality: Lave and Seskin (1977), Crocker et al (1979), Chappie and Lave (1982). Mendelsohn and Orcutt (1979), and Schwing and McDonald (1976).

Comparison between studies of single pollutant effects are made difficult by differences in the pollutants considered in any particular study. Correlation between included and excluded pollutants hampers comparisons. Except for the estimates from Crocker, et.al. effects of sulfur oxides (SO2 and S04 are positive and often substantial. The sign of effects of particulates (TSP) are not consistent across studies. Except for the results in Mendelsohm and Orcutt, effects of nitrogen oxides appear positive.

Besides differences in the pollutants considered, the studies contain a variety of study designs differences. The Lave and Seskin and Mendelsohm and Orcutt studies do not control for smoking or dietary behavior. Correlation between these measures and the pollutant variables may bias the estimated pollutant effects making serious inference from these two studies suspect. The Schwing and McDonald study suffers similarly from lack of inclusion of many of these potentially important variables.

The Chappie and Lave and Crocker, et.al studies are similar in that they include smoking and dietary variables, and they consider the effect of physicians per capita on mortality rates. Yet, the estimates differ substantially. Substantially larger effects of protein consumption on mortality rates are found by Crocker, et.al than by Chappie and Lave. These effects are more precisely estimated by Crocker, et.al. This finding suggests a potentially important influences of correlation between dietary characteristics and the various pollutants considered in each study. The differences may also be due to the difference between the effects of sulfates and the effect of S02-

Both Crocker, et.al and Chappie and Lave address the endogeneity of physicians per capita within a cross-sectional setting. Endogeneity is expected if use of physician services is one form of avoidance or averting behavior. However, avoidance behavior may also be reflected in dietary, smoking, and alchohol consumption which needs to be seriously treated in further empirical work.

Avoidance or averting behavior in place, such as described above, does not exhaust avoidance possibilities. People may also change their residence location. Individuals may locationally sort themselves according to environmental quality, with those least affected living in relatively low quality areas. Estimates of mortality rates differences between areas as a function of pollution could then understate the effect of changes in overall pollution levels (especially those occuring in high pollution areas to begin with). Furthermore, individuals may change location in response to what would otherwise be continued ill-health effects of pollution in one area. Persons adversely affected by pollution may then end up dying (and increasing the mortality rate) in low pollution areas. This effect would also lead to an understatement of the true effect of pollutants on mortality rates such as those based on the existing crosssectional analysis.

Cost of Illness Approach (Section 2.4)

Turning to studies that have been explicitly concerned with placing monetary values on illness, the cost of illness approach is the most widely used approach. A recent survey by Hu and Sandifer (1981) identifies over 200 studies using the approach. The cost of illness is measured as the sum of three components: 1) medical expenditures; 2) the earnings lost due to morbidity; and 3) the earnings lost due to “premature" death due to illness. Since the valuation of small changes in the risk of death and the possible relation of foregone earnings to this measure has received much attention, section 2.4 emphasizes the problem of valuing changes in morbidity, and the role of medical expenditures.

A contribution of the present project has been to put aggregate costs of illness on an individual per case and per day spent ill basis. Results indicate that a typical case of acute respiratory disease involves $87 of medical expenditures, and $56 of foregone earnings. A case of emphysema involves $441 of medical expenditures, and $2,753 of foregone earnings. A day spent ill due to a typical case of acute respiratory illness costs $35, while a day spent ill due to emphysema implies costs of $89. Estimates of this kind on an individual basis needed to evaluate environmental policy changes have not been available heretofore.

The cost of illness approach is an important source of estimates for the value of health, because it is commonly accepted by many researchers in the health care fields, and it provides estimates for the value of a wide range of health effects. Therefore, section 2.4 includes a careful evaluation of the approach to assess its usefulness and accuracy.

The cost of illness approach ignores the costs of pain and suffering due to illness, the value of leisure time, and the role of preventive expenditures. While the quantities the cost of illness approach measures are clearly related to the value of a health improvement, they are not identical to the willingness to to pay for an improvement. Though it seems reasonable to assume that the cost of illness approach understates individual willingness to pay, the extent of the underestimate is uncertain.

The problem is further complicated when the distinction is made between individual and societal willingness to pay. The treatment of consumption, non-labor earnings and taxes by the cost of illness approach might be described as an uneasy compromise between adopting an individual or a societal viewpoint. Characteristics of the market for health care that may cause further divergences between individual and societal willingness to pay include the extent of third party payments, the importance of non-profit organizations in providing hospital services, the role of the physician in influencing demand for his own services, and the possible lack of competition in the supply of physician

services. Paid sick leave, and altruism complete the list of possible reasons the cost of illness approach may not produce a measure of societal willingness to pay for health improvements. While these problems have yet to be rigourously addressed, it is apparent that the distinction between individual and societal willingness to pay is both an important and a complex issue. No simple rule for adjusting the cost of illness approach to better reflect the viewpoint of society is found.

In typical cost of illness studies such as Rice (1966) and Cooper and Rice(1976), the calculation of medical expenditures and foregone earnings due to illness is quite involved, since the expenditures and earnings must be allocated to particular illnesses or disease categories. In allocating medical expenditures to specific illnesses, the problems lie in the numerous inaccuracies in the estimation of the expenditures by service category and in the estimation of the weights needed to allocate expenditures to disease categories. The net result is that the estimates of medical expenditures due to particular diseases are inaccurate, but by how much or even in which direction the estimates are biased is difficult to determine. The estimation of foregone earnings due to different diseases is also subject to error, mainly because of limitations of the data available. In this case, most of the errors tend to understate the foregone earnings due to morbidity.

Review of Contingent Valuation Studies of Health (Section 2.5)

One approach to valuing a non-market good is to conduct a survey and ask people what they would pay for the good, hypothetically assuming (contingent upon) the existence of a market for the good. This approach, the contingent valuation method (CVM), has been applied to a variety of environmental goods including air quality and health.

This section reviewed three major studies that applied the CVM to the problem of valuing health effects related to air pollution: Loehman et al. (1979), Rowe and Chestnut (1984), and Tolley et al. (1985). Each of these studies seems to be carefully designed, though certain problems are noted. As a result, the value estimates are probably as accurate as any estimates based on contingent valuation; similar to Cummings et al. (forthcoming), the reference accuracy may be set at plus or minus 50 percent.

While the health effects valued are not exactly the same, certain comparisons can be made between the results of the three studies. For instance, each of the studies implies a value for one day of respiratory symptoms, though not always of the same symptoms. From the Loehman et al. study, one day of of coughing/sneezing has a mean value of $138 (mild day) or $236 (severe day). The Rowe and Chestnut study implies that relief from one day of asthma symptoms is worth on average about $20.

The Tolley et al. study finds that relief from one day of coughing, throat, and sinus problems has a mean value of $113.

These different values can be reconciled, to some extent. First, the Rowe and Chestnut value is not a value for a marginal day of relief, but an average value for one day, given an average of 19 days of symptoms relieved. Thus, it is not really comparable to the other estimates. The Loehman et al. and Tolley et al. studies are more directly comparable. In general, though, different values result. But comparing median bids across the two studies, or comparing mean bids across the two studies, the values do not seem to be necessarily inconsistent.

Comparing Costs of Illness and Continigent Valuation (Section 2.6)

The cost of illness (COI) approach and contingent valuation (CV) are two important methods that allow a dollar value to be placed on a change in morbidity or sickness. A direct comparison of values based on these methods is undertaken in this section. This comparison is especially interesting because the methods are in some sense complementary. The cost of illness approach, focusing on medical expenditures and foregone earnings, uses widely available data and comparatively straightforward empirical techniques, so it is generally accepted on a practical level. However, there is no strong theoretical basis for using COI values in benefit cost analysis. As noted, COI may be below and not very close to what an individual would actually be willing to pay. In contrast, contingent valuation experiments can be designed to directly estimate what an individual, would be willing to pay, but proper design of CV experiments is So on a practical level COI values are often judged superior to CV values, while on a theoretical or conceptual level, CV values are preferred.

Our empirical work provides direct comparisons of WTP and COI from the same study of seven symptoms: coughing spells, stuffed up sinuses, throat congestion, itching eyes, heavy drowsiness, headache, and nausea. The WTP values that are obtained are equivalent to consumer surpluses. The results suggest that WTP exceeds COI, but there is no strong indication that WTP and COI move together in any systematic fashion. Assuming that exogenous changes affecting health risks reduce preventive expenditures, our results also imply that the WTP for reduction in health risks which arises from our uncertainty based model exceeds expected COI. We then provide an illustrative lower bound estimate of willingness to pay for a reduction in health risks from our contingent valuation survey. The results of the contingent valuation survey only directly apply to the case of changes that occur with certainty, however.

The results of the new empirical work tend to confirm Rowe and Chestnut's (1984) preliminary results that WTP exceeds COI. It should be noted that this relationship is also found in the

experimental mail survey completed (see section 3.7); but the results are for a very small sample. So there is a growing body of evidence that suggests contingent valuation responses on WTP exceed COI, as predicted by several theoretical models.

Household Production of Health and Averting Behavior (Section 2.7)

In studies following the household production approach, as in Grossman (1972), the individual is visualized to produce the commodity health by combining his own time and effort with purchased goods such as medical care, diet, and so on. Health is partially under the control of the individual or partly endogeneous, though it is also affected by exogeneous factors such as environmental quality. Some recent theoretical and empirical work has used this framework to derive expressions for what an individual would be willing to pay for an exogeneous improvement in environmental quality. The theoretical studies, such as the model developed in section 2.2 and the studies referenced therein, investigate how the conceptually correct willingness to pay measure will be related to observable quantities such as the costs of illness and preventive expenditures.

Two empirical studies have taken the analysis further and attempt to estimate willingness to pay directly. Gerking and Stanley (1984) estimate willingness to pay for health risks related to ozone exposure, and Cropper (1981) estimates willingness to pay for health risks related to an index of air pollutants. The implied values for health are about $40 for a day of restricted activity from the Gerking and Stanley study, and $176 for a work loss day in the Cropper study. Since a work loss day is a more severe effect than a day of restricted activity (as defined in these studies), it is not unexpected that the Cropper estimate is larger than.the Gerking and Stanley estimate. The magnitude of the difference does seem large. However, due to the limitations of these studies noted by the authors, these value estimates are probably best described, as illustrative of the order of magnitude of the value of health. In this context, the two studies do not produce inconsistent results.

Housing Values and the Value of Health (Section 2.8)

One way that individuals reveal their willingness to pay for environmental quality is through their location choices and the corresponding housing price premiums for various locational attributes, including air quality. The benefit estimates thus obtained represent the total benefits of an improvement in air quality, not just the health benefits. So these estimates could be upper bound estimates of the benefits of improved health. On the other hand individuals may not have full knowledge of environmental effects in purchasing property, leading to underes-

timation. Finally, in applying hedonic analysis to the demand for air quality, a number of econometric problems are encountered that could cause bias or inaccuracy.

Bender et al. suggest that a permanent 10 percent reduction in suspended particulates would result in a $700 to $1800 benefit (present value) per household. Similarly, Harrison and Rubinfeld estimate that a 2 ppm reduction in nitrogen oxides would create a benefit of $800 per middle-income household. Estimates of this kind from from the housing market hedonic literature can be combined with estimates from the health econometrics literature of the effects of air pollution on mortality, to arrive at an idea of how much people are willing to pay through property values for a reduction in mortality risk. Using typical values from the housing market hedonic literature and the health econometrics literature gives a value for marginal risk reduction, or a value of life in the statistical sense, of $740,000. This figure must be viewed with caution in view of the problems noted above.

However, the value of $740,000 is not inconsistent with the values of risk reduction resulting from hedonic analysis of labor markets, or consumption activity. It lies somewhere in the middle of the very wide range of empirical results existing in this literature. The value also can be reconciled to estimates of the value of health risks from the cost of illness approach, especially when considering the argument that neglecting averting behavior causes the cost of illness approach estimates to be lower bounds to the willingness to pay for health risk reduction.

Conclusions: Interim Values for the Health Effects of Air Pollution (Section 2.9)

The purpose of section 2.9 is to bring together the foregoing results to arrive at a set of health risk values useable in environmental assessments. The application in this study is to health effects of air pollution.

In section 2.9.2 a framework for value estimates is discussed. The framework addresses two major questions: First, for what types of health effects are values needed ? Second, what constitutes complete and conceptually correct value estimates for these health effects? The answers to these questions are summarized in Table 1. The first column indicates that the health effects due to air pollution include various types of acute or short-term morbidity, aggravation of previously existing chronic morbidity, increased incidence of non-fatal chronic morbidity. and mortality whose value may vary according to cause of death. The second column indicates the forms taken by the value components for each of these effects and indicates the need to value morbidity preceding death.

Table 1-1

Framework for Health Values

Health Effects Valued	Value reflects
Acute or Short-term Morbidity	
--light symptoms	--physical and mental discomfort
--marginal change in time spent ill	--work time lost
	--other time lost
	--medical expenditures
	--costs of averting behavior or preventive measures
Aggravation of Previously Existing Chronic Morbidity	
--chronic lung conditions	--a larger degree of all of the above
--chronic heart conditions	
marginal and non-marginal changes in time spent ill	--individuals' health status is already low
Increased Incidence of Non-fatal Chronic Morbidity	
--chronic lung conditions	--all of the above
--chronic heart conditions	--lifestyle and work changes due to the existence of chronic illness
--cancer	
Mortality	
--unforseen instant death	--mortality risks
--chronic lung conditions	--morbidity preceding mortality valued as above
--chronic heart conditions	
--cancer	--psychic costs of imminent death

In section 2.9.3 the framework is used to arrive at a set of interim values applicable to air pollution. For each of the health effects, value estimates are brought together and expressed on a comparable basis noting the components of value included and excluded for each estimate and the ranges that have been obtained for particular components. Previously published estimates are used, as well as the cost of illness and contingent value estimates developed as part of the present project. The available evidence is compared to the framework, in terms of which health effects are valued, and how complete these values will be. In light of this discussion, reasonable ranges and interim values are developed. These values are presented in Table 2.

In placing a value on a day of acute or short-term morbidity, five separate sources of estimates are used.. The most complete estimates come from the contingent valuation study described in Volume 3 of this report, and from the contingent valuation study of Loehman et al (1979). A lower bound value from cost of illness estimates expressed on a per day basis is also used. Additional information is available from the health production studies of Cropper (1981) and Gerking and Stanley (1984). These sources are combined to yield values for specific symptoms and a likely combination of symptoms, for an average day of restricted activity, a severe day of work loss, and a mild day of discomfort alone. As a rough rule of thumb, a severe day is valued at twice the value of an average day, and an averate day is worth twice a mild day. For instance, the medium estimate for an average day of a likely combination of symptoms is $60, while a severe day is valued at $125 and a mild day at $25.

To move on from acute or short-term health effects, the second major class of health effects to be valued is the aggravation of previously existing chronic morbidity. Values are placed on one additional day of symptoms for people who even without air pollution suffer from emphysema, asthma/bronchitis, or a heart condition. To value an additional day of emphysema or asthma/bronchitis, the evidence on the value of acute or short-term respiratory illness is clearly relevant, but the per day values for chronic lung conditions will generally be higher. Additional evidence from the contingent valuation study of Section 3 of this Report, cost of illness per day estimates, and the Rowe and Chestnut (1984) contingent valuation study is used to develop the interim values. Due to more uncertainty of the estimates, wider ranges of interim values are developed: for example, an additional day of angina may be worth as little as $75 or as much as $400, but the best medium estimate is $150.

In addition to the aggravation of previously existing chronic conditions, it is possible that air pollution will cause new cases of chronic conditions. Interim values are developed for one year of non-fatal cases of emphysema, asthma/bronchitis. lung cancer, and heart conditions. Most of the evidence for the value of these serious health effects comes from the cost of

illness approach, such as the study by Hartunian, et al (1981). In developing the interim values an attempt is made to take into account the fact that cost of illness estimates are incomplete measures, ignoring the value of discomfort (pain and suffering), and the costs of preventive actions. Evidence from the contingent valuation study in Volume 3 of the present report of the value of relief from 30 days of light symptoms, and the value of 10 to 20 days of relief from angina is also important, as is the Rowe and Chestnut estimate of the value of a 50 percent reduction in asthma symptoms. There is a wide range of severity of chronic symptoms, so a case of asthma/bronchitis is valued at only $900, while preventing a year of emphysema is judged to be worth $7000. The final effect to be valued is an increase in mortality risks. Most empirical estimates of the value of mortality risks have been obtained from job-related or traffic accident data. These estimates suggest that a risk of an unforseen instant death is worth somehwhere between $0.5 million and $5 million, with a medium estimate being about $2 million.

However, air pollution at the levels found in the U.S. could not cause instant death, but instead must influence mortality risks by increasing the mortality rates due to chronic illnesses. The value of preventing a death from these causes is clearly higher than the value of preventing an instant death, in view of the difference in physical suffering before the death, and the psychic costs of imminent death. Developing methods to estimate the value of mortality risks depending upon the cause of death is an important achievement of this section.

One approach to valuing mortality risks depending upon the cause of death is to use cost of illness and other estimates to value the morbidity preceding the mortality. Morbidity values are added to the value of an instant death, using the fact that every current death due to a condition is associated with a much larger prevalence of cases that eventually will be fatal. For instance, if the average life expectancy with a condition is 10 years, the value of 10 person-years of morbidity is added to the the value for an unforseen instant death. Calculations along these lines are combined with information from a survey by Jones-Lee et al (1985) that included questions about how people valued different causes of death. These sources allowed the interim values to reflect important differences in the value of mortality risks depending upon cause of death. So the medium value of a death from lung cancer ($4 million) is much higher than the medium value of an instant death ($2 million) that is commonly reported. Estimates of the value of health risks developed in this study combined with previous empirical estimates allowed the development of these interim values of morbidity and mortality effects. These values should be useful for assessing environmental policy scenarios. However, considerable additional work is required to refine these interim values, to narrow the ranges of values and allow more confidence to be placed in them.

Table 1-2

Interim Values for Morbidity and Mortality Effects of Air Pollution

Category	Value Estimate Low	Medium	High
Acute or short-term morbidity			
average day (restricted activity day):			
--sinus	$20	$35	$60
--throat	10	25	40
--respiratory symptoms	15	30	50
--eye irritation	20	40	100
--headache	30	50	110
--likely combination	35	60	100
severe day (work loss day):			
--likely combination	80	125	175
mild day (discomfort):			
--likely combination	10	25	50
Aggravation of previously existing chronic morbidity (per day)			
lung conditions:			
--emphysema	50	100	300
--asthma/bronchitis	35	60	100
heart conditions:			
--angina, possibly with other heart disease	75	150	400
--likely combination of lung and heart	45	80	190

Table 1-2
Interim Values for Morbidity and Mortality Effects of Air Pollution

Category	Value Estimate Low	Medium	High
Increased Incidence of Non-fatal Chronic Morbidity (per case per year)			
lung conditions:			
--emphysema	$3,200	$7,000	$10,000
--asthma/bronchitis	200	900	1,200
--lung cancer	30,000	60,000	100,000
heart conditions:			
--angina uncomplicated	500	800	2,000
--other heart disease	2,500	4,000	10,000
--likely combination of lung and heart	1,700	3,800	5,900
Mortality (per statistical life)			
--unforseen instant death	.5 mill.	2 mill.	5 mill.
--emphysema	.64 m	3.5 m	9 m
--asthma/bronchitis	.53 m	2.5 m	5.5 m
--lung cancer	.58 m	4 m	10 m
--heart disease	.54 m	3 m	7 m
--weighted average of all causes	.58 m	3.8 m	9.4 m

CONTINGENT VALUATION STUDY OF LIGHT SYMPTOMS AND ANGINA (Volume 3)

Introduction (Section 3.1)

The purpose of this part of the study is to devise and apply a theoretically sound approach to estimating the benefits of light symptom reduction and angina relief resulting from improvements in ambient air quality. Contingent valuation is the research method used to accomplish this objective. Contingent valuation offers a technique capable of getting at values that are difficult to measure by other means, such as property value or revealed behavior methods. While some previous contingent valuation studies of health effects have been undertaken, the present study apparently represents the most intensive effort of this kind to date.

The approach of the study has been based on extensive focus group experimentation prior to systematic household sampling. The study has given particular attention to three methodological areas. These are, first, the information and prefernce context of contingent valuation. This area frames the problem for the respondent and helps him research his preferences in order to provide a high quality response.

The second area, the structure of the contingent market, defines the good to be valued in a clear, concise and quantitative manner. - The area also considers the importance of both the payment vehicle and the delivery vehicle of the good. In this study, pure willingness to pay questions without specific payment vehicle (outright payment rather than through, say, utility bill or increased taxes) and without specific delivery vehicle (outright relief rather than relief through, say, a pill) were selected because they were acceptable to respondents and avoided distractions, bias and information overload.

The third methodological area is the bidding game process. Based on focus group experience, an iterative bidding process was chosen as the method of eliciting willingness-to-pay responses. Care was taken to avoid the problems of the respondent choosing a convenient unvarying bid for all programs (anchoring) and the respondent being influenced by the initial bid (starting point bias). These types of problems tend to occur when the respondents' understanding of the good and the market and of their own preferences is so limited that extraneous information predominates in determining bids.

The Dose-Response Problem and the Definition of Symptom Relief (Section 3.2

The values that respondents place on improvements in ambient air quality levels depend on the degree of pollution reduction and the time pattern of reduction, e.g. whether pollution is reduced on many days or only a few days. The value of an extra day of relief may depend on the level of symptoms prevailing before the relief. People might value an extra day of relief from symptoms differently if they have been experiencing several weeks of symptoms than if they have been experiencing only one or two days.

The general problem is to develop a way of valuing reductions in symptoms from pollution depending on the amount of relief from symptoms, where the relief may vary among areas and of people (sensitive vs. nonsensitive) in amounts that are not known beforehand. In short, the problem is to estimate, not a single value, but a function that specifies value depending on both the amount of relief given and the symptom level prevailing in the absence of the policy being evaluated. This function provides a tool that can be used to value the variety of symptom reductions among areas and types of people.

Respondents had to be asked about a sufficient variety of situations, but the variety had to be in the realm of reality. The requirement of reality is to be partiuclary stressed. if values are obtained for far greater or far less relief than will actually be brought about by environmental controls, then their applicability will be suspect. For example, the willingness to pay to be completely rid of a large number of days of a symptom may throw little light on how much would be paid to be rid of one day. If values are not obtained for realistic degrees of relief, it will be necessary to tenuously extend estimates into unkown regions.

The problem of choosing realistic values is made difficult by the imperfect state of knowledge about pollutant reduction. The critique of evidence undertaken as part of this study makes clear that a great range of uncertainty still attaches to the health effects of the criteria air pollutants, particularly with respect to light symptom effects. However, two conclusions stand out. First, realistic pollution control po1icies wi11 give fractional day or at most a few days of relief to the majority of people. Second, the evidence is more tenuous regarding sensitive populations. The possibility needs to be allowed for that sensitive or susceptible persons would obtain greater relief.

For the light symptoms, one version of the questionnaire asked about one day of relief to establish values per day attaching to fractional-day relief or at most a few days of relief applicable to large numbers of people under many policies. A second version of the questionnaire asked about relief of thirty days to encompass sensitive groups whose allergic balance could be affected by ambient air quality changes.

A similar strategy was followed in the questionnaires on angina. To find out how the value of varying degrees of relief are related to a prevailing level of symptoms, in one version of the angina survey people were asked to suppose alternatively that they started from levels of one, five and ten days of mild and severe angina. In the second version of the survey respondents were asked to suppose alternatively that they started from levels of one, ten and twenty symptom days of mild and severe angina.

Structure of CV Instrument (Sections 3.3 and 3.4)

The structure of the health survey is reflected partly in the organization of the questionnaires, and partly in the relationship of the questionnaires to each other. Four questionnaires were used, each with essentially the same organization: 1) one day of relief from each of seven light symptoms and some combinations of the symptoms, 2) thirty days of relief from the same symptoms, 3) relief from up to ten days of angina and 4) relief from up to twenty days of angina.

All survey instruments feature questions on health endowment in the beginning followed by contingent valuation questions and ending with questions on socioeconomic characteristics. The questionnaires feature a high degree of interaction between interviewer and respondent. Responses were pooled during analyis into single data sets for the seven symptom and for angina.

Household Sampling (Section 3.5)

An objective of the sample design was to obtain a representative cross section of households on which to base inferences about health values. Two metropolitan areas were sampled--Chicago and Denver.

One hundred ninety nine interviews were conducted, divided about equally between the two cities. Twenty three interviews had to be deleted, due to various inconsistencies in the bidding. Median income for respondent's census tract was used as a default for those respondent's not revealing their income.

Empirical Results for Household Survey (Section 3.6)

The seven light symptoms considered were coughing, sinus problems, throat congestion, itchy eyes, drowsiness, headache and nausea. The mean bids to relieve a one day endowment of each of the seven light symptoms range from $50.28 to relieve one day of nausea to $25.20 to relieve one day of coughing. The range of the bids to relieve thirty days of each symptom was $488.20 to relieve thirty days of headaches to $166.50 to relieve thirty days of coughing. Large bids were obtained for the relief of

various combinations of hypothetical and actual endowments.

The angina ten day survey yielded a range of $261.84 to relieve ten days of severe angina when the respondent is endowed with ten days, to $66.08 to relieve one day of mild angina when only afflicted with one day of the condition. The angina twenty day results ranged from $844.38 to relieve twenty days of severe angina when confronted with twenty days of the condition, to $90.24 for eliminating one day of mild angina a month when the respondent experiences only one day of mild angina. The bids, in general, varied with the level of relief provided and the severity of the endowment.

The respondent's experience with each symptom or class of symtoms was obtained. For example, in the one day seven-symptom survey, experience with the symptom days range from 19.75 days of itchy eyes to 1.3 days with nausea.

Regressions performed to explain the willingness to pay bids used household income, age, sex, education, and race of the respondent, a measure of general health status and experience with the symptoms were used as independent variables.

The regression results are consistent with the hypothesis of increasing marginal disutility of symptoms. The actual experience with a symptom or class of symptoms is often a positive and significant determinant of the willingness to pay bids. Adding further credence to this proposition is the performance of the health status variables. It indicates that the respondents who are in poor hea1th are wi11ing to bid more to re1ieve the additional endowments.

Other independent variables, such as age, education, and income, tend to have coefficients that vary in significance and sign. The regression results are thus consistent with other findings in the survey that indicated the main reason for the willingness to pay bids was personal comfort, i.e. the taste for health. It is not surprising that the socioeconomic variables were not systematically related to the respondents' degree of discomfort, and so also not systematically related to the willingness to pay bids.

Table 1-3 gives a sample of the regression results from the seven symptom health one day data. As can be seen by the large t-statistic, the respondent's experience with the particular symptom is a significant influence on the bid.

Table 1-3
Seven Light Symptom One Day
Regression Results

	Bids to Relieve One Additional Day of:			
Variable	Coughing	Sinus Problems	Throat	Itchy Eyes
Intercept	-103.79 (-2.84)	-56.73 (-1.48)	-46.75 -(1.00)	-95.05 (-2.69)
Income	-0.000026 (-0.10)	0.000036 (0.14)	-0.00051 (-1.57)	-0.000023 (-0.11)
Educationl	2.85 (1.91)	2.72 (1.71)	2.51 (1.33)	4.22 (2.79)
White,	22.41 (1.47)	-3.47 (-0.21)	21.21 (1.13)	19.02 (1.42)
Agel	1.56 (3.23)	0.74 (1.46)	0.46 (0.83)	0.64 (1.65)
Sex	-20.77 (-1.62)	10.57 (0.77)	-10.98 (-0.69)	4.91 (0.42)
Noexhlth	4.58 (0.30)	8.95 (0.59)	31.53 (1.86)	20.36 (1.65)
Days of Depen- dent Variable	1.43 (3.43)	0.71 (3.23)	1.12 (2.14)	0.15 (1.79)
F Value	3.23	2.83	2.00	2.07
R-Square	0.48	0.45	0.37	0.38

Note: t values in parentheses

Table 1-3 (continued)

	Drowsiness	Headaches	Nausea
Intercept	45.40 (0.93)	47.84 (0.74)	-101.20 (-1.62)
Income	-0.00018 (-0.54)	-0.00081 (-1.82)	-0.00019 (-0.45)
Education1	-2.24 (-1.10)	1.21 (0.45)	3.53 (1.38)
White	3.62 (0.18)	39.18 (1.46)	43.93 (1.77)
Agel	0.74 (1.16)	-1.88 (-2.15)	0.77 (1.06)
Sex	-28.63 (-1.61)	29.87 (1.27)	-4.24 (-0.20)
NoExhlth	-2.22 (-0.11)	73.32 (2.83)	47.05 (2.08)
Days of Dependent Variable	3.25 (2.93)	-0.006 (-0.03)	16.91 (8.23)
F Value	2.11	2.84	18.22
R-Square	0.38	0.45	0.84

Note: t values in parentheses

Mail Questionnaire (Section 3.7)

An experimental mail survey was conducted to determine whether it would be feasible to greatly expand the number of cases on which the contingent valuation estimates could be based. As in the personal interview questionnaires, the indirect symptom based approach to willingness to pay was adopted, using six common air pollution caused symptoms, including those caused by general air pollution, ozone, and carbon monoxide. Two questionnaires were developed, identical except that one questionnaire, Type B, added a set of comparative questions which measure earnings lost and medical care expense occasioned by the symptoms. The Dillman mail survey method was employed for this survey.

An equal probability sample of 103 names and addresses representing the Chicago metropolitan area adult resident population was drawn from reverse telephone directories. Discounting 15 addresses which had changed, a response rate of 48 percent of the 88 possible interviews was achieved, forming a data-base of 42 cases.

The willingness to pay question was based on an endowment of 3 symptom days per month for each symptom. The bids were for an effective, safe, side-effect-free medication which would have to be taken only once a month. The mean bids to eliminate the personal discomfort symptoms of headache, coughing, stuffed up sinuses, irritated throat, and itching eyes ranged between $8.42 and $9.68 per month, or $101 and $116 per year. The mean willingness to pay to eliminate heavy drowsiness when driving was $5.41 per month, or $65 per year.

By far the most common reason underlying the amount of the bids was personal comfort. Next most frequently mentioned was to avoid loss of work or other usual activity.

Stuffed up sinuses were the most commonly experienced symptom, followed by headaches, irritated throat, and coughing, which also were common. In terms of days of work or other usual activity lost, headaches produced the largest mean number of days lost, 1.1 per year averaged over all respondents. Earnings lost because of headache was by far the largest--averaging $108 per year across all respondents. Medical care expenses were also by far the largest for headaches--averaging $60 per year over all respondents. Coughing caused the next highest mean level of earnings loss and stuffed up sinuses the next highest mean medical expenses. In terms of comparative analysis, mean willingness to pay greatly exceeded both mean earnings loss and medical expense and the total of these two means for all symptoms except headache, for which mean willingness to pay, mean earnings lost and mean medical expense all were of the same approximate magnitude.

A comparison of the mail questionnaire results with results from the personal interviews reveals that the mail survey mean

bids, which involve the elimination three symptom days, are intermediate in value between the one day and thirty day relief bids from the personal interviews. Also comparable to the personal interviews, the mail survey sample indicates a positive relationship between the mean bid for a symptom and the number of days the symptom was actually observed, corroborating the hypothesis of increasing marginal disutility for experiencing a particular symptom.

CONCEPTS AND APPROACHES TO THE VALUATION OF SERIOUS ILLNESES (Volume 4)

Introduction (Section 4.1)

Volume 4 extends the analysis of health valuation to the domain of life threatening illness. It develops an original framework that can be used to obtain values of increased longevity and reduced risks of death from serious illness.

Health Definition and Measurement (Section 4.2)

Section 4.2 provides an evaluation of approaches to the definition and measurement of health status. This evaluation is a prerequisite to determining how to measure health attributes and design a study aimed at determining health values. This section provided a number of guides to later sections, including guides as to estalishment of health endowment as a determinant of value of health improvement, clear definition of the health good, and the development of warm-up health experience questions needed if a a contingent valuation approach is to be used .

Section 4.2 first considers alternative definitions of health, making a distinction between definitions cast in terms of positive attributes of well-being and definitions cast in terms of the absence of undesirable symptoms or diseases. The multifaceted nature of health is stressed. For the study of serious illnesses resulting from environmental causes, it is concluded that a definition in terms of absence of symptoms should be used. Section 4.2 next considers the role of the causes of ill health in defining and measuring health. The indication that lifestyle is a far more pervasive determinant of health and longevity than the environment is brought out. An implication is that environmental values need to be considered in a context where they are additions to larger risks from other causes. The potential contributions of various pollutants to the risks of serious illnesses are reviewed, in order to choose which diseases should be studied and what ranges of risks are relevant in a study seeking to obtain health values for environmental assessment.

Finally section 4.2 considers the measurement of health status. Self assessed health status is observed to be the most widely used health status measurement technique. While this approach has limitations, it is seen to have an important role to play in health risk reduction benefits research. Its importance stems partly from the role that self-perception plays in the benefits that people perceive they receive from improvements in their health prospects. Because health is a multi-dimensional condition, it is necessary to supplement self-assessment with other measures of health status.

The Quantity and Quality of Life and the Relation Between Morbidity and Mortality Benefits (Section 4.3)

Section 4.3 develops an explanatory framework for studying the values that result from reductions in life-threatening illness. This framework makes it clear that people's decisions regarding health and longevity depend on their life situations and the streams of experiences that have developed over long periods of time. This framework puts the intertemporal decision process in the forefront. An implication is that the quality of life and longevity are part of a single decision making process, and that they must be considered together in a unified context.

Some important specific implications were derived from the framework. One implication is that young people, presented with a public health policy that improves their prospects for greater health and longevilty only after a long period of time, will heavily discount the benefits. Hence they are willing to pay relatively very little for the prospect, even though they may be fully aware that their preferences many years hence will be very different. On the other hand, policies that promise a near-term benefit will be valued much more highly by people of any age.

Another implication is that intertemporal substitution of lifetime consumption may occur. If people feel that they can not substitute near term consumption for long deferred consumption, they will place greater values on additions to life expectancy. The theory also identifies changing capacity for consumption over the life cycle. An added year of life accompanied by high income or accumulated wealth, together with a high quality of leisure time, will be valued relatively highly. This result underscores the inseparability of quantity and quality of life considerations.

One of the greatest challenges revealed by the life cycle framework is measuring the value people place on the reduction of threats to health that have their effects only after a latency period that may be many years in duration. Analysis of this problem is one of the contributions of section 4.3.

The life cycle framework leads to the recognition that contingent valuation questions must be framed in a way that takes account of the respondent's life cycle situation. That recognition is reflected in the CV module of the contingent value approach considered later in Volume 4. It is also reflected in the health experience module, which obtains information on the life cycle experience most pertinent to health valuation. It is reflected in various ways in the defensive measures and risk modules.

A Model of Uncertain Preferences for Explaining Inidividual Behavior Toward Risk (Section 4.4)

Section 4.4 is another source of theoretical guidance to the study of life threatening illness. This section brings utility theory to bear on the problem of valuing small changes in events that are thought of only infrequently and may involve low probabilities of occurrence. This problem encompasses a large class of events, important to environmental policy, about which people's preferences are unclear--even to themselves. Researchers have found under these circumstances that people's expressions of value may appear internally inconsistent. Various explanations have been advanced to explain the phenomena. The present theoretical framework provides an approach, based on information costs rather than assuming irrational behavior, that is suited to estimating values of health risk reductions.

Section 4.4 brings economic theory to bear on the problem of how people think about and value small changes in small probabilities of damage to health or risk to life. The theoretical perspective is that environmental health risks are unfamiliar to most people, and that health risks are unfamiliar to most people, and that because people seldom have occasion to think carefully about them they are uncertain about their preferences concerning them.

The model developed in section 4.4 leads to a series of theorems that have implications about efficient ways of stimulating people to obtain improved knowledge about their own risk preferences and to state valid, consistent risk reduction values in a contingent valuation context. Apparent inconsistencies are interpreted as reflecting uncertain preferences among respondents. The framework is developed in a way that provides operational approaches to resolving these difficulties by assisting respondents in clarifying their own preferences.

The model unfolds in terms of a series of theorems that deal with the process of preference revelation. Several theorems address the problem of how respondents think about their preferences. One theorem is concerned with the question: Which would you rather have--a benefit (such as better health) or a sum of money. The theorem states that the closer the sum of money is to

the (unknown) value of the program benefit, the harder the respondent will think about the choice. Iterative bidding begins with a rather arbitrary starting point. In subsequent bidding, however, the theorem is applied by taking account of previous completed bids on related programs. The starting point is made identical or close to the final bid on the similar previous program to encourage careful thinking from the beginning.

An important objective is to realistically relate contingent goods to the respondent's own circumstances. This means tailoring the good to the respondents's own endowment. An implication of the theorems is that introspection. about preferences is much more effective when this is accomplished. Much of the work of this project was accordingly devoted to tailoring contingent market goods to individual endowments.

Design of Contingent Valuation Approaches to Serious Illness (Section 4.5)

Section 4.5 brings together and applies all of section 4 research on life threatening illness. A structure for an intensive interviewing process is developed, based on tyechniques of in-depth interviewing. It embodies refinements growing out of focus group experiments conducted as part of the present project.

The proposed interview structure contains four modules. The interview is designed to be conducted with from six to ten people and last about four hours including breaks. The extended encounter is necessary because of the great difficulty of achieving its central task--obtaining values of events that entail small changes in small probabilities.

The first module concerns the repsondents' health experiences. It establishes the health endowmment and prepares respondents to give detailed thought to their health preferences and values. One possible approach, the health risk appraisal, gives a computer-based statement of respondents' risk of death by comparing their health characteristics with the average experience of a large population. It holds considerable promise for future application by permitting detailed tailoring of questions to respondents' own endowments, and construction of realistic life path scenarios for comparitive valuation.

The defensive measures module is the second module of the intensive interview framework. Defensive measures, or averting behavior, are a part of many people's efforts to increase the probability of good health over the life cycle. They are evidence of a willingness to pay for improved life prospects even when returns are not immediate. Smoking, diet, drinking and exercise are examples. This is a challenging area of research because it can not be measured by expenditurees; in some cases averting behavior entails increased expenditures (for example air

conditioning), while in other cases reduced expenditures occur (for example smoking). The defensive measures module develops some contingent market structures directed at obtaining expressions of willingness to pay for improved health prospects in terms of averting behavior.

The third module pertains to risk perception and risk behavior. This module begins by teaching respondents the basic notion of probability and relates it to their everyday experience. It then obtains information about their perceptions of and attitudes towards risk in a variety of situations. Next it conveys an idea of the kinds of probabilities that are involved in matters that concern their health. This module brings home to respondents the pervasive importance of risk in their lives and the fact that they have already made many conscious or subconcious judgements and valuations about risk. Thinking about these problems prepares them to think about the risks presented to them in the contingent markets that follow, and helps them to be more receptive to the contingent valuation exercise.

Contingent valuation questions form the fourth module. The contingent valuation module establishes contingent markets in health. There are hypothetical life experiences involving both quality and length of life that people are asked to evaluate in comparison with their own prospects, established in the health status module. The questions increase in complexity, beginning with simple questions involving certainty scenarios and mortality only. Next, serious illnesses are introduced, and respondents are asked their willingness to pay to eliminate the risks of getting diseases. These questions are followed by life path scenarios that combine morbidity and mortality in a life cycle setting. Alternative life path possibilities are presented and respondents are asked to choose among and value them, first in a certainty and then an uncertainty setting.

It is believed that the survey approach developed in Volume 4, and the extensive preparation for obtaining expressions of willingness to pay described in the modules, constitute an advance in survey research on the values of health improvements, and that intensive empirical applications are needed.