Appendix E.—Values Assigned to Selected Variables

This appendix describes the sources of data, methods, and assumptions that OTA used to assign values to the following variables in its analysis of the cost effectiveness of influenza vaccination: 1) vaccination cost, 2) vaccine effectiveness rate, 3) duration of vaccine-induced immunity, 4) vaccine side effects and their treatment costs, s) hospitalization related to influenza, *6)* ambulatory care related to influenza, 7) excess mortality related to influenza, *8)* the cost of treating illnesses in extended years of life, 9) medicare expenditures, 10) work loss, 11) values assigned to selected characteristics of the influenza high-risk population, and 12) the discount rate.

Vaccination Cost

Base Case: Adult: $6.00 Child: $11.09
Sensitivity Analysis: Adult: $155 to $9.39
Child: $4.50 to $19.60

There are two components to vaccination cost—purchase price of the vaccine and the cost of administering the vaccine. Both components can vary substantially each year. The price of the vaccine is determined by such factors as these:

- manufacturers' production and distribution costs;
- manufacturers' desired profit margin;
- level of competition among manufacturers;
- number of doses being purchased (purchasers of large quantities usually pay a lower price per dose);
- type of vaccine (whole virus v. split product; monovalent v. polyvalent);
- type of purchases—public v. private;
- number of doses administered per person (children and young adults in some years require two doses per season; adults usually require one dose);
- type and size of product container purchased (e.g., prefilled syringes v. multiple-disc vial); and
- the "returned goods" policy of manufacturers (i.e., a manufacturer's willingness to purchase back unused portions of vaccine).

Factors that affect the cost (or the price) of administering the vaccine include these:

. number of doses administered per person;

- type of place or person administering the vaccine (e.g., private physician's office v. public health clinic);
- geographical location of vaccination; and
- type of vaccination procedure used (e. g., "jet" gun v. syringe and needle).

The estimates of influenza vaccination costs in OTA's study were based on the following data and observations. **First, data on vaccine selling prices were obtained from an OTA survey of selected vaccine manufacturers.** Overall, selling prices for the whole virus influenza vaccine—when purchased in lo-dose (5CC) vials—ranged from $0.45 to around $1.70/dose over the period from 1977 through 1980. The cost of split virus vaccine most often was higher than that of whole virus and ranged from about $1 to $2/dose. Whole virus vaccine sold in prefilled syringes from one company ranged from about $1.65/dose to approximately $2.00/dose in 1978-79.

Second, the vaccine purchase prices paid during the years 1977-78 through 1980-81 were obtained from selected public and private vaccine purchasers (see table E-1). The purchase price of influenza vaccine varied substantially from year to year (e.g., a private sector purchaser experienced a 50-percent increase in 2 years). Further, in all years, public sector purchasers commanded a lower price than private sector purchasers. In **1979-80,** the Federal Government through the Centers for Disease Control (CDC) negotiated with manufacturers a purchase price that applied to all State government vaccine consumption. In that year, public sector purchasers bought a dose of whole virus vaccine for *$0.29,* while some private sector purchasers paid $1.07. In 1980-81, CDC did not negotiate a uniform purchase price, but some State health departments are paying a price up to **20** percent lower than some private sector purchasers.

Third, the cost incurred or the price charged for administering influenza vaccine was solicited from selected private and public sector sources. The six public health clinics surveyed do not charge a fee for administering the vaccine. Some, however, are contemplating charging $1 to $2 per person. On the basis of data generated from the **1976** swine influenza program, Tolsma and Millar estimated that vaccine was administered in that program for about $1/dose, exclusive of the cost of vaccine **(122).** The use of "jet gun" vaccine administration undoubtedly contributed to low vaccine costs. Updated for inflation, that $1.00 cost would be $1.25 in 1978,

In the private sector, surveyed clinics charged $3.00 to $8.00 to administer the vaccine. In some

Table E-1.—Price per Dose of Influenza Vaccines Paid by Selected Purchasers, 1977-78 Through 1980.81

Purchaser and type of vaccine	1977-78	1978-79	1979-80[a]	1980-81
Public sector				
West **coast State** health department:				
Whole virus		$ .65	$ .29	$1.00
Split virus	$.65	$1.80	$.99	–
Southern State health department:				
Whole virus	—	—	$ .29	$1.18
Split virus	—	—	$ .99	$1.95
Center for Disease Control:				
Adult formula	—	$.34 to $ .49	–	–
Youth formula.	—	$.77 to $1.66		
Whole virus	—	—	$ .29	–
Split virus	—	—	$ .99	–
Private sector				
West coast university hospital:				
Whole virus		$ .82	$1.07	$1.12
Split virus	$.78			
Syringes	—	$1.15	$1.38	-
Northeast university hospital:				
Whole virus	—	$ .82	$1.07	$1.20

[a]In 1979-80 the Federal Government negotiated a set price with manufacturers for the price of influenza vaccine. State governments participating in federally sponsored influenza immunization programs received vaccines at those negotiated prices

SOURCE" Office of Technology Assessment.

cases, vaccine was supplied by State health departments free of charge to practicing physicians who can charge patients their normal vaccine administration fees, exclusive of the cost of vaccine. When persons require 2 doses of vaccine (e.g., those under 25 years), some physicians reportedly reduce their administration fees somewhat to yield a "package cost" per person.

Fourth, the vaccine administration fee charged by physicians was also calculated with data from three other sources. First, it was determined from the 1969 California Relative Value Scale that vaccine administration is valued at one-half the value of a brief examination followup visit for an established patient (17). Second, it was determined from an article by Muller and Otelsburg (76) that in 1977 the mean physician charge for such a visit for a medicare patient was **$9.56.** Third, one-half of this charge, i.e., $4.78, **was** then adjusted for inflation for years 1977-78 by multiplying it by the physician services component of the consumer price index (CPI). The vaccination charge thus calculated for 1978, for example, was $5.18.

For the past 3 to 4 years, the Immunization Practices Advisory Committee (ACIP), the official vaccination advisory body to the Federal Government, has recommended that children and young people receive two doses of split virus vaccine instead of one dose of whole virus vaccine. Therefore, OTA derived special vaccination costs for those vaccinees under 25 years of age.

For public and private sector provision of influenza vaccination in 1978, OTA derived the following costs:

	Vaccine price	+ Administration cost	= Total vaccination cost per person per year
Public Sector			
Low Estimate			
Adult ≥ 25 years	**$0.30/dose**	**+ $1 25/dose**	**= $1.55**
Child/young adult <25	**$2.00/2** doses	**+ $2,50/2 doses**	**= $4.50**
High Estimate			
Adult ≥ 25 years	$0.65/dose	+ $1 25/dose	= $190
Child/young adult <25	$3.60/2 doses	+ $2 50/2 doses	= $6.10
Private Sector			
Low Estimate			
Adult ≥ 25 years	**$0.82/dose**	**+** $5.18/dose	= $6.00
Child/young adult <25	$3.32/2 doses	+ $77712 doses	= $1109
High Estimate			
Adult ≥ 25 years	$1.39/dose	+ $8.00/dose	= $9.39
Child/young adult <25	$3.60/2 doses	+ $16.00/2 doses	= $1960

Vaccine Effectiveness Rate

As described in appendix B, the effectiveness of influenza vaccine is measured in terms of either: 1) its documented ability to reduce in clinical trials the incidence—and perhaps the morbidity and mortality—of influenza among vaccinated subjects; or 2) its ability to stimulate the production of antibodies which are presumed to provide protection against influenza among vaccinated subjects. In OTA's analysis, the effectiveness rate of inactivated influenza

virus vaccine was based only on data relating to the vaccine's ability to reduce clinical disease. Such data are difficult to find and, in some cases, quite difficult to interpret and extrapolate to populations beyond the clinical trial setting. Based on data outlined in appendix B, a vaccine effectiveness rate of 60 percent was used for all years in the base case analysis; that rate was varied from 30 to 90 percent in the sensitivity analysis.

Duration of Vaccine-Induced Immunity

As explained in appendix A (by Dr. Gary Noble, CDC), the duration of immunity provided by a particular influenza vaccine can vary substantially. Because there is no reliable indicator of the population's influenza antibody status—especially concerning antibodies to an upcoming variant of an influenza virus, ACIP recommends yearly influenza vaccinations for selected high-risk groups. On the basis of ACIP's recommendation, it was assumed in OTA's analysis that the effective duration of immunity of influenza vaccination would be 1 year. Undoubtedly, for some individuals, vaccine-induced immunity against some influenza viruses exceeds 1 year; however, on the basis of existing data, it is not possible to quantify differences in duration of immunity beyond 1 year among populations.

Vaccine Side Effects and Their Treatment Costs

The incidence, health effects, and costs of treating adverse reactions to influenza vaccines were quantified as described below.

Mild Local and Systemic Reactions (see app. B for description of reactions)

The following data were used to quantify mild local and systemic vaccine side effects in the base case and in the sensitivity analysis.

Adults (18 years and older)
- Incidence: 5 percent of all vaccinees (90)
- Treatment costs: 1 physician visit = $10.36 (in 1978) (76)
- Health effects: 1 day of nonbed disability

Children (under 18 years)
- Incidence: 13 percent of all vaccinees (90)
- Treatment costs: 1 physician visit = $10.36 (in 1978) (76)
- Health effects: 1 day of nonbed disability

Guillain-Barre Syndrome (GBS)

In the base case, it was assumed that, in all years except *1976-77,* no excess GBS was attributable to influenza vaccine. For 1976-77, the incidence and nature of GBS occurring during the swine flu immunization program were used, The types, incidence, and treatment costs of GBS during 1976-77 are displayed in table E-2 (4,112),

Table E.2.—Guillain Barre Syndrome Among 1976-77 A/New Jersey Influenza Vaccinees

Type of GBS case	Duration	Percent of GBS cases[a]	Death rate	Health effect (days of disability) Bed[b]	Nonbed[c]	Cost per case by age Under 3 years	3-14 years	15-64 years	≥ 65 years
Mild	≤ 1 year	25%	0%	21	161	$11,405	$ 9,347	$ 6,582	$ 9,087
Moderate	≤ 1 year	25%	0%	120	245	$24,500	$22,990	$23,071	$22,608
Moderate	≤ 1 year	35%	0%	21	344	$11,164	$ 9,106	$ 9,323	$ 8,838
						($663 for each added year of life)			
Severe (respiratory insufficiency)	≥ 1 year	5 %	00/0	365	–	$33,181	$30,241	$30,319	$29,865
						($1,832 for the 2nd year)			
						($1,552 for each added year of life)			
Severe (paralysis of extremeties)	≥ 1 year	5 %	0 %	365	–	$43,659	$37,779	$36,129	$37,040
						($5,140 for the 2nd year)			
						($3,661 for each added year of life)			
Death	—	5 %	1000/0	60	–	$23,685	$20,689	$20,839	$22,734

[a] To obtain age-specific incidences, these estimates were multiplied by the following attack rates (112):

Age	Attack rate (cases/million vaccinees)
0-17 years	1.1
18-24 years	3.3
25-44 years	9.1
45-64 years	7.5
≥ 65 years	7.3

[b] Bed days are equivalent to total number of days spent in a hospital or long-term care facility

[c] Nonbed days are equivalent to the difference between bed days and either 180 or 365, depending on type of GBS case.

SOURCE Based on data from *Estimated Economic Costs of Selected Medical Events Known or Suspected To Be Related to the Administration of Common Vaccines* (4)

Anaphylaxis

It was assumed in the base **case and** in the sensitivity analysis that the incidence of severe anaphylaxis (severe allergic reaction) associated with influenza vaccination for any year was 1 case per 4 million vaccinees (107). The assigned treatment costs (in 1978 dollars) and health effects of such a reaction were the following.

costs	
3 days of hospitalization	= $581.43
6 inpatient physician visits	= 132.72
1 outpatient physician visit	· 10.36
Total cost per case	$724.51
Health Effects	
3 days of bed disability	
2 days of nonbed disability	

Hospitalization Related to Influenza

The content and cost of a hospitalized case of influenza/pneumonia were constructed with data obtained from the Hospital Discharge Survey of the National Center for Health Statistics (NCHS), an article by Muller and Otelsberg **(76),** and the Blue Cross/Blue Shield option of the Federal Employee Health Benefits Program.

The construction of a hospitalized case is as described below.

Length of Stay

The length of stay for a hospitalized case of influenza/pneumonia was calculated from data provided by the Hospital Discharge Survey. The total number of days of hospitalization assigned to 8th Revision ICDA Codes 470-474 (all influenzas) and 480-486 (all pneumonias) as a first-listed diagnosis was divided by the total number of hospital discharges assigned to the same ICDA codes. The average length of stay (ALOS) ranged from *3.92* to 12.5 days per case, depending on patients' sex, age, and year of hospitalization.

Hospital Cost per Day

Hospital costs were obtained from the Blue Cross/Blue Shield option of the Federal Employees Health Benefit Program. In 1977, the average cost per day for a nonsurgical inpatient admission for influenza was $112.88. This figure includes charges for room and board, intensive care unit, treatment rooms, drugs and medication, oxygen, blood and ancillary services such as lab tests, X-rays, and other tests if billed by the hospital. It does not include physician-billed care.

The average cost per day for a nonsurgical inpatient admission for pneumonia in 1977, again based on data from Blue Cross/Blue Shield, was $140.12. According to data from the Hospital Discharge Survey of NCHS, approximately 80 percent of all hospital discharges with a diagnosis of either influenza or pneumonