Return on Investment of Nationwide Health Tracking

A Report of the
Public Health Foundation
1220 L Street NW, Suite 350
Washington, DC 20005

Final Report

Under contract with Health-Track

August 2001

Executive Summary

What kind of return can we expect from a nationwide health tracking network? As a follow-up to the recommendations of the Pew Environmental Health Commission, Health-Track commissioned the Public Health Foundation to find the answer to this important question.

Environment-Related Health Tracking Will Pay For Itself

For every dollar invested by the federal government in the nationwide health tracking network, the federal government alone would **receive a return of $1.44** in reductions in federal health care costs. This estimated return on investment is based on the best data available and estimates of a range of governmental costs and cost savings. The policies and interventions that may emerge based on what is learned from this nationwide tracking network are likely to receive a greater return for the American public, in terms of both sickness-related costs and human health.

This study demonstrates that a federal government investment in a nationwide health tracking network is a sound investment. Not only would there be economic benefits to the federal government, similar savings are likely to be witnessed by state and local governments, business and industry, and individuals. These savings are above and beyond the additional benefits that would be realized through increased productivity and improved quality of life.

Poor health, sick care visits to physicians and hospitals, and premature deaths are avoidable when the public health and clinical health systems of care are armed with information about who is at risk, the level of risk, the source of risk, and ways to prevent, or reduce, exposure to risk. Investment in interventions to reduce environment-related disease, disability, and death will have tangible and real effects, as enumerated in the table below.

With the advent of nationwide health tracking, poor health outcomes can be averted. These numbers represent annual preventable disease, disability, and death attributable to environmental factors.

3,400	Major congenital malformations among newborns*
24,000	Spontaneous abortions*
80,500	Deaths**
136,000	Low weight births*
1,122,000	Asthma attacks among children***
11,946,000	Asthma attacks among adults***

* In addition to the number of births and population attributable risk (PAR), estimates are based on the prevalence of spontaneous abortions, low weight births, and congenital malformations (Marcus et al., 1993).
** Based on Health United States 1996-97 and Injury Chartbook (NCHS, 1997).
*** Based on incidence of asthma (Kunzli et al., 2000).

What We Can Expect From Investments in Tracking and Research

Research will return specific benefits. The Lasker Foundation describes "exceptional returns" and "the economic value of America's investment in medical research." For example, "a 17-year program that invested only $56 million in research on testicular cancer has led to a 91% cure rate and an annual savings of $166 million." Currently, medical and health research is just 1% of the federal budget (Mary Woodard Lasker Charitable Trust, 2000).

Food Safety as a Tracking Success Story

Success stories in food safety -- the implementation of tracking, assessment of needs, and development of targeted policies-- illustrate what can be achieved with environment-related health tracking. Over the past decade, in response to better tracking of foodborne illnesses and higher risk foods containing the most common bacterial foodborne pathogens, policies have been developed to target food items and areas of the country where improved farm-to-table control measures are desirable. Policies include targeted interventions such as farm control measures, refrigeration, and educational programs. Between 1997 and 1999, illness from these foodborne pathogens declined by nearly 20 percent, resulting in at least 855,000 fewer illnesses per year (CDC, 3/17/00).

It is estimated that there are nearly 1.3 million salmonellosis cases each year in the United States that are due mainly to consumption of tainted food. As a result of these illnesses, each year approximately 170,000 individuals visit a physician, 16,400 individuals require hospitalization, and 600 individuals die. The estimated annual cost of medical care and lost productivity ranges between $0.5 billion and $2.3 billion (Frenzen et al, 1999). Policies to promote the better handling and transporting of eggs are believed to have contributed to a seven percent decline in Salmonella infection associated with egg consumption between 1998 and 1999 (CDC, 3/17/00). At the same time, it is important to note that in 1999 an increase in total cases of salmonellosis was identified. This increase has been traced to new sources, such as unpasteurized orange juice, imported mangos, and raw sprouts. Effective tracking has led to this determination as well as the development of new policies for eliminating Salmonella in orange juice, sampling and detentions of imported mangos from high-risk locations, and guidance on the production of raw sprouts.

Health Tracking Provides Substantial Return

Environment-related interventions have costs and benefits to government. In many instances, as discussed throughout this report, the benefits outweigh the costs. An expenditure of $275 million for nationwide health tracking – about $1 for every American – along with development of programs and policies building on the information the network generates, would return to the federal government alone a savings in health care costs of over $1/2 billion. In particular, health tracking would lead to many reductions in illness, death, and medical costs. With information, interventions can be shaped to meet the needs of the population and be as effective and efficient as possible.

This study demonstrates that a federal government investment in a nationwide health tracking network is a sound investment. Not only would there be economic benefits to the federal government, similar savings are likely to be witnessed by state and local governments, business and industry, and individuals. These savings are above and beyond the additional benefits that would be realized through increased productivity and improved quality of life.

Return on Investment of Nationwide Health Tracking

Table of Contents

I. Project Background/Overview

Health-Track commissioned this report to help move discussions forward on nationwide health tracking. A recent report developed by the Pew Environmental Health Commission (Environmental Health Tracking Project Team, 2000) advocates a nationwide health tracking network for environmental health. Such a health tracking network will supply information for decision making and add value to joint public health and environment ventures by increasing efficiency and effectiveness in planning and programming interventions.

To this end, Health-Track requested this study about the potential costs and benefits associated with the use of a nationwide health tracking network. A nationwide health tracking network will generate information to enhance health planning and assure the best use of resources. It is important to know the total costs of tracking, the net gain achieved with any intervention begun with the aid of tracking data, and the benefits gained as a result of an intervention.

