An Ounce of Prevention

What are the returns?

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TABLE OF CONTENTS

Introduction

In 1996, the Centers for Disease Control and Prevention (CDC) celebrated its first half century of working to safeguard the nation's health. While specific health threats have changed over time, the fundamental challenge remains the same. CDC strives to improve the quality of people's lives by preventing disease, injury, and disability through collaboration with public and private partners throughout the world.

As the nation's prevention agency, CDC seeks not only to improve health, but to do so in economically responsible ways. In times of limited human and financial resources, public health efforts should focus on areas that yield the most benefit for our investment. Many prevention interventions, particularly at the community levels, are excellent strategies for promoting good health at a reasonable cost. A standardized approach to evaluating the economic impact of public health programs and policies is vital for obtaining comparable information.

Prevention effectiveness research provides a sound economic perspective for guiding public health decision making and resource allocation. Few things of benefit to society are either truly cost saving or free. For example, the maintenance of a national defense system costs billions of dollars; it is in place because the resulting security is deemed worth that cost. Similarly, public health should be held to the appropriate investment standard of reaping reasonable benefits as a result of the money expended.

All of the health interventions presented here contribute to people leading longer, healthier lives, and often result in considerable financial savings. Some childhood vaccines, for example, generate a savings of up to $29 in direct medical costs for every dollar spent. Other interventions, such as yearly mammograms, carry a net cost, but are still considered cost-effective because they provide reasonable value for the money invested.

For each prevention strategy in this publication, the following information is presented: the impact of the related disease, injury, or disability on U.S. society; the prevention strategies and their effectiveness; the costs incurred due to the disease, injury, or disability; and the cost-effectiveness of the intervention. While articles were selected based upon an extensive search and rigorous evaluation, the information presented here is limited by the methods, assumptions, and accuracy of the original research. The reader is referred to the Appendix for a description of the assumptions and variables of the articles citing cost-effectiveness data. Original publications should be consulted when a more thorough understanding is needed. Similarly, many of the studies cited were conducted in selected populations, and caution needs to be exercised in generalizing the findings. Clearly, continued research is essential to demonstrate the effectiveness and value of these and other public health strategies.

BICYCLE-RELATED HEAD INJURIES

Approximately 45% of American youth under the age of 20 ride bicycles (an estimated 33 million bicyclists). Each year, about 247 of these young cyclists are fatally injured, and more than 144,000 are treated at emergency departments for bicycle-related head injuries [1]. The risk of head injury is reduced by an estimated 74% to 85% by the use of bicycle helmets [2]. Counseling bicyclists and parents of children who ride bicycles about the importance of helmet use is recommended to reduce injuries and deaths caused by bicycle crashes [3]. Such counseling appears to have a positive effect on helmet use among children [4].

Bicycle crashes for all age groups have an annual economic cost of over $8 billion ($US 1991) [1]. A law passed in Maryland in 1990 requiring the use of a helmet for bicyclists under the age of 16 increased helmet usage from 4% to 47% at a cost of $36,643 per injury averted ($US 1992); a community-wide promotional program resulted in a cost of $37,732 per injury avoided [5].

BREAST CANCER

Breast cancer is the most common cancer diagnosed in women, and the second leading cause of death by cancer among women in the United States. Approximately 44,300 women will die from breast cancer this year, and 184,300 new cases will be diagnosed [6]. While definitive prevention of breast cancer is not possible, early detection of the disease greatly improves a woman's prognosis. In addition to monthly self-examination, routine screening for breast cancer every 1 to 2 years with mammography alone or mammography and annual clinical breast examination is recommended for women ages 50 to 69. Numerous studies confirm that such screening results in a reduction in breast cancer mortality of 20% to 30% [3].

In 1990, breast cancer generated $6.5 billion in medical care costs, more than any other cancer ($US 1993) [7]. Estimates of the cost of mammography screening range from $8,280 ($US 1993) to $134,000 ($US 1984) per year of life saved, depending on the screening strategy employed and the baseline used [7, 8]. A synthesis of the cost-effectiveness literature on mammography screening showed that, relative to annual clinical breast examination alone, annual mammography screening costs an estimated $36,000 per year of life saved ($US 1991) [9].

CERVICAL CANCER

Over 4,400 women will die from cervical cancer this year, and 15,700 new cases of cervical cancer will be diagnosed. Currently, a third of all women with cervical cancer die within 5 years after diagnosis. Early detection, however, increases the 5-year survival rate to 91% [10]. Routine screening for cervical cancer with Pap testing at least once every 3 years is recommended for women beginning with the onset of sexual activity [3]. Performing Pap tests every 3 years results in a reduction of cervical cancer by 90.8%. Only a slightly greater reduction of 93.5% results from annual screening [11]. Studies conducted in the United States, Canada, and Europe in the last several decades have found that mortality attributed to cervical cancer has been reduced 20% to 60% since the implementation of cervical cancer screening programs [3].

The costs for diagnosis, treatment, and follow-up associated with early stages of cervical cancer are $4,359, while the same costs for late, invasive cervical cancer are more than triple that amount, or $13,359 ($US 1988) [12]. Screening average-risk, asymptomatic women ages 20 to 75 every 3 years costs $13,346 per year of life gained. The cost of annual screening of the same population is $39,617 per year of life gained ($US 1988) [13].

CHILDHOOD INJURY

Injury is the leading cause of death and disability--as well as the leading cause of childhood medical spending--among America's children under the age of 20. An estimated 600,000 injured children are hospitalized, and about 12 million are treated in emergency departments every year [3, 14]. The major causes of injury for the nation's youth are motor vehicle crashes, fires, and falls. Primary care-based counseling for parents of young children about prevention of pediatric injury has been shown to reduce injuries [14].

The lifetime economic cost for injuries that occurred in the United States in 1985 has been estimated at $182 billion ($US 1988) [15]. The Injury Prevention Program (TIPP), developed by the American Academy of Pediatrics, consists of counseling by physicians to educate the parents of young children on child safety issues, such as fall prevention, burn prevention, and safety seat use in motor vehicles. At a cost of $69 per child for the program, TIPP saves $880 per child in future medical spending, work loss, and quality of life. If parents of all 19.2 million children ages 0 to 4 years in the United States were to complete TIPP, annual injury costs would decline by $3.4 billion. Net savings would be $230 million each year ($US 1992) [14].

CHILDHOOD LEAD POISONING

Elevated blood lead levels in children have been associated with lower IQs, increased behavioral problems, and a host of other health complications. Approximately one of every 23 U.S. children ages 1 to 5 has an elevated blood lead level (□10 µg/dl) associated with adverse health effects [16]. Population-wide prevention strategies are effective in reducing the incidence of lead poisoning. For example, the virtual elimination of lead from gasoline has reduced the blood lead levels of children ages 1 to 5 by more than 70% [17]. However, reducing the amount of leaded paint in residences and public buildings remains a public health priority. Today, an estimated 57 million residences in the United States still contain leaded paint; young children live in 3.8 million of those homes [18].