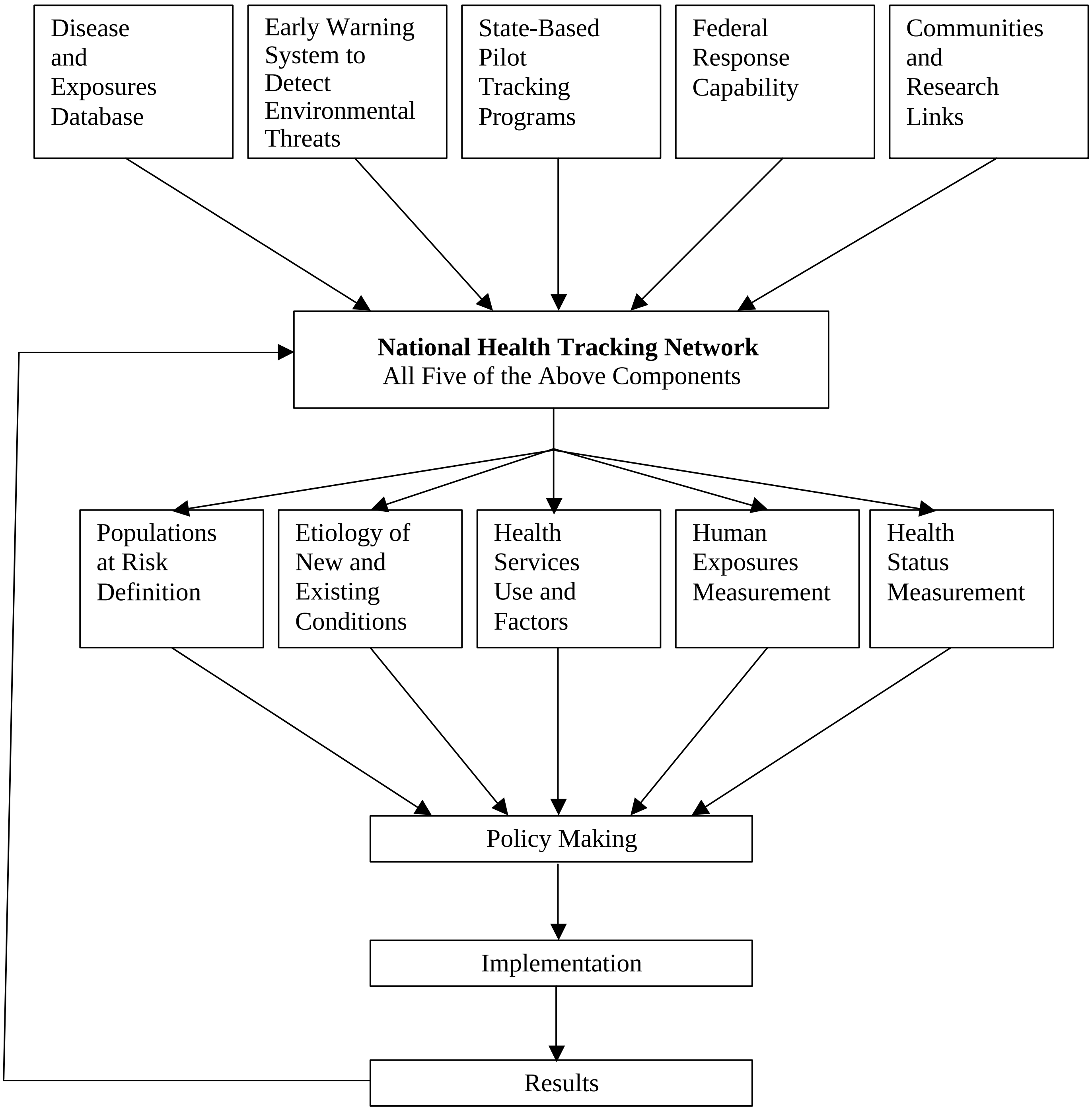
Progression from single tracking activities to bona fide health benefits is illustrated below. Figure 1 shows the interactions among: (1) individual tracking activities, (2) a nationwide health tracking network, (3) various information sets obtained, (4) data-based policy making, (5) implementation of an appropriate intervention, and (6) the results achieved. The following are definitions of each component.

- ***individual tracking activities****:* the five types of tracking activities recommended by the Pew Commission Report - disease and exposure databases, an early warning system to detect environmental threats, state-based pilot tracking programs, federal response capability, and linking of communities and research activities.
- ***a nationwide health tracking network:*** an integrated surveillance system for environment-related outcomes.
- ***various information sets obtained:*** information obtained will provide research findings about the topics of who's at risk, the etiology of new or existing conditions, health services use, human exposure, and health status.
- ***data-based policy making:*** integration of information about the problem will yield some policy options, persuade policy makers to act, and guide future program interventions. Policy may include public education, legislation, rule making, contractual relationships, and preferred methods.
- ***implementation of an appropriate intervention:*** implementation of a policy will require information for launching an intervention.
- ***results achieved:*** the tracking network will provide feedback, over time, about the course of the intervention, changes in the distribution of disease or condition, and who's at risk. This is evaluation and quality improvement/assurance data.

Tracking precipitates a fairly complex set of activities that cascade to improve health. This cascade of events is positive when human health is improved at the smallest cost (Eddy, 1992). Tracking is essential to identifying populations at risk, understanding the etiology of new and existing conditions, evaluating health services use and associated factors, measuring human exposure, and providing health status monitoring (Klaucke et al., 1988). These factors combined become the basis for making policy and implementing programs. From Figure 1, one can envision the utility of tracking to the cycle of health improvement.

Figure 1

How Tracking Leads to Results



Section II of this report, *Why do we need this information?*, focuses on why this environment-related health tracking activity is important. Section III, *Cost-benefit methodologies*, discusses the various methods for presenting calculations of costs and benefits. Section IV, *The payback ratio of an environment-related nationwide tracking network*, provides the costs-benefits payback ratio calculated for this report, and the related methods and assumptions. Finally, Section V, *Summary*, focuses on the key findings of this report.

II. Why Do We Need This Information?

Diseases Affected by Environmental Risks are Costly.
The Pew Environmental Health Commission report makes the case that several adverse health conditions have increased dramatically over the past decade and may be caused by factors present in the environment (Pew Environmental Health Commission, 2000). Table 1 shows some of the costs of diseases that are environment-related or that have substantial, unknown etiologies.

Environment-Related Disease is Substantial.
In the current task of estimating costs and benefits of environment-related health tracking, only total costs may be known and apportioning costs, disease, or death due to a particular exposure can be done using a population attributable risk (PAR) percent. The PAR is a useful epidemiologic tool, which allows constituent information from different sources to be applied to obtain one number.

"The attributable risk is a measure of how much of the disease burden could be eliminated if the exposure were eliminated" (Brownson et al, 1993). The formula for calculating the fraction that is preventable in the population is:

$$\text{Population Attributable Risk} = \frac{\text{Pe (relative risk-1)}}{\text{1+ Pe (relative risk-1)}}$$

where "Pe represents the proportion of the population that is exposed." Relative risk is the ratio of the disease rate among the exposed to the disease rate among the unexposed (Brownson et al, 1993).

Once calculated, the PAR can be used to estimate the saving of lives, disease cases, or health care services delivered if the exposure were eliminated or avoided. The PAR for most diseases will vary for deaths, disease occurrence, and health services. For instance, a high-occurrence-from-exposure disease with low case fatality will have a higher PAR for disease than for death. Similarly, a high-occurrence-from-exposure disease with few or low cost services will have a lower PAR for services costs than for disease occurrence. Using our knowledge about the natural history of the disease, we will be able to establish the direction and make informed estimates to fill information gaps.

Table 2 contains examples from the published scientific literature about population attributable risk percents that pertain to contributions from the environment to the burden of death, disease, or health care costs. To allocate the environment's share, numbers based on these published estimates were assembled to portray a range (low-high) of likely contributions. A mid-range value based on the best evidence is used in the calculations throughout this report. PAR for all deaths (Table 2) has not exceeded 33% in any study. On the other hand, for specific conditions with strong environment associations, the PAR is larger (Table 2).

Table 1. Costs of selected conditions which have an environmental basis							
				Total Indirect Costs			
Condition (Source)	**Year**	**# People Affected**	**Direct Health Care Costs**	**Direct Non-Health Care Services**	**Indirect Costs- Lost Productivity**	**Indirect Costs – Lost Lives**	**Total Direct and Indirect Costs**
All Health Care Costs (Levit et al., 2000)	1998		$1,100 billion (annual)				
Respiratory Disease – COPD (American Lung Association, 2000)	1996	16.4 million (annual)		$20.7 billion (annual)	$11.2 billion (annual)		$31.9 billion (annual)
Respiratory Disease- Asthma (American Lung Association, 1999a; American Lung Association, 1999b)	1996	17 million 12 million adults 5 million children	$10.7 billion (annual) $7.5 billion (adults, annual) $3.2 billion (children, annual)		$3.8 billion (annual)		$14.5 billion (annual)
Birth Defects-Structural** (CDC, 1992) (National Research Council Committee on Developmental Toxicology, 2000)	1988 1992	33,000 newborns with structural birth defects/ year	$2.1 billion	$0.9 billion	$5.0 billion		$8 billion (lifetime)

Table 1. Costs of selected conditions which have an environmental basis (cont'd)							
				Total Indirect Costs			
Condition (Source)	**Year**	**# People Affected**	**Direct Health Care Costs**	**Direct Non-Health Care Services**	**Indirect Costs- Lost Productivity**	**Indirect Costs – Lost Lives**	**Total Direct and Indirect Costs**
Birth Defects- Develop-mental*** (Honeycutt et al., 1999) (National Research Council Committee on Developmental Toxicology, 2000)	1996	44,200 cases of mental retardation/ year 4,700 cases of autism/ year 11,614 cases of cerebral palsy/ year	$4.8 billion (lifetime) $0.12 billion (lifetime) $0.52 billion (lifetime)	$1.3 billion (lifetime) $0.13 billion (lifetime) $0.29 billion (lifetime)	$40.8 billion (lifetime) $4.6 billion (lifetime) $11.2 billion (lifetime)		$46.9 billion (lifetime) $4.9 billion (lifetime) $12.0 billion (lifetime)
High lead levels (See Table 2)	1994				$105 billion (annual)		
Cancer (American Cancer Society, 2001a; American Cancer Society, 2001b)	2000	1.2 million new patients/ year	$37 billion (annual)		$11 billion (annual)	$59 billion (annual)	$107 billion (annual)
All CVD Disease (AHA, 2000)	1990-1994	60 million live with heart disease	$186 billion (annual)		$113 billion (annual)	$28 billion (annual)	$327 billion (annual)

- *Health Commission. Factsheet: America's Environmental Health Gap, 2000
- **Includes 18 major structural defects including spina bifida, cerebral palsy, cardiac abnormalities, Down's Syndrome, limb deformities, etc.
- ***Includes mental retardation, autism, and cerebral palsy.

Table 2. Examples of Population Attributable Risk (PAR)				
	Proportion Affected (Location)	**Relative Risk/Odds Ratio**	**Pop Frequency (Per million Pop/Yr)**	**PAR%**
(Aunan et al., 1998)	Air pollution (Hungary)			Deaths: 6%
(Buffler and Kyle, 1996)	(TX, US)			Lung cancer deaths: 3%
(Dunnette, 1989)	(Global health)			Disease: 25-33%
(Kunzli et al., 2000)	PM10>7.5, 94-100% (Austria, France, Switzerland)	Death: 1.026-1.061 Hosp Admission- Resp: 1.001-1.025 CVD: 1.007-1.019 Bronchitis Incid: 1.009-1.194 Restricted Activity Days: 1.079-1.502 Asthma Attacks (Child): 1.027-1.062 Asthma Attacks (Adults): 1.019-1.059	8260-9330 10,300-17830 17270-36790 4660-5010 2.6-3.4 million 56700-62800 169500-173400	Deaths: 6% Asthma attacks: 43-56%
(McGinnis and Foege, 1991)	(USA)	Toxic Agents Microbial Agents Environmental Tobacco Smoke		Deaths: 3% Deaths: 4% Deaths: 0.3%
(Michaud Catherine M et al., 2001)	(Global)	Poor water supply, occupational risks, air pollution		DALY's: 8.6%
(Ostro and Chestnut, 1998)	10PM change (USA)			Deaths: 3.5% Premature deaths: 7,200 Asthma symptom days: 10.9%
(Smith et al., 1999)	(Global)			Disease: 25-33%

Once the percentages of risk attributable to the environment have been estimated, they can be applied to the number of deaths or other events occurring in a given time period. Using U.S. population deaths and births, the following avoidable environment-related events were estimated:

3,400	Major congenital malformations among newborns*
24,000	Spontaneous abortions (annual)*
80,500	Deaths (annual)**
136,000	Low weight births (annual)*
1,122,000	Asthma attacks among children***
11,946,000	Asthma attacks among adults***

* In addition to the number of births and a mid-range PAR of 3.5%, estimates are based on the prevalence of spontaneous abortions, low weight births, and congenital malformations (Marcus et al., 1993).
** Based on Health United States 1996-97 and Injury Chartbook (NCHS, 1997) and a mid-range PAR of 3.5%.
*** Based on incidence of asthma (Kunzli et al., 2000) and a mid-range PAR for asthma of 33%.

III. Cost Benefit Methodologies

It is useful to calculate costs of disease and benefits derived from treatment or other interventions on a common basis so that the yield from spending may be compared to relative benefits achieved. There are two common calculations that are used in health care to justify new preventive interventions to show that a new technology or intervention may be comparable to existing practice and to illustrate that a significant outlay of dollars will result in savings, somewhere in the system. They are cost-effectiveness and cost-benefit ratios. After exploring these two methods, we adopted an approach using the components of both methods most appropriate for calculating costs and benefits associated with the nationwide health tracking network. The payback ratio approach enables us to focus on the return of direct benefits to the bearer of direct costs.

Cost-Effectiveness

Cost-effectiveness analysis is described in this way.

> "Cost-effectiveness analysis is commonly used to conduct economic analyses of health programs….results are presented in the form of costs per health outcome, such as 'cost per case prevented' or 'cost per life saved.' The decision maker is left to make value judgements about the intrinsic value of the health outcomes" (Haddix, 1996b).

The Dictionary of Epidemiology discusses how decisions are made using cost-effectiveness:

> "…(Cost-effectiveness) seeks to determine the costs and effectiveness of an activity, or to compare similar alternative activities to determine the relative degree to which they will obtain the desired objectives or outcomes. The preferred action or alternative is the one that requires the least cost to produce a given level of effectiveness…" (Last, 1983).

The dollars spent per year of life saved are shown in Table 3, which contains selected, environment-related cost-effectiveness ratios from a general collection of more than 500 "life-saving" interventions (Tengs et al., 1995). These selected interventions also denote the range of costs (from less than $0 to $240,000 per year of life saved) encountered. The Centers for Disease Control and Prevention has produced these calculations for a range of public health prevention activities (Haddix, 1996a) to illustrate the good buy of various preventive interventions.

The advantage to this calculation is that every reader can quickly assess that a year of life is an important event and one worth saving. The expression of dollars spent provides data for the economic choice involved. It may not, however, convey well the costs relative to benefits when death is not a prominent outcome or other effects such as disability (which may be regarded just as important as deaths) can be determined. For this report, where a specific intervention has not been selected, a valuation of dollars spent per life saved is not possible because of lack of information about individuals affected and because of unknown total benefits of a potential intervention.

Table 3. Examples of Cost-Effectiveness

Tracking Type*	**Type of Intervention**	**Intervention**	**Cost-Effectiveness ****
Hazard tracking	Remediation of the hazard	Control of existing benzene fugitive emissions	$240,000
	Occlusion of exposure route	Radon remediation in homes with levels ≥21.6 pCi/L (≥8.11 and ≥4)	$6,100 ($35,000 and $140,000)
		Immunization for all infants and pre-school children	≤ $0
Exposure tracking	Exposure reduction	Reduce lead content of gasoline from 1.1 to 0.1 grams per leaded gallon	≤ $0
		Chlorination of drinking water	$3,100
	Prophylaxis after exposure	Prophylactic AZT following needlestick injury in health care workers	$41,000
Health outcome tracking	Screen and treat an adverse effect	Colon cancer screening, 40+	$4,500-$90,000
	Treat clinically apparent problem	Intensive care and mechanical ventilation for acute respiratory distress syndrome	$3,100

* Environmental Health Tracking Project Team. America's Environmental Health Gap: Why the Country Needs a Nationwide Health Tracking Network, September 2000.
** Cost-effectiveness is the ratio of dollars represented in direct costs (1993 dollars) per year of life saved (Tengs T, et. al. Five-hundred life-saving interventions and their cost-effectiveness. Risk Analysis. 1995. Vol. 15(3): 369-391).

Cost-Benefit Ratio

The cost-benefit ratio is another calculation that compares costs to benefits. Costs and benefits are both conveyed as dollars and calculated as a ratio on the basis of dollars.

> "Cost-benefit analysis (CBA) is a technique that attempts to value the consequences or benefits of an intervention program in monetary terms…CBA attempts to place dollar values on program outcomes. All health outcomes are evaluated…" (Haddix, 1996b).

Table 4 shows several cost-benefit ratios obtained from a brief search of the public health literature. Annual cost-benefit ratios in these examples range from $1.35 to $9.14 worth of benefits for every dollar spent. In lifetime cost-benefits, the range is similar, $4.63 to $15.40. These benefits and costs include all benefits and all costs realized to any sector of society, valuing in dollars, events like lost productivity, premature death, and disability.

While this is a powerful technique because it characterizes full sources of benefits and costs, it presents difficulties for the assessor wishing to compare one intervention to another. First, the assignment of dollar value to life, disability, lost wages, and the like is not uniform from one study to another (Government Accounting Office, 2000). Second, figures on the costs and benefits for the same individuals are required, a daunting requirement for many research projects. Third, even though the computation of value is made using dollar amounts, sometimes it is too difficult to place a value on a lifetime disability which involves diminished quality of life, lost earning potential and perhaps additional health care costs. And last, those reaping the benefits are not always the ones bearing the costs. This latter argument is often invoked when the case for prevention is made in managed care organizations where patients are apt to be enrolled one year and not the next in the same HMO. In this case, the health care provider who paid for prevention may not reap the cost savings that occur later. This is a common situation with social benefits, as for example, where lead is reduced in the environment, a cost to consumers, and the benefits of greater employability and productivity are shared broadly across many sectors of society (Table 5). For this report we did not collect new cost and benefit data on individuals and thus did not have the data for a cost-benefit analysis.

Payback Ratio

A payback ratio was developed and has been employed in the following section to describe the costs and benefits of nationwide health tracking. The payback ratio, an approach combining elements of both cost-benefit and cost-effectiveness analysis, has been adopted for use here to maximize the use of extant information and to avoid the shortcomings of cost-effectiveness and cost-benefit analysis that exist when data elements are not available. The payback ratio may be defined as the ratio of dollars saved to dollars spent by a particular entity (such as government, industry, etc.). The determining factors for calculation of the payback ratio are acquisition of the entity costs and benefits or savings. These estimates of costs, benefits, and savings could be found or derived, as they pertain to nationwide health tracking, making the use of the payback ratio method appropriate for this study.

Table 4. Examples of cost-benefit ratios by policy intervention type				
Cost-Benefit Ratios Using Annual Health Care Cost Savings				
Type of Policy Intervention	**Intervention (Source)**	**Costs Per Person Affected**		**Cost-Benefit Ratio**
		Direct Medical	**Indirect Costs**	
Multi-agency governmental services	Screening, diagnosis and treatment of syphilis among county jail inmates (Varley et al., 1998)			$9.14: 1
Service delivery	Clinical pharmacist-managed medication assistance program among renal transplant patients (Hedemann-Jensen and Yatsalo, 1998)	$2,046 per year		$7.50:1
Service availability	Personal emergency response systems use among community-dwelling elderly (Denman and Phillips, 1998)			$7.19: 1
Regulation of industry discharge	NO2 Control			$6.00:1
Exposure prevention	Nosocomial respiratory infection program in a pediatric hospital (Qu and Ehrhardt, 1998)	$9,419 per occurrence		$6.00:1
Primary prevention	Flu vaccination among the elderly (Mullooly, et al, 1994)	$7.11 per vaccination		$3.08:1
Point of (clinical) service	Routine second-trimester ultrasonography performed in tertiary care centers (Gage-White, 1998)			$1.35:1
Cost-Benefit Ratios Using Productivity Per Lifetime				
Type of Intervention	**Intervention (Source)**	**Costs Per Person Affected**		**Cost-Benefit Ratio**
		Direct Medical	**Indirect Costs**	
Primary prevention - children	School-based smoking prevention program (Mathers et al., 2000)	$3,400 per lifetime	$14,000 productivity per lifetime	$15.40:1
Risk-lowering services	Brief physician advice about alcohol use directed to problem drinkers (Zaza et al., 2000)			$5.63:1
Universal coverage	Prenatal care for undocumented immigrants (Dettenkofer et al., 1997)	$5,588 per childhood		$4.63:1

Table 5. Society benefits from reducing lead exposures to children			
Components of Savings	**Amount**	**Source: Author and Year of Publication**	**Total Societal Savings**
Reducing blood lead level by 10 micrograms/dL	Raises IQ by 2.6 points	Schwartz, 1994	
Reduction in Lead between 1976-80 and 1991-94	Average 12.4 micrograms/dL	Annest et al., 1983 and Pirkle et al., 1998	
# Children born annually	3.9 million	Ventura, et al., 2000	
# IQ Points Saved	Salvage 12.6 million IQ points annually	EPA, 1998	
IQ Point Lifetime Economic Value	$8,350	EPA, 1998	
			$105 billion
Adapted from: National Environmental Trust, Physicians for Social Responsibility, and Learning Disabilities Association of America. "Polluting our future: Chemical pollution in the U.S. that affects child development and learning," September 2000. http://www.psr.org/trireport.pdf			

In calculating costs and benefits for a nationwide health tracking network, we are interested in knowing the payback on a federal investment of $275,000,000 in health tracking (the cost of a health tracking network determined by the Pew Environmental Health Commission). How much benefit can be accrued by the federal government as a result of this investment, taking into account the costs of new interventions? Benefits are direct federal government savings accrued in health care services programs of Medicaid, Medicare, and others. Health tracking is generally a small cost that generates more targeted interventions, etiologic or treatment efficacy information, and coordinated and synergistic research.

Choice of Interventions

The question of benefits relative to costs to government relates very closely to the intervention selected. The cost and effectiveness of the intervention and whether it is feasible to implement are questions which will precede the benefits to costs assessment.

There are a number of types of interventions available to a practitioner of public health that might be employed to protect the health of a population. The Pew Environmental Health Commission report provides a model for thinking about remediation of environmental exposures, risks, and poor outcomes. Interventions range across at least 6 categories:

- Remediation of the hazard
- Occlusion of exposure route
- Exposure reduction
- Prophylaxis after exposure
- Screen and treat an adverse effect
- Treat clinically apparent problem (Pew Environmental Health Commission, 2000)

Further, each type of intervention addresses three areas of environmental effects and health: 1) hazards in the environment, 2) exposure of individuals to these hazards, and 3) the ultimate effects on health status. There are differences in the intervention costs per year of life saved by these categories, as shown in Table 4. In general, the first two, hazard cleanup and containment, are by far the most expensive (per year of life saved) interventions. Given a choice between equally effective treatments with differing costs, the lower cost alternative is the preferred policy option (Eddy, 1992).

In addition to cost, whether a problem can feasibly be addressed with known, efficacious, and effective interventions and whether it is a large or a serious problem are also important. Interventions should also be judged against the following qualities: “propriety,” “economics,” “acceptability,” “resources,” or “legality” (Vilnius and Dandoy, 1990). Frequently these are judgements made without benefit of a formal cost and benefit calculation. Nevertheless, these judgements are useful to identify and address gaps in interventions.

IV. The Payback Ratio of an Environment-Related Nationwide Health Tracking Network

The basic approach taken by the Public Health Foundation for calculating the relative value of health tracking involves a range of scenarios for payback to the federal government from an investment in a nationwide health tracking network for environment-related health events. Such a payback ratio conveys the comparison of direct health benefits to direct health costs accrued solely by the federal government. Other methods used elsewhere describe the savings per year of life saved (cost-effectiveness) and benefits-to-costs ratios achieved in all sectors (cost-benefit ratios). (See Section III.)

The payback ratio consists of an aggregated range of costs and benefits from prior experiences described in the literature, which were then used to specify a mid-range outcome. We then calculated the payback ratio for that mid-range outcome. The payback ratio consists of new benefits measured by reduced health care costs divided by the total costs of health tracking and the total new costs of intervention. The three subsequent subsections provide details about the components of the payback ratio:

(A) costs of a nationwide health tracking network,
(B) new benefits measured by reduced health care costs, and
(C) total costs of new interventions.

Our calculations for the mid-range values yield the payback ratio of 1.44. For every $1.00 spent by the federal government for a nationwide health tracking network for environment-related disease and new interventions there is a larger payback to federal government of $1.44 in direct health care costs saved. A return of the initial dollar spent and an additional forty-four cents is accomplished for this mid-range scenario. Using the mid-range values communicates what might be a return on a typical choice, but actual payback ratios will be dependent on types of interventions, implementation costs, and intervention effectiveness. In other words, achieving a positive flow of return on investment will depend on the combination of improved targeting of populations in need, the launch of effective interventions, and the ability of the intervention to reduce costs in the health care delivery sector.

Factors ultimately affecting return on investment to the federal government are: 1) the actual investment in health tracking, 2) the amount each investment returns as savings in health services, and 3) the degree to which current and new dollars may be invested in appropriate interventions. For the current, mid-range estimation of $1.44 paid back for every dollar spent, we used $275 million as the annual cost of the nationwide health tracking network. Costs of new interventions may total an additional $100 million. New benefits, measured by reductions in health care costs, amount to $540 million. The remainder of this section describes how these figures were derived. The calculation of the payback ratio is found below.

Payback Ratio Formula and Its Components:

		(A)	(B)	(C)
Benefits to Costs Ratio 1.44	=		***New Benefits Measured by Reduced Health Care Costs*** $540 million	
		Costs of Nationwide Health Tracking Network $275 million	+	***Costs of New Interventions*** $100 million

Three subsequent sections follow that provide more detail about the elements in the payback ratio calculation above.

(A) Costs of Nationwide Health Tracking Network

The Pew Environmental Health Commission suggested that $275 million would supply critical elements of a environment-related nationwide health tracking network. The $275 million would buy an integrated effort with new tracking components as well as better integration and coordination of what already exists (Pew Environmental Health Commission, 2000).

The Mary Woodard Lasker Foundation in “Exceptional Returns: The Economic Value of America’s Research Investment in Medical Research” reports that 19 cents a day or just $69.35 per year is spent by the federal government on medical and health research (Mary Woodard Lasker Charitable Trust, 2000) with even greater benefits realized. For every dollar the federal government spends on medical and health research, two more dollars are invested by the private sector (Mary Woodard Lasker Charitable Trust, 2000). The suggested one dollar per American for environment-related health tracking is less than one percent of what is currently spent on medical and health research. As we know, the quality and merits of research are dependent upon the data used for conducting this research. The nationwide health tracking network will provide new and better data necessary for research to improve human health.

(B) New Benefits Measured By Reduced Health Care Costs

New benefits aggregated for the federal government payback ratio were conceptualized as a combination of three factors: 1) federal government health care costs attributable to the environment (B1); 2) the percentage of health care costs which can be avoided when new interventions are implemented as a result of better tracking information (B2); and 3) potential policy interventions implemented as a result of better tracking information (B3). Multiplied out, as shown below, a calculation of reduced health care costs was obtained. For the simple case of one policy intervention, four percent of all federal government borne health care costs that are environment-related would be saved. This is total new benefits of $540 million accrued by the federal government.

(B1) Federal Government Health Care Costs Attributable to the Environment		(B2) Percent of Federal Government Health Care Costs Avoided with New Interventions		(B3) Number of Federal Policy Interventions Implemented	=	(B) New Benefits to the Federal Government Measured by Reduced Health Care Costs
$13.5 billion	x	4.0%	x	1		$540 million

The components of and background information relevant to the calculation of each of the factors (B1, B2, and B3) of the formula are described next.

<u>(B1) Federal Government Health Care Costs Attributable to the Environment</u>
Federal government health care costs attributable to the environment amounting to $13.5 billion was derived using the formula below. The calculation apportions national health care expenditures paid by the federal government to the percent of disease or deaths attributable to the environment (i.e., the amount of disease associated with an exposure within a population) (Last, 1983). The percentage of health care costs is assumed to be equivalent to the percentage of disease or deaths caused by the environment.

(B1a) Total Federal Government Health Care Expenditures	x	(B1b) Percent Attributable to the Environment	=	(B1) Federal Government Health Care Costs Attributable to the Environment
$384.7 billion		3.5%		$13.5 billion

<u>(B1a) Total Federal Government Health Care Expenditures</u>
In 1999, $384.7 billion was spent by the federal government on health care services (Medicare, Medicaid, VA, and other programs) out of total national health expenditures of $1,210.7 billion (Heffler, et.al, 2001).

<u>(B1b) Percent Attributable to the Environment</u>
The predominate attributable risk percent for deaths attributable to the environment in the peer-reviewed science literature is six percent (Vineis, 1995; Doll and Peto, 1981; Coultas and Samet, 1992; Schmahl et al., 1989; Davis et al., 1983; CDC, 1993; McGinnis and Foege, 1991). The range observed was 1-12%. The lowest value, 1%, was found by Buffler and Kyle (Buffler and Kyle, 1996) who found a contribution of air pollution to lung cancer mortality. The predominant value, 6%, was estimated by many authors for all deaths (Aunan et al., 1998; Aunan, 1996; Kunzli et al., 2000). Others (Smith et al., 1999; Dunnette, 1989) estimate even greater percentages (8.6-25% globally). We used the mid-range value between 1% and 6%, which is 3.5%. Ostro and Chestnut (Ostro and Chestnut, 2000) also estimated 3.5% and this value is within the range described by McGinnis and Foege (McGinnis and Foege, 1991). Differences in

the estimates revolve around the definition for "environment" and the scope of disease considered. For the calculation, B1b, health care costs attributable to the environment, was assigned the value of 3.5% ((1% + 6%)/2).

<u>(B2) Percent of Health Care Costs Avoided with New Interventions</u>
The level of effectiveness of interventions will vary according to the proportion of the population reached and the efficacy of the intervention (Rose, 1991). This is true for the percentage of health care costs that can be avoided with the introduction of new interventions.

(B2)		(B2a)		(B2b)		(B2c)		(B2d)
Percent of Health Costs Avoided with New Interventions	=	Efficacy	x	Targeted Population	x	Target Population Reached	x	Reduction in Health Care Expenditures
4%		95%		50%		85%		10%

An intervention having the mid-range characteristics above would reduce total costs by 4%.

(B2a) The mid-range value selected was 95%. Efficacy for immunizations ranges from 90 – 100% (Centers for Disease Control and Prevention, 2001b). The sensitivity of screening tests, a measure comparable to vaccine efficacy, ranges from 55-95%. The actual percentage of true positives detected depends on the screening test examined (e.g., fecal occult blood test, colonoscopy, mammography, gonorrhea testing, and Pap smear) and the application of the screening (i.e., serial and parallel testing, the characteristics of the population screened) (U.S. Preventive Services Task Force, 1997). It is assumed, for the purposes of this study, that the selected intervention will be chosen because of its high level of efficacy.

(B2b) The mid-range value selected was 50%. The population targeted for an intervention may vary by age (e.g., children, adults above a specific age), health (e.g., chronic conditions present), or location (e.g., geographic area, worksite, etc.). In the case of an environmental exposure the target group may be close to 100%, as with air quality. On the other hand, an industrial exposure may produce a percentage close to zero.

(B2c) The mid-range value, 85% of the target population, reflects experience with screening and vaccine programs. Childhood (19-35 months) immunization rates vary from 79% to 96% (CDC, 2001b). Screening for cervical cancer, which has been promoted since the 1970s, is at 85% among adult women (CDC, 2001a).

(B2d) The mid-range value selected was 10%. Screening finds cases at earlier stages and early stage disease is generally easier and less expensive to treat. Reductions in mortality, ranging from 20-60% (U.S. Preventive Services Task Force, 1997), have been demonstrated for application of screening tests to cancer. Fireman and colleagues found a savings from cancer screening of 24-43% in all medical costs for colon, rectum and breast cancer. From an example in food safety, a policy to promote the better handling and transporting of eggs is believed to have contributed to a 7 percent decline in Salmonella infection associated with egg consumption between 1998 and 1999 (CDC, 3/17/00). Even greater reductions are projected for the future. We chose 10% as the mid-range value for the reduction in health care costs because of the uncertainty surrounding the direct impact on health care costs of an environmental intervention and the evidence that a targeted intervention can significantly reduce morbidity and mortality.

Some interventions, and environment-related programs especially, have the advantage of affecting everyone (as with clean air). For an intervention targeting the entire population, the target population percent (B2b) would be virtually 100% and the overall percent of health care costs avoided with new interventions would be higher at 8%. Similarly, relatively more savings can be made through early detection when a sizable proportion of expenses can be avoided because early detection and diagnosis are the norm. This calculation is sensitive to the type of intervention, it's efficacy and its ability to find and affect the people in need.

(B3) Number of Policy Interventions Implemented

Presumably there would be several potential interventions from which to choose, with the aim to implement "low cost, high return" policy options (Eddy, 1992). The number of interventions implemented may range from one to several; we have used one. The selection and implementation of more than one intervention with a high level of efficacy would potentially have an even greater impact on reductions in health care costs attributable to the nationwide health tracking network.

(C) Total Costs of New Interventions

(C1) **New Intervention Costs**		(C2) **Reduction in Current Costs**		(C) **Total Costs of New Interventions**
$100 million*	-	$0	=	$100 million

* $0-531.4 million per rule per year. More costs tend to the low end of this estimate than the high end. An "average" of $100 million is assumed.

We chose the value of $100 million, assuming that a number of intervention options would convey benefit at costs less than the average of the range. The Office of Management and Budget (OMB) considers $100 million to be an "economically significant" policy (OMB, 2000; OMB, 1999). We did, however, calculate a range of potential costs to the federal government between $0 and $531.4 million per year. Variations in implementation of new interventions upon existing interventions create a range of net costs of interventions. Some policies have zero actual new costs and others have significant expenditures to implement. Costs to the federal government of new interventions need to take into account the new costs of the intervention, the supplantation of current costs affecting the same outcomes, and reductions in current costs.

The higher estimate for federal government cost of new interventions is $531.4 million per EPA rule per year ($71 billion total costs, of which EPA's (i.e., environment–related health) share of regulation costs is 75.8% for nine rules over 11 years 3 months) (OMB, 2000; OMB, 1999). These rules include the Clean Air Act, which is comprehensive and regulates several components of air emissions. The calculation using nine rules as a divisor (based on OMB calculations) produces an average cost per rule. The average is misleading because Clean Air Act rules are comprehensive and could be considered as multiple rules; the median value, were it provided, would be lower.

An excellent example of a federal policy intervention that resulted from surveillance data indicating a need is the National Breast and Cervical Cancer Early Detection Program. The federal government allocated $100 million in FY95 for this nationwide program that targets screening for the medically underserved. While the dollars for this program flow through the Department of Health and Human Services, most of the outreach and screening is done through state and local public health agencies. In the fifth year of the program (FY95), over half a million medically underserved women had been screened, resulting in earlier and more effective treatment of disease (Henson RM, et.al., 1996).

The total cost of new interventions is the sum of two cost factors - new intervention costs and current intervention cost reductions. There may be savings or costs associated with new interventions that are captured outside the health services industry and are not included here. Based on the assumptions laid out above, the estimated annual total costs to the federal government for new interventions associated with implementation of the nationwide health tracking network would be $100 million.

<u>(C1) New Intervention Costs</u>

Costs of implementing new policies or other interventions are included as new intervention costs (NIC). Costs of doing business in a new way are added to the cost equation. In the instance where new interventions are comparable to the current intervention (as when a standard is changed but the reporting and verification remains the same), new intervention costs are offset by the current intervention costs. For this study, we assume a new and significant intervention cost of $100 million.

<u>(C2) Reduction in Current Costs</u>

New interventions may supplant or reduce existing interventions, in part or in whole. Taking a conservative approach to developing estimates of costs and savings for this study, we assume no reduction in current federal government costs associated with interventions.

V. Summary

This study concludes that there will be a likely economic return on a federal government investment in a nationwide health tracking network. The return for every dollar invested is estimated to be $1.44. With the federal government's investment in a nationwide health tracking network of $275 million and development of programs and policies building on the information the network generates, the payback to the federal government alone in reduced health care costs is estimated to be over $1/2 billion. The return is based on mid-range values decided upon and made conservatively with the best knowledge available. We know that assuring the return on an investment will rely on several factors:

- a coordinated tracking effort which measures, reports, and evaluates;
- selection of the most effective interventions;
- using tracking information to target persons in need, to match an intervention with the level of need, and to ascertain the causative and protective factors that control the rate of disease and death; and
- making informed choices about interventions.

We have not calculated impacts on state and local government, private sector, or individual health care expenditures. However, it is reasonable to assume that they too will witness significant reductions in costs attributable to the nationwide health tracking network. States will save dollars in shared programs such as Medicaid. Localities will save dollars in direct health care services they provide. Business will benefit through reductions in direct health care costs paid for insurance or an employer funded health benefits pool. Individuals will benefit through reductions in direct health care costs and in improved quality of life. The benefit to industry and other sectors is not so certain, but if benefits to industry are similar to those associated with the Clean Air Act (benefits are projected to outweigh costs by 4 to 1 by 2010) the payback ratio to industry is also likely to be greater than one (EPA, 1999).

Many studies suggest that environment-related deaths and disease comprise between 1 and 6% of all poor health events. As we learn more about the relationship between the environment and poor health, we will clarify and strengthen the knowledge of the etiology of the diseases and the relevant health services. With existing knowledge, control and abatement of hazards and human exposure would avert thousands of deaths annually, as well as significant episodes of poor health, such as asthma attacks.

VI. Reference List

American Cancer Society. Costs of Cancer, 2001a.

American Cancer Society. Statistics, 2001b.

American Lung Association. Asthma in Adults, 1999a. Fact Sheet.

American Lung Association. Asthma in Children, 1999b.

American Lung Association. Chronic Obstructive Pulmonary Disease (COPD), 2000. Fact Sheet.

American Lung Association. Trends in Asthma Morbidity and Mortality, January, 2001.

Annest, JL et.al Chronological trend in blood lead levels between 1976 and 1980, New England Journal of Medicine, Vol. 308, No. 23, June 1983, 1373-1377.

Aunan K. Exposure-response functions for health effects of air pollutants based on epidemiological findings. Risk Analysis, 1996; 16:693-709.

Aunan K, Patzay G, Asbjorn AH, Martin SH. Health and environmental benefits from air pollution reductions in Hungary. Sci Total Environ, 1998; 212:245-268.

Brownson RC, Remington Pl, Davis JR. Chronic Disease Epidemiology and Control. Washington, D.C.; American Public Health Association, 1993.

Buffler PA, Kyle AD. Regulatory reform proposals and the public health. Environ.Health Perspect, 1996; 104:356-361.

Centers for Disease Control and Prevention. Mortality trends for selected smoking-related cancers and breast cancer -- United States, 1950-1990. Morbidity Mortality Weekly Report, 1993; 42:857-866.

Centers for Disease Control and Prevention. Behavioral Risk Factor Surveillance System. http://apps.nccd.cdc.gov/brfss/index.asp, last accessed 3-9-2001a.

Centers for Disease Control and Prevention. Epidemiology and Prevention of Vaccine-Preventable diseases. Atlanta, GA: Department of Health and Human Services, 2001b.

Coultas DB, Samet JM. Occupational lung cancer. Clin Chest Med, 1992; 13:341-354.

Davis DL, Bridbord K, Shneiderman M. Cancer prevention: assessing causes, exposures, and recent trends in mortality for U.S. males, 1968-1978. Int J Health Serv, 1983; 13:337-372.

Denman A, Phillips P. Reducing radon levels. Householders are not prepared to pay [letter; comment]. British Medical Journal, 1998; 317:1455-1456.

Dettenkofer M, Kummerer K, Schuster A, Muhlich M, Scherrer M, Daschner FD. Environmental auditing in hospitals: approach and implementation in an university hospital. J Hosp Infect, 1997; 36:17-22.

Doll R, Peto R. The causes of cancer: quantitative estimates of avoidable risks of cancer in the United States today. J Natl Cancer Inst, 1981; 66:1191-1308.

Dunnette DA. Assessing risks and preventing disease from environmental chemicals. J Community Health, 1989; 14:169-186.

Eddy DM. Clinical decision making: from theory to practice. Cost-effectiveness analysis. A conversation with my father. Journal of the American Medical Association, 1992; 267:1669-1675.

Environmental Protection Agency. Economic Analysis of Toxic Substances Control Act Section 403: Hazard Standards. Office of Pollution Prevention and Toxics, May 1998.

Environmental Protection Agency. The Clean Air Act: Protecting Our Health. Washington, D.C., 1999.

Gage-White L. Practical environmental modifications for the inhalant allergy patient. Otolaryngol. Clin North Am, 1998; 31:83-90.

Government Accounting Office. Long-term coordinated strategy needed to measure exposures in humans. GAO/HEHS-00-80 B-282172, 2000; 1-78.

Haddix AC, et.al. Prevention Effectiveness: A Guide to Decision Analysis and Economic Evaluation. NY, NY, Oxford University Press, 1996a.

Haddix AC, et.al,. Cost-effectiveness analysis. In: Prevention effectiveness: a guide to decision analysis and economic evaluation. New York; Oxford University Press, 1996b.

Hedemann-Jensen P, Yatsalo BI. Methodology for determining action levels for clean-up contaminated urban and agricultural environments. Health Phys., 1998; 75:120-129.

Heffler S, et.al. Health spending growth up in 1999; faster growth expected in the future. Health Affairs, March/April 2001, 20:193-203.

Henson RM, et.al. The national breast and cervical cancer early detection program: A comprehensive public health response to two major health issues for women. Journal of Public Health Management and Practice, Spring 1996, Vol. 2; No.2, 36-47.

Honeycutt D, Dunlap L, Chen H, al Homal G. The cost of developmental disabilities. Final Report, 1999. RTP, NC, Research Triangle Institute (Center for Economic Research). Task Order No. 021-09. RTI Project No. 6900-09.

Jorgensen SE, Halling-Sorensen B. Drugs in the environment [editorial]. Chemosphere, 2000; 40:691-699.

Klaucke DN, Buehler JW, Thacker SB, Parrish RG, Trowbridge FL, Berkelman RL, Surveillance Coordination Group. Guidelines for Evaluating Surveillance Systems. Morbidity and Mortality Weekly Report, 1988; 37:1-18.

Kunzli N, Kaiser R, Medina S, Studnicka M, Chanel O, Fillinger P, Puybonnieux-Texier V, Quenet P, Schneider J, Seethaler J-C, Sommer H. Public-health impact of outdoor and traffic-related air pollution: a European assessment. Lancet, 2000; 356:795-801.

Last J. The Dictionary of Epidemiology. New York, New York: Oxford University Press, 1983.

Levit K, Cowan C, Lazenby H, Sensenig A, McDonnell P, Stiller J, Martin A. Health spending in 1998: signals of change. The Health Accounts Team [see comments]. Health Affairs, 2000; 19:124-132.

Marcus M, Silbergeld E, Mattison D. A reproductive hazards research agenda for the 1990s. Research Needs Working Group. Environ Health Perspect, 1993: 101 Suppl 2:175-80.

Mary Woodard Lasker Charitable Trust (Funding First Initiative). Exceptional returns: The economic value of America's investment in medical research, 2000.

Mathers CD, Vos ET, Stevenson CE, Begg SJ. The Australian Burden of Disease Study: measuring the loss of health from diseases, injuries and risk factors [see comments]. Med J Aust, 2000; 19;172:592-596.

McGinnis JM, Foege WH. Actual causes of death in the United States. Journal of the American Medical Association, 1991; 270:2207-2212.

Michaud Catherine M, Murray CJL, Bloom BR. Burden of disease - Implications for future research. Journal of the American Medical Association, 2001; 285:535-539.

Mullooly JP, Bennett MD, Hornbrook MC, Barker WH, Williams, WW, Patriarca PA, and Rhodes PH. Influenza vaccination programs for elderly persons: Cost-effectiveness in a health maintenance organization. Annals of Internal Medicine, 1994; 121(12);947-52.

National Center for Health Statistics. Health United States 1996-97 and Injury Chartbook. Hyattsville, MD, 1997.

National Research Council (Committee on Developmental Toxicology BoESaT). Scientific Frontiers in Developmental Toxicology and Risk Assessment. Washington, D.C.: National Academy Press, 2000.

Office of Management and Budget. Report to Congress on the Costs and Benefits of Federal Regulations. Washington, D.C., 1999.

Office of Management and Budget. Report to Congress on the Costs and Benefits of Federal Regulations. Washington, D.C., 2000.

Ostro B, Chestnut L. Assessing the health benefits of reducing particulate matter air pollution in the United States. Environmental Research, 1998; 76:94-106.

Pew Environmental Health Commission. American's Environmental Health Gap: Why the Country Needs a Nationwide Health Tracking Network: Technical Report. Johns Hopkins School of Public Health, Baltimore, 2000.

Pirkel et.al. Exposure of the U.S. population to lead, 1991-1994. Environ Health Perspect. 1998, 106:745-750.

Qu J, Ehrhardt J. Dose and cost considerations for relocation after nuclear accidents. Health Phys, 1998; 75:130-135.

Rose G. Environmental health: problems and prospects. J.R.Coll.Physicians Lond, 1991; 25:48-52.

Schmahl D, Preussmann R, Berger MR. Causes of cancer --- an alternative view to Doll and Peto (1981). Klin Wochenschr, 1989; 67:1169-1173.

Schwartz J. Low-level lead exposure and children's IQ: A meta-analysis and search for a threshold. Environmental Research, 1994; 65:42-55.

Smith KR, Corvalan CF, Kjellstrom T. How much global ill health is attributable to environmental factors? Epidemiology, 1999; 10:573-584.

Tengs TO, Adams ME, Pliskin JS, Safran DG, Siegel JE, Weinstein MC, Graham JD. Five-hundred life-saving interventions and their cost-effectiveness. Risk Analysis, 1995; 15:369-390.

U.S.Preventive Services Task Force. Guide to Clinical Preventive Services. Alexandria, VA: International Medical Publishing, 1997.

Varley RC, Tarvid J, Chao DN. A reassessment of the cost-effectiveness of water and sanitation interventions in programmes for controlling childhood diarrhea. Bull World Health Organ, 1998; 76:617-631.

Ventura, et.al. Births final data for 1998. National Vital Statistics Reports, March 2000.

Vilnius D, Dandoy S. A priority rating system for public health programs. Public Health Reports, 1990; 105:463-470.

Vineis P. Environmental risks: scientific concepts and social perception. Theor Med, 1995; 16:153-169.

Zaza S, Lawrence RS, Mahan CS, Fullilove M, Fleming D, Isham GJ, Pappaioanou M. Scope and organization of the Guide to Community Preventive Services. The Task Force on Community Preventive Services. Am J Prev Med, 2000; 18:27-34.