The long-term benefits of removing leaded paint from a home ("abating") far outweigh the short term financial costs. It is estimated that abating an average pre-1950 lead-painted home costs $2,225 and that the benefits over the lifetime of the home are $4,323. Thus, abatement of a home results in a net benefit of $2,098. If carried out today, abating all pre-1950, lead-painted homes would yield $48 billion in net benefits. If abatements were carried out over the next 20 years, the total net benefits would be $28 billion ($US 1989) [19].

CHILDHOOD VACCINE-PREVENTABLE DISEASES

Reported cases of childhood diseases that can be prevented by vaccination have decreased dramatically in the United States in the past century. Examples include:

Paralytic polio, virtually eliminated [20]
Diphtheria, virtually eliminated [21]
Measles, reduced by 99.97% [22]
Rubella, reduced by 99.75% [22]
Mumps, reduced by 99.45% [22]
Pertussis, reduced by 98.37% [21]
Tetanus, reduced by 97.82% [21]
Haemophilus influenzae type b disease, reduced by 98.65% [23]

Immunization against childhood diseases is one of the most cost-effective health interventions available. For example, the MMR (measles, mumps, and rubella) vaccine saves $10.30 in direct medical costs for every dollar invested [22], while the DTP (diphtheria, tetanus, and pertussis) vaccine saves $6.00 for every dollar invested [21].

A new vaccine for chickenpox (varicella zoster) has recently been recommended for use in this country. The typical costs of a case of chickenpox include approximately $16 in medications and $201 in work loss by parents. A routine vaccination program for healthy children would cost $4.20 per chickenpox case prevented, or $2,500 per life-year gained. When productivity losses are considered, a savings of $5.40 is realized for every $1.00 spent on the vaccination program. ($US 1990) [24].

COLORECTAL CANCER

Each year, an estimated 57,000 people will die from colorectal cancer, and approximately 133,500 new cases will be diagnosed. Colorectal cancer is the third leading cause of both cancer and cancer-related deaths in the United States [10]. Experts recommend that all persons ages 50 and older be screened annually with fecal occult blood testing (FOBT), or sigmoidoscopy, or both; these tests permit the detection of precancerous and cancerous polyps and lesions. Studies show a 31% to 57% reduction in cases of colon cancer among persons receiving FOBT, and a 33% to 43% reduction in deaths from the disease [3]. Studies indicate that combining FOBT with sigmoidoscopy is even more effective than FOBT alone in early detection and prevention of colorectal cancer [3].

The cost of treating a patient with colorectal cancer varies from $20,000 to $30,000, depending on the stage of the disease. In a 65-year-old U.S. population, an annual FOBT would cost $35,054 per year of life saved. Combining FOBT with sigmoidoscopy every 3 years would prevent more cancers at the higher cost of $42,900 per year of life gained ($US 1989) [25].

CORONARY HEART DISEASE

Coronary heart disease (CHD) is the leading cause of death in the United States, accounting for nearly 500,000 deaths annually. Experts recommend that physicians emphasize methods to prevent coronary heart disease, including counseling to promote physical activity and a healthy diet [3]. An estimated 35% of the excess CHD that occurs among sedentary individuals could be eliminated by increasing physical activity [26]. Reducing society's fat intake by 1% to 3% would reduce the overall incidence of CHD by 32,000 to 92,700 events, respectively, at a savings of $4.1 to $12.7 billion in medical costs and productivity losses over 10 years ($US 1993) [27].

The total direct medical care costs of coronary heart disease in 1997 ap_ estimated to be $47.5 billion [18]. Including lost productivity, CHD is expected to cost society $138.4 billion in 1997 [28]. One cost-effectiveness model showed that a regular exercise regimen would cost $3,433 per year of life gained, and $27,851 per year of life gained when the indirect costs of time expended for exercise are considered ($US 1995) [29].

DENTAL CARIES AND WATER FLUORIDATION

Approximately 39% of the population served by public drinking water, or 87.8 million people, do not have access to water with sufficient fluoride to prevent dental caries (cavities) [30]. Children who live in communities without fluoridated water are expected to have up to 40% more dental caries than children who live in communities with fluoridated water [18].

Of all persons receiving optimally fluoridated community drinking water, approximately 85% are served by water systems for which the annual per capita cost of fluoridation is $.12 to $.75 ($US 1988) [18]. The average cost of fluoridating drinking water for one individual's lifetime is $38.25. Every dollar spent on water fluoridation could result in a savings of $80 in treatment costs for dental caries among children ($US 1988) [31].

DIABETIC RETINOPATHY

Diabetes mellitus is the leading cause of blindness in adults ages5X0 to 74 and accounts for over 12,000 to 24,000 new cases of blindness each year (approximately 12% of all new cases) [32]. Early detection through screening and timely intervention with laser photocoagulation can reduce the incidence of severe vision loss by 50% to 90% [33].

Screening is highly cost-effective. The cost of providing currently suggested screening and treatment of diabetic retinopathy is $1,757 per person-year of sight saved, or $3,190 per quality adjusted life year saved [33].

INFLUENZA AMONG ELDERLY PERSONS

During each of nine different influenza epidemics from 1972 through 1991, 20,000 or more excess deaths have been reported. More than 90% of the deaths attributed to pneumonia and influenza in these epidemics occurred among persons ages 65 and older [34]. Annual influenza vaccine is recommended for all persons ages 65 and older and persons in selected high-risk groups [3].

It has been estimated that vaccination saved $117 in hospitalization costs per person vaccinated and reduced mortality from influenza and pneumonia, all acute and chronic respiratory conditions, and congestive heart failure by 39% to 54% during the 1990-1993 influenza seasons [35]. Other estimates indicate that vaccination costs Medicare $145 per year of life gained [36].

HIV/AIDS TRANSMISSION

Acquired immunodeficiency syndrome (AIDS) is the leading cause of death among men ages 25 to 44, and the fourth leading cause of death for women in the same age group [37, 38]. As of December 1996, 581,429 persons were reported diagnosed with AIDS [39]. An estimated 650,000 to 900,000 persons in the United States are infected with human immunodeficiency virus (HIV), and each year more than 60,000 persons have an AIDS opportunistic infection diagnosed [40]. Perinatal transmission results in 1,000 to 2,000 HIV-infected infants being born annually. If HIV is identified in asymptomatic persons, they can benefit from early treatment, and further transmission of the virus can potentially be prevented. Periodic screening and counseling is recommended for all people at high risk of infection, and for pregnant women with any risk of infection [3].

The lifetime cost of treating a person with HIV from the time of infection, through the development of AIDS, to death is estimated to be $119,000 ($US 1992) [41]. Annually, AIDS costs the United States an estimated $15.2 billion ($US 1991) [42]. In populations with high HIV rates, annual screening followed by medical treatment costs less than $11,000 per year of life gained ($US 1990) [43]. Programs that combine HIV counseling, testing, referral, and partner notification services yield benefits of $20 for every dollar invested ($US 1990) [44]. A voluntary counseling and testing program for pregnant women in conjunction with treatment of infected mothers with zidovudine (ZDV) would prevent 656 infant HIV infections each year, at an annual net savings of $38.1 million [45].

LOW BIRTH WEIGHT

Low birth weight is a principal cause of infant mortality and a leading cause of childhood illness [3]. In the United States in 1991, the low-birth-weight (<2,500 grams) rate was 13% among black babies and 5.8% among white babies [46]. Early and adequate prenatal care and proper nutrition during pregnancy can lower the risk of having a low-birth-weight infant [47].

In 1988, $4 billion of medical costs were incurred by low-birth-weight infants in the first year of life. This amounted to almost $15,000 additional cost for each of the 271,000 infants born weighing <2,500 grams [48]. If all U.S. women received adequate prenatal care, there would be an estimated savings of $14,755 for every low-birth-weight birth averted ($US 1984) [47]. A cost-benefit analysis showed that the U.S. Department of Agriculture Supplemental Nutrition Program for Women, Infants and Children (WIC), in conjunction with Medicaid benefits for the prevention of low-birth-weight infants born to women in poverty, can produce $2.91 in Medicaid savings for each dollar spent on WIC ($US 1988) [49].

NEURAL TUBE DEFECTS

One of every 1,000 pregnancies is affected by a neural tube defect (NTD), such as spina bifida and anencephaly [50]. NTDs are serious central nervous system birth defects that often result in death and cause lifelong disability in survivors. The Public Health Service has recommended that all women of childbearing age capable of becoming pregnant consume 400 micrograms of folic acid every day to reduce their risk of an NTD-affected pregnancy. It is estimated that at least 50% of all NTDs can be prevented with folic acid [51].

The cost to society of treating and caring for an individual affected by an NTD is approximately $181,000 ($US 1993), resulting in total annual cost to society of $709 million. Low level fortification of the food supply, as mandated by the Food and Drug Administration, will save $3,656 per quality-adjusted life year saved. Higher levels of fortification result in increasing cost savings [52].

PERINATAL HEPATITIS B

Each year 150,000 people in the United States become infected with hepatitis B virus (HBV). Infants and young children, who represent approximately 10% of these infections, are at highest risk of developing chronic infection [3, 53]. Annually, an estimated 20,000 births occur to HBV-infected women. Early detection in pregnant women can prevent infection in the newborn [3]. Thus, HBV screening is recommended for all pregnant women at their first prenatal visit. For infants born to HBV-infected mothers, vaccine in combination with a single dose of hepatitis B immune globulin (HBIG) given within 12 hours of birth is 75% to 95% efficacious in preventing chronic HBV infection, whereas vaccine alone has an efficacy of 65% to 96%. When these regimens have been directly compared, however, the combination of vaccine and HBIG vaccine was generally more effective [3].

For all children born in 1991, lifetime medical costs associated with HBV infection are estimated at $13.7 million for perinatal infections and $26.9 million for infant infections ($US 1993) [53]. At an annual cost of $12.6 million, a national program to prevent perinatal HBV infection would save 640 young lives each year at a cost of $4,803 per life saved. When both medical and work-loss costs are considered, the prevention program would save $41.8 million. ($US 1993) [53].

PNEUMOCOCCAL PNEUMONIA

Pneumococcal infections are a leading cause of morbidity and mortality in the United States. *Streptococcus pneumoniae* causes more than 500,000 cases of pneumonia, 55,000 cases of bacteremia, and 6,000 cases of meningitis annually, which result in 40,000 deaths [54]. Surveillance studies have reported annual invasive pneumococcal disease (e.g., septicemia, meningitis) rates of 15 to 30 per 100,000 people. Significantly higher rates are reported for persons 2 years of age or younger and ages 65 and older; blacks, Native Americans, and Alaska natives; nursing home residents; alcoholics; and those with underlying chronic medical or immunodeficient conditions. Elderly persons and patients with other life-threatening conditions are most likely to die from pneumococcal disease [3]. Pneumococcal vaccine is recommended for individuals ages 65 and older and for others at increased risk. The current vaccine is estimated to be 56% to 57% effective in preventing invasive pneumococcal disease [55, 56].

About 1 million persons are hospitalized with pneumonia annually, generating more than $4 billion in medical expenses ($US 1991). Pneumococcal pneumonia accounts for approximately 15% of those cases, costing more than $600 million per year [57]. Studies of the cost-effectiveness of the vaccine show a net savings per quality-adjusted life year of $141 ($US 1987) [58] to $613 ($US 1983) [59].

SEXUALLY TRANSMITTED DISEASE-RELATED INFERTILITY

In the United States, chlamydia infection is the most common of the bacterial sexually transmitted diseases, affecting an estimated 4 million people [3]. Approximately 75% of women and 50% of men who are infected have no symptoms of the disease and, thus, may go untreated. Of the approximately 2.6 million women with untreated infections, 20% to 40% develop pelvic inflammatory disease (PID). Of PID cases, approximately 20% will result in infertility and 9% in potentially fatal ectopic pregnancy [60]. Routine screening and treatment are recommended for sexually active female adolescents and other women at high risk for infection [3]. Chlamydia screening and treatment can reduce the incidence of PID by as much as 56% [61].

Chlamydia and its complications cost the United States approximately $2.1 billion each year [62]. Universal screening and treatment for chlamydia of women ages 15 to 20 in STD and family planning clinics with a 6.6% prevalence of chlamydia infection would save approximately $900 to $1,000 for each case of chlamydia successfully treated. ($US 1993) [63].

SICKLE CELL ANEMIA IN NEWBORNS

An estimated 50,000 Americans have sickle cell anemia, which results in a significant decrease in life expectancy [64]. Sickle cell disease affects persons in all racial and ethnic groups; however, African-Americans are at highest risk, with one in every 375 newborns affected compared with one in 3,000 Native Americans, one in 20,000 Hispanics, and one in 60,000 whites. The death rate for children with sickle cell disease peaks between 1 and 3 years of age, and death is chiefly due to sepsis caused by *Streptococcus pneumoniae*. Trials have shown that screening and treatment of infants and young children can reduce the incidence of pneumoccal septicemia and related deaths by up to 84%. Neonatal screening for sickle cell, followed by treatment to prevent sepsis, is recommended, particularly for those at high risk [3].

Among infants born in the United States, the cost of sickle cell disease is $2.44 million per year per 1 million black infants, and $1.71 million per year per 1 million nonblack infants in a low

prevalence population ($US 1987). A one-time screening of black infants and treatment of affected infants would cost between $3,100 and $206,000 per life saved. Screening in a low-prevalence population is dramatically more costly, at $450 billion per life saved ($US 1987) [65, 66].

SMOKING

Smoking is the leading cause of preventable death in the United States, causing an estimated 420,000 deaths each year. In 1994, 25.5% of U.S. adults (48 million adults) were smokers. Every day, 3,000 young people start to smoke regularly, and about one out of three will eventually die from their smoking. Clinical trials have demonstrated that certain forms of clinician and group counseling are effective in changing smoking behavior. An analysis of 39 clinical trials has shown an average 6% higher cessation rate after 1 year for those who received counseling compared with those who did not. Tobacco cessation counseling on a regular basis is recommended for all persons who use tobacco products [3].

In 1993, estimated medical care costs attributed to smoking totaled $50 billion [67]. A male smoker incurs approximately $11,000 more in medical care costs over his lifetime than a male who has never smoked; and a female smoker, approximately $13,000 more than a female nonsmoker ($US 1994) [68]. Given a 2.7% cessation rate, brief advice and counseling by a physician about quitting smoking costs from $705 to $988 per year of life saved for men and from $1,204 to $2,058 for women, depending on the patient's age ($US 1984) [69].

TUBERCULOSIS

A total of 21,327 new cases of tuberculosis (TB) were reported in the United States in 1996 [CDC provisional data]. Another 10 to 15 million people are latently infected with TB and at risk of developing clinically active TB. Persons also infected with HIV are more than 100 times as likely to develop active TB than are those with competent immune systems [3]. Screening for infection with tuberculin skin testing is recommended for asymptomatic, high-risk individuals [70]. Persons with a positive skin test should be evaluated for preventive therapy with isoniazid (INH). For high-risk individuals completing a 6-month or 1-year treatment with INH, the percentage of people who develop TB has been reduced by 69% and 93%, respectively [71].

The average cost of caring for a patient with TB is about $20,000 per year ($US 1992) [72]. Medical expenditures nationwide for TB in 1991 were estimated at $703.1 million ($US 1991) [73]. Among patients at a TB clinic, a 6-month program of screening and preventive therapy with INH costs $7,112 per case prevented ($US 1983) [74]. A program to prevent cases of TB by screening high-risk kindergartners and high school entrants, followed by treatment with INH, would save $1.20 for every $1.00 spent ($US 1993) [75].

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52. Kelly AE, Haddix AC, Scanlon KS, Helmick CG, Mulinare J. Worked example: cost-effectiveness of strategies to prevent neural tube defects. In Gold MR, Siegel JE, Russell LB, Weinstein MC, eds. Cost effectiveness in health and medicine, New York, NY: Oxford University Press; 1996:313-348.

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55. Butler JC, Breiman RF, Campbell JF, Lipman HB, Broome CV, Facklam RR. Polysaccharide pneumococcal vaccine efficacy: an evaluation of current recommendations. JAMA. 1993;270:1826-1831.

56. Shapiro ED, Clemens JD. A controlled evaluation of the protective efficacy of pneumococcal vaccine for patients at high risk of serious pneumococcal infections. Ann Intern Med. 1984;101:325-330.

57. Ortiz CR, LaForce FM. Prevention of community-acquired pneumonia. Med Clinics North Am. 1994;78:1173-1183.

58. Gable CB, Holzer SS, Engelhart L, Friedman RB, Smeltz F, Schroeder D, Baum K. Pneumococcal vaccine: efficacy and associated cost savings. JAMA. 1990;264:2910-2915.

59. Sisk JE, Riegelman RK. Cost effectiveness of vaccination against pneumococcal pneumonia: an update. Ann Intern Med. 1986;104:79-86.

60. Haddix AC, Hillis SD, Kassler WJ. The cost effectiveness of azithromycin for *Chlamydia trachomatis* infections in women. Sex Transm Dis. 1995;22:274-280.

61. Scholes D, Stergachis A, Heidrich FE, Andrilla H, Holmes KK, Stamm WE. Prevention of pelvic inflammatory disease by screening for cervical chlamydia infection. N Engl J Med. 1996;334:1362-1366.

62. Washington AE, Johnson RE, Sanders LL. *Chlamydia trachomatis* infections in the United States: what are they costing us? JAMA. 1987;257:2070-2072.

63. Marrazzo JM, Celum CL, Hillis SD, Fine D, DeLisle S, Handsfield HH. Performance and cost-effectiveness of selective screening criteria for *Chlamydia trachomatis* infection in women. Sex Transm Dis. 1997;24:131-141.

64. Agency for Health Care Policy & Research. Sickle Cell Disease: Screening, diagnosis, management, and counseling in newborns and infants. Clinical Practice Guideline no. 6. Rockville, Md: AHCPR; 1993. Publication no. 93-0562.

65. Tsevat J, Wong JB, Pauker SG, Steinberg MH. Neonatal screening for sickle cell disease: a cost-effectiveness analysis. J Pediatr. 1991;118:546-554.

66. Gessner BD, Teutsch SM, Shaffer PA. A cost-effectiveness evaluation of newborn hemoglobinopathies from the perspective of state health care systems. Early Hum Dev. 1996;45:257-275.

67. CDC. Medical-care expenditures attributable to cigarette smoking -- United States. MMWR. 1993;43:469 472.

68. Hodgson TA. Cigarette smoking and lifetime medical expenditures. Milbank Q. 1992;70:81-125.

69. Cummings SR, Rubin SM, Oster G. The cost-effectiveness of counseling smokers to quit. JAMA. 1984;261:75-79.

70. CDC. Screening for tuberculosis and tuberculosis infection in high-risk populations. MMWR. 1995;44(RR 11):19-34.

71. Thompson NJ. Efficacy of various durations of isoniazid preventive therapy for tuberculosis: five years of follow-up in the IUAT trial. Bull World Health Organ. 1982;60:555-564.

72. Shulkin DJ, Brennan PJ. The cost of caring for patients with tuberculosis: planning for a disease on the rise. Am J Infect Control. 1995;23:1-4.

73. Brown RE, Miller B, Taylor WR, et al. Health-care expenditure for tuberculosis in the United States. Arch Intern Med. 1995;155:1595-1600.

74. Snider DE, Caras GJ, Koplan JP. Preventive therapy with isoniazid. JAMA. 1986;255:1579-1583.

75. Mohle-Boetani JC, Miller B, Halpern M, Trivedi A, Lessler J, Solomon SL, Fenstersheib M. School-based screening for tuberculosis infection. JAMA. 1995;274:613-619.

APPENDIX

Below are the basic criteria used for the inclusion of specific cost-effectiveness studies. These criteria were derived from articles, textbooks, and expert opinion describing appropriate methods for cost-effectiveness analysis.†

Literature Inclusion Criteria

Articles were selected for inclusion based on the following criteria:

- Written in the English language
- Published after 1980
- Relevant to U.S. population-based interventions
- Results presented in U.S. dollars

Furthermore, articles were systematically reviewed based upon the guidelines below. Those articles most closely adhering to the preferred approach were selected.

(1) Effectiveness of intervention: The improvement in health outcome that a prevention strategy can produce. Preferred approach: the intervention is consistent with the *Guide to Clinical Preventive Services (GCPS)* ‡ recommendation.
(2) Health outcome measure: The unit of analysis used to compare costs. Preferred approach: the analysis includes a measurement of quality-adjusted life years (QALYs), life years gained, or deaths averted. Quality-adjusted life years incorporate the quality or desirability of a health state with the duration of survival. Discounted quality-adjusted life years are often used as the outcome measure in a cost-utility analysis.
(3) Target population: The population that has been recommended by the GCPS. The recommendations are grouped by age, sex, and other risk factors. Preferred approach: the analysis is consistent with the GCPS recommendation.
(4) Perspective: Determines which costs and benefits are included in the analysis. Preferred approach: the analysis provides a societal perspective, which includes all benefits of a program, regardless of who receives them, and all costs, regardless of who pays them.
(5) Cost-effectiveness analysis: An economic analysis in which all costs are related to a single, common effect. Preferred approach: the analysis presents an incremental cost-effectiveness analysis, in which strategies are ranked in order of effectiveness, and costs are presented in terms of the additional cost incurred by a strategy to produce an additional unit of the health outcome, as compared with the next most closely ranked strategy.
(6) Costs included: Costs associated with the incidence, treatment, and prevention of a disease, disability, or health outcome. Preferred approach: the analysis considers both direct costs, which include those resources expended for prevention activities or health care, such as costs of the prevention intervention and treatment costs averted, and indirect costs, which include the resources forgone by the participant due either to participating in an intervention or as the result of a health condition. All relevant costs should be specified per unit or per person.
(7) Analytic horizon: The time period over which the costs and benefits of health outcomes that occur as a result of the intervention are considered. Preferred approach: the analysis includes the time period in which the intervention will be implemented and the future costs and effects that accrue from the intervention over a lifetime.

† The criteria were derived in part from the *Prevention Effectiveness*: *A Guide to Decision Analysis and Economic Evaluation*, edited by Anne C. Haddix, et al, Oxford University Press, New York, New York, 1996; the *Guide to Clinical Preventive Services: Report of the U.S. Preventive Services Task Force*, 2nd ed. Baltimore: William & Wilkins, 1996; ``Five-Hundred Life-Saving Interventions and Their Cost-Effectiveness´´ (1995), an article by Tammy O. Tengs, et al, in *Risk Analysis*, Vol 15, No. 3 ; and *Cost-Effectiveness in Health and Medicine*, edited by MR Gold, et al, Oxford University Press, NY, NY 1996.

‡ The *Guide to Clinical Preventive Services* is an updated and expanded version of the 1989 report of the U.S. Preventive Services Task Force. This Guide serves as a reference source on the efficacy of clinical preventive services--screening tests for early detection of disease, immunizations to prevent infections, and counseling for risk reduction.

(8) Discount rate: The rate at which future costs and benefits are discounted to account for time preference. Preferred approach: the analysis discounts future costs and health outcomes at 3% or 5%, where applicable.
(9) Sensitivity analysis: Mathematical calculations that isolate factors involved in decision analysis or economic analysis to indicate the degree of influence each factor has on the outcome of the entire analysis. Preferred approach: the analysis provides univariate and multivariate sensitivity analyses on all important variables.

Limitations

The literature review of cost-effectiveness analyses under our set criteria suggests that the existing literature does not adhere well to basic analytic guidelines. The accuracy of the information presented in this document is limited to the accuracy of data and assumptions in the original analysis. The lack of clearly defined assumptions compromises the scientific integrity of a study and severely limits the comparison of results. The cost-effectiveness analyses examined in this literature review are based upon a wide variety of assumptions and contain data of inconsistent quality. As a result, duplication of results and/or comparison of the costs per health outcome of one intervention to another are problematic.

Below is a brief description of the assumptions and variables (described in the Literature Inclusion Criteria) under which the best cost estimate was made for each clinical prevention strategy.

Bicycle-Related Head Injuries

5. Hatziandreu EJ, Sacks JJ, Brown R, Taylor WR, Rosenberg ML, Graham JD. The cost-effectiveness of three programs to increase use of bicycle helmets among children. Public Health Rep. 1995;110:251-259.

Program effectiveness: not specified (provides number of cases prevented for each strategy) • health outcome: costs for bicycle-related head injuries prevented (legislative approach, community approach, and school-based approach are compared to no intervention) • target population: children ages 5 to 16 years • societal perspective • cost-effectiveness analysis • costs included: direct costs only, including program costs (costs for helmets, start-up and maintenance costs), and cost of illness averted (costs due to injury) • analytic horizon: 4 years • 5% discount rate • $US 1992 • sensitivity analysis on all important variables.

Breast Cancer

7. Kattlove H, Liberati A, Keeler E, Brook RH. Benefits and costs of screening and treatment for early breast cancer. JAMA. 1995;273:142-148.

Screening effectiveness: 30% reduction in breast cancer mortality; sensitivity and specificity of mammography is 92% and 94%, respectively • health outcome: charge per life saved and charge per year of life gained (screening strategy compared with no screening) • target population: women 50 to 69 years old in a hypothetical health care organization of 500,000 • health care system perspective • cost-effectiveness analysis • costs included: direct costs only, including program costs ($88.50 for a mammography) and cost of illness averted (cost of treatment for breast cancer and follow-up) • analytic horizon: 5 years • discount rate not available • $US 1993 • no sensitivity analysis.

8. Eddy DM. Screening for breast cancer. Ann Int Med. 1989;111:389-399.

Screening effectiveness: 24% to 30% reduction in breast cancer mortality for the Health Insurance Plan Study and 57% to 60% for the Breast Cancer Detection Demonstration Project study; sensitivity and specificity of mammography is 50% and 98 99%, respectively • health outcome: incremental cost per year of life gained (screening strategy compared with no screening and/or breast physical examination) • target population: women between the ages of 55 and 75 years old • societal perspective • incremental cost-effectiveness analysis • costs included: direct costs only, including program costs ($75 for a mammography and $25 for a breast physical examination) and cost of illness averted (cost of treating different stages of breast cancer) • analytic horizon: lifetime • 5% discount rate • $US 1984 • sensitivity analysis on all variables.

9. White E, Urban N, Taylor V. Mammography utilization, public health impact, and cost-effectiveness in the United States. Annu Rev Public Health. 1993;14:605-633.

Screening effectiveness: from BCDDP trials • health outcome: cost per year of life saved • target population: women over age 50 • societal perspective • incremental cost-effectiveness analysis of mammography, when added to clinical breast exam alone • costs included: direct costs only, including screening costs and costs of false-positives, and costs of illness averted • analytic horizon: not specified • 5% discount rate • $US 1991 • sensitivity analyses -- meta-analysis.

Cervical Cancer

13. Eddy D. Screening for cervical cancer. Ann Int Med. 1990;113:214-226.

Screening effectiveness: 93.5% reduction in cumulative rate of invasive cervical cancer for an annual screening, 92.5% reduction for screening every 2 years, and 90% reduction for screening every 3 years • health outcome: incremental cost per year of life gained (screening strategy compared with no screening, with screening every 4 years, every 3 years, and every 2 years) • target population: an average-risk asymptomatic 20-year-old woman • health care system perspective • incremental cost-effectiveness analysis • costs included: direct costs only, including program costs ($76 for Pap and $150 for a false-positive) and cost of illness averted (cost of lesions and costs for terminal care) • analytic horizon: from age 20 to age 74 • 5% discount rate • $US 1988 • sensitivity analysis on all variables.

Childhood Injury

14. Miller TR, Galbraith M. Injury prevention counseling by pediatricians: a benefit-cost comparison. Pediatrics. 1995;96:1-4.

Counseling effectiveness: 12% in reducing motor vehicle injuries, 33% in reducing burns, and 54.7% in reducing falls • health outcome: savings per child following The Injury Prevention Program (TIPP) (compared to no program) • target population: children ages 0 to 4 • societal perspective • cost-benefit analysis • costs included: direct costs that include program costs (pediatric well-care visit at $50 and written material for TIPP at $1.09) and medical care spending averted on motor vehicle injuries, burns and falls, and indirect costs (productivity losses) • analytic horizon: ages 0 to 4 years • 2.5% discount rate • $US 1992 • sensitivity analysis on most measures.

Childhood Lead Poisoning

19. CDC. Strategic plan for elimination of childhood lead poisoning. Atlanta, Ga: CDC; 1991: QU 292 s898 c.2, 10 - 25.

Screening effectiveness: each 1 µg/dL change in blood lead level results in a 0.25 point change in IQ; Abatement of homes effectiveness: a decrease of 25% in a child's blood lead level • health

outcome: net present costs avoided through preventing lead poisoning; net present costs of abatement of lead-based homes of children • target population: children with blood lead levels greater than 25 µg/dL; average pre-1950 lead-painted home • societal perspective • cost-benefit analysis • costs included: direct costs, including screening and treatment costs, costs of abatement of homes and costs averted for special education and medical care, and indirect costs (productivity losses) • analytic horizon: one-time; 20 years • 5% discount rate • $US 1989 • sensitivity analysis on some variables.

Childhood Vaccine-Preventable Diseases

21. Hatziandreu EJ, Palmer CS, Brown RE, Halpern MT. A cost benefit analysis of the diphtheria-tetanus-pertussis (DPT) vaccine. Battelle Medical Technology Assessment and Policy (MEDTAP) Research Program, CPHRE; 1994:ii - 46.

Vaccine effectiveness: 99% reduction in diphtheria cases and deaths, 90% reduction in tetanus cases and 92% reduction in deaths, 98% reduction in pertussis cases and 97% reduction in deaths • health outcome: benefits, risks, and costs of a DPT vaccination program compared with the absence of a vaccination program • target population: 1992 U.S. birth cohort (4.1 million) • societal perspective • cost-benefit analysis • costs included: direct costs that include vaccine dose and administration costs ($20.69 with excise tax, $16.11 without excise tax), costs for adverse reactions, and cost of illness averted; and indirect costs (human capital value of $5 million and productivity losses) • analytic horizon: from birth to 15 years • 3% discount rate • $US 1992 • sensitivity analysis on all important variables.

22. Hatziandreu EJ, Brown RE, Halpern MT. A cost benefit analysis of the measles-mumps-rubella (MMR) vaccine. Battelle Medical Technology Assessment and Policy Research Program, CPHRE; 1994:ii-69.

Vaccine effectiveness: 90% case reduction in MMR cases • health outcome: benefits, risks, and costs of a measles, mumps, and rubella vaccination program compared with the absence of a vaccination program • target population: 1992 U.S. birth cohort (4.1 million) • societal perspective • cost-benefit analysis • costs included: direct costs that include vaccination program costs ($15.33 for vaccine, $10.34 for vaccine administration and other costs) and cost of illness averted, and indirect costs (human capital value of $5 million and productivity losses) • analytic horizon: from birth to 40 years • 3% discount rate • $US 1992 • sensitivity analysis on all variables.

24. Lieu TA, Cochi SL, Black SB, et al. Cost effectiveness of a routine varicella vaccination program for U.S. children. JAMA. 1994;271:375-381.

Vaccine effectiveness: 94% reduction in future chickenpox cases • health outcome: cost per case prevented, cost per life-year saved and benefit-cost ratio (one-time vaccination versus no vaccination) • target population: children under age 6 • health care system perspective and a societal perspective for the cost-benefit ratio • cost-effectiveness analysis and cost-benefit analysis • costs included: health care system perspective--direct costs only, including program costs ($35 for vaccine and $5 to $10 for administration) and cost of illness averted (medication and hospitalization); societal perspective--includes some direct costs and indirect costs (parent work loss, sick adult work loss, and productivity loss due to death) • analytic horizon: 30 years • 5% discount rate • $US 1990 • sensitivity analysis on all variables.

Colorectal Cancer

25. Wagner JL, Herdman RC, Wadhwa S. Cost-effectiveness of colorectal cancer screening in the elderly. Ann Int Med. 1991;115:807-917.

Screening effectiveness: not specified • health outcome: cost per year of life gained (annual FOBT plus sigmoidoscopy every 3 years, every 5 years, and/or on entry to Medicare; and annual FOBT, only) • target population: persons 65 to 85 years of age, 1989 U.S. 65-year-old cohort of 2.1 million • health care system perspective • cost-effectiveness analysis • costs included: direct costs only, including program costs ($3.58 for FOBT, $98 for sigmoidoscopy, $411 for diagnostic colonoscopy, $653 for colonoscopy with polypectomy and $51 for pathology) and cost of illness averted (treatment of early cancer, complications and late cancer) • analytic horizon: lifetime • 5% discount rate • $US 1989 • sensitivity analysis on some variables.

Coronary Heart Disease

27 . Oster G, Thompson D. Estimated effects of reducing dietary saturated fat intake on the incidence and costs of coronary heart disease in the United States. J Am Diet Assoc. 1996;96:127-131.

Effectiveness of reducing fat intake by 1% to 3%: declines in incidence of CHD of 32,000 to 99,700 events, respectively • health outcome: cost of CHD • target population: men and women, ages 35 to 69 • societal perspective • cost of illness analysis • costs included: direct and indirect costs of disease • analytic horizon: lifetime • 5% discount rate • $US 1993 • sensitivity analysis performed on all important variables.

29. Hatziandru EI, Koplan JP, Weinstein MC, Caspersen CJ, Warner KE. A cost-effectiveness analysis of exercise as a health promotion activity. Am J Public Health. 1988;78:1471-1421.

Program effectiveness: 50% reduction in coronary heart disease from exercise consuming 2,000 kcal per week • health outcome: costs per year of life gained (compared to no regular exercise regimen) • target population: 1,000 35-year-old men • societal perspective • cost-effectiveness analysis • costs included: direct costs that include program costs ($75 for physician visit and $100 for exercise) and cost of illness averted (total of $1.4 million) and indirect costs (value of time and productivity loss due to exercise and injury) • analytic horizon: 30 years • 3% discount rate • $US 1985 • sensitivity on all important variables.

Dental Caries and Water Fluoridation

31. CDC. Public health focus: fluoridation of community water systems. MMWR. 1992;41:372.

Effectiveness: assumes that one dental cary is prevented for every one year of fluoride use • health outcome: costs of fluoride versus no fluoride • target population: general public • individual perspective • cost comparison • costs included: national average cost per restoration ($40) and a mean national weighted cost to fluoridate drinking water ($.51/person) • analytic horizon: lifetime (75 years) • no discounting • $US 1988 • no sensitivity analysis.

Diabetic Retinopathy

33. Javitt JC, Aiello LP. Cost-effectiveness of detecting and treating diabetic retinopathy. Ann Int Med. 1996;124:164-169.

Screening effectiveness: 60% to 90% reduction in progression to blindness from proliferative retinopathy; sensitivity and specificity of dilated ophthalmoscopy is 80% and 97%, respectively • health outcome: QALYs gained and person-years of sight saved • target population: Americans with insulin dependent and noninsulin dependent diabetes mellitus (DM) • health care system perspective • cost-effectiveness and cost-utility analyses • costs included: direct costs only, including program costs ($62 per dilated fundus screening examination and $1,980 for photocoagulation treatment of both eyes including fluorescein angiograms) and cost of illness averted ($14,296 and $32 annual cost to U.S. government per DM patient younger than 65 and 65 or older, respectively) • analytic horizon: lifetime • 5% discount rate • $US 1990 • sensitivity analysis on QALYs.

Influenza Among Elderly Persons

35. Nichol KL, Margolis KL, Wuorenma J, Von Sternberg T. The efficacy and cost effectiveness of vaccination against influenza among elderly persons living in the community. N Engl J of Med. 1994;331:778-84.

Vaccine effectiveness: 48% to 57% fewer hospitalizations for pneumonia and influenza, 39% to 54% reduction in mortality • health outcome: annual costs per person vaccinated (compared to an unvaccinated person) • target population: persons 65 years of age or older • societal perspective • cost-effectiveness analysis • costs included: direct costs only, including costs of hospitalization and costs of vaccination program • analytic horizon: 1 year • discount rate not applicable • $US 1990-1993 • no sensitivity analysis.

36. CDC. Final results: Medicare influenza vaccine demonstration -- selected states, 1988-1992. MMWR. 1993;42:601-604.

Vaccine effectiveness: 40% reduction in pneumonia hospitalizations and deaths for mild and severe years • health outcome: cost per year of life gained • target population: persons aged >65 years • societal perspective • cost-effectiveness and cost benefit analysis • costs included: direct costs only, including vaccine and administration costs ($0.80 and $1.15, respectively) and cost of illness averted ($5,308 per pneumonia and influenza admission) • analytic horizon: 10 years • discount rate not specified • $US 1990 • sensitivity analysis on vaccine effectiveness.

HIV/AIDS Transmission

43. McCarthy BD, Wong JB, Munoz A, Sonnenberg FA. Who should be screened for HIV infection? A cost effectiveness analysis. Arch Intern Med. 1993;153:1107-1116.

Screening effectiveness: 50% reduction in the rate of development of initial and recurrent episodes of *Pneumocystis carinii* pneumonia • health outcome: incremental cost per life year gained (a comparison of screening and treatment strategy for infected persons who have or who develop low CD4+ (T4) cell counts vs. no screening) • target population: high risk groups (e.g. intravenous drug users) • societal perspective • incremental cost-effectiveness analysis • costs included: direct costs only, including screening costs ($67 for seronegative person and $116 for seropositive person) and follow-up care for various levels of T4 cell count (ranges from $258 to $4,000) • analytic horizon: life-time • 5% discount rate • $US 1990 • sensitivity analysis on all important variables.

44. Holtgrave DR, Valdiserri RO, Gerber AR, Hinman AR. Human immunodeficiency virus counseling, referral, and partner notification services. Arch Intern Med. 1993;153:1225-1230.

Program effectiveness: 20% to 50% of those persons testing HIV positive reduce risky behavior preventing at least one other infection • health outcome: costs and benefits of counseling,

testing, referral, and partner notification services compared to no intervention • target population: the general public and high risk groups • societal perspective • cost-benefit analysis • costs included: direct and indirect costs combined (program costs, ancillary costs, treatment costs averted and productivity losses) • analytic horizon: lifetime • 6% discount rate • $US 1990 • sensitivity analysis on all important variables.

45. Gorsky RD, Straus WL, Caldwell B, et al. Preventing perinatal human immunodeficiency virus (HIV) transmission: costs and effectiveness of a recommended intervention. Public Health Rep. 1996;111:335-8.

Treatment effectiveness: 50% reduction in HIV transmission by ZDV treatment • health outcome: lifetime cost-savings from newborn infections prevented (voluntary counseling and testing of pregnant women and treatment of infected mothers versus no intervention) • target population: pregnant women and infants • health care system perspective • costs included: direct costs only, including program costs (counseling and testing and ZDV treatment costs) and cost of illness averted (HIV and AIDS-related) • analytic horizon: lifetime • 5% discount rate • $US 1994 • sensitivity analysis on all important variables.

Low Birth Weight

47. Gorsky RD, Colby JP. The cost-effectiveness of prenatal care in reducing low birth weight in New Hampshire. Health Serv Res. 1989;24:583-599.

Screening effectiveness: not specified • health outcome: low-birth-weight cost savings associated with additional prenatal care • target population: New Hampshire births from 1981 to 1984 • health care system perspective • incremental cost-benefit analysis • costs included: direct costs only, including costs of prenatal care and morbidity care for comparison of adequate, intermediate, and inadequate prenatal care • analytic horizon: 4 years • discount rate not applicable • $US 1984 • no sensitivity analysis.

49. Buescher PA, Larson LC, Nelson MD, Lenihan AJ. Prenatal WIC participation can reduce low birth weight and newborn medical costs: a cost-benefit analysis of WIC participation in North Carolina. J Am Diet Assoc. 1993;93:163-166.

Program effectiveness: 22% to 31% reduction in low-birth-weight babies < 2,500 grams, and 44% to 57% reduction in low-birth-weight babies < 1,500 grams • health outcome: costs and benefits of WIC participation versus non-participation within a group of Medicaid-births • target population: live births in North Carolina in 1988 • societal perspective • cost-benefit analysis • costs included: direct costs only, including hospitalization costs (from Medicaid claims) and WIC program costs • analytic horizon: from birth to 60 days (for hospitalization costs) • discount rate not applicable • $US 1988 • no sensitivity analysis.

Neural Tube Defects

52. Kelly AE, Haddix AC, Scanlon KS, Helmick CG, Mulinare J. Worked example: cost-effectiveness of strategies to prevent neural tube defects. In Gold MR, Siegel JE, Russell LB, Weinstein MC, eds. Cost effectiveness in health and medicine, New York, NY: Oxford University Press; 1996:313-348.

Screening effectiveness: women consuming 0.4 mg of folic acid experience a 50% reduction in risk for an NTD-affected pregnancy • health outcome: incremental cost per QALY (food fortification compared to "no program") • target population: all women in the U.S. capable of becoming pregnant • societal perspective • incremental cost-effectiveness analysis • costs included: direct costs only that include program costs of fortification ($4.5 million for label changes; $2.5 million for analytic testing; $2 million for fortification) and cost of illness averted (cost of prenatal care, termination, anencephaly, spina bifida, care giver, and neurologic complications) • analytic horizon: lifetime • 3% discount rate • $US 1993 • univariate and multivariate sensitivity analyses on all important variables.

Perinatal Hepatitis B

53. Margolis HS, Coleman PJ, Brown RE, Mast EE, Sheingold SH, Arevalo JA. Prevention of hepatitis B virus transmission by immunization. JAMA. 1995;274:1201-1208.

Screening effectiveness: 69% program efficacy in preventing perinatal HBV cases, 68% in preventing infant HBV, and 42% to 45% in preventing adolescent HBV • health outcome: cost per chronic infection prevented, cost per death prevented, and cost per year of life saved (prevention of perinatal HBV infection, routine infant vaccination, and routine adolescent vaccination versus no intervention) • target population: prenatal infections, infants, and adolescents • societal perspective • cost-effectiveness analysis • costs included: direct costs that include program costs of vaccinating for each strategy and cost of illness averted (cost of HBV, cirrhosis, and primary hepatocellular carcinoma), and indirect costs (productivity losses) • analytic horizon: 0 to 13 years • 5% discount rate • $US 1993 • sensitivity analysis on all variables.

Pneumococcal Pneumonia

58. Gable CB, Holzer SS, Engelhart L, Friedman RB, Smeltz F, Schroeder D, Baum K. Pneumococcal vaccine: efficacy and associated cost savings. JAMA. 1990;264:2910-2915.

Vaccine effectiveness: 69% reduction in pneumococcal pneumonia cases • health outcome: cost savings (costs compared in vaccinated and unvaccinated groups) • target population: age 50 years and older • health care system perspective • cost-benefit analysis • costs included: direct costs only, including program costs ($18.53 for total cost of vaccine) and cost of illness averted (outpatient and inpatient costs per case) • analytic horizon: 1 year • discount rate not applicable • $US 1987 • sensitivity analysis limited.

59. Sisk JE, Riegelman RK. Cost effectiveness of vaccination against pneumococcal pneumonia: an update. Ann Intern Med. 1986;104:79-86.

Vaccine effectiveness: 60% reduction in pneumococcal pneumonia cases • health outcome: net savings per QALY (23-valent vaccine versus no vaccination) • target population: age 65 and older • health care system perspective • cost-effectiveness analysis • costs included: direct costs only, including program costs ($14.65 for vaccination and $3.80 for public provision of vaccine) and cost of illness averted • analytic horizon: 8 years • 5% discount rate • $US 1983 • sensitivity analysis limited.

Sexually Transmitted Disease-Related Infertility

63. Marrazzo JM, Celum CL, Hillis SD, Fine D, DeLisle S, Handsfield HH. Performance and cost-effectiveness of selective screening criteria for *Chlamydia trachomatis* infection in women. Sex Transm Dis. 1997;24:131-141.

Screening effectiveness: sensitivity of 75% for direct fluorescent antibody test; 25% probability of all PID arising from untreated *Chlamydia trachomatis* infection • health outcome: incremental cost per case of chlamydia infection prevented (a comparison of selective screening and universal screening to no screening) • target population: women ages 15 to 20 attending family planning and STD clinics • societal perspective • cost-effectiveness analysis • costs included: direct costs only, including program costs ($5 per test) and cost of illness averted (costs of PID and its sequelae) • analytic horizon: 10 years • 5% discount rate • $US 1993 • sensitivity analysis on all important variables.

Sickle Cell Anemia in Newborns

65. Tsevat J, Wong JB, Pauker SG, Steinberg MH. Neonatal screening for sickle cell disease: a cost-effectiveness analysis. J Pediatr. 1991;118:546-554.

Treatment effectiveness: 84% reduction in pneumococcal sepsis using penicillin prophylaxis • health outcome: incremental cost per year of life saved (screening and then treating for hemoglobin S genes versus no screening) • target population: black infants, non-black infants with relatively low or high prevalence rates of hemoglobin S genes • health care system perspective • incremental cost-effectiveness analysis • costs included: direct costs only, including program costs ($0.64 for screening battery, $0.42 for consumable supplies, and $0.42 for technician time) and cost of illness averted ($1,600 for hospitalization for sepsis and other costs) • analytic horizon: at least 3 years • 5% discount rate • $US 1987 • sensitivity analysis on all important variables.

66. Gessner BD, Teutsch SM, Shaffer PA. A cost-effectiveness evaluation of newborn hemoglobinopathies from the perspective of state health care systems. Early Hum Dev. 1996;45:257-275.

Screening effectiveness: prevents 50% of sickle cell disease deaths • target population: newborns in Alaska (1995 cohort) • health care system perspective • incremental cost-effectiveness analysis • costs included: direct costs only, including program costs (annual program cost of $47,803 per 100 abnormal tests) and cost of illness averted (hospitalization for sepsis and meningitis, treatment, educational costs, home care, and mental retardation care costs) • analytic horizon: 1.75 years • 5% discount rate • $US 1993 • sensitivity analysis on all important variables.

Smoking

69. Cummings SR, Rubin SM, Oster G. The cost-effectiveness of counseling smokers to quit. JAMA. 1984;261:75-79.

Counseling effectiveness: 2.7% increase in cessation rate • health outcome: cost per year of life saved • target population: men and women, ages 35 to 69 • societal perspective • cost-effectiveness analysis • costs included: program costs only • analytic horizon: not specified • 5% discount rate • $US 1984 • sensitivity analyses performed on all important variables.

Tuberculosis

74. Snider DE, Caras GJ, Koplan JP. Preventive therapy with isoniazid. JAMA. 1986;255:1579-1583.

Treatment effectiveness: 75% reduction in tuberculosis cases using isoniazid for treatment • health outcome: cost per case prevented and cost per quality-adjusted life year gained (a comparison of treatment program to no program) • target population: clinic patients with tuberculosis • health care system perspective • cost-utility analysis • costs included: direct costs only, including program costs (isoniazid costs) and costs of illness averted • analytic horizon: 20 years • 5% discount rate • $US 1983 • sensitivity analysis on all variables.

75. Mohle-Boetani JC, Miller B, Halpern M, Trivedi A, Lessler J, Solomon SL, Fenstersheib M. School-based screening for tuberculosis infection. JAMA. 1995;274:613-619.

Screening effectiveness: 70% reduction in tuberculosis cases using isoniazid for treatment • health outcome: benefit/cost ratio (targeted screening and screen-all strategies compared to no screening) • target population: kindergartners and high school students in a large urban and rural county • health care system perspective • cost-benefit analysis and cost-effectiveness analysis • costs included: direct costs only, including program costs ($166.85 for screening, chest/radiograph, and prevention therapy) and cost of illness averted ($16,319 for treatment of tuberculosis) • analytic horizon: 5 years • 3% discount rate • $US 1993 • sensitivity analysis on all variables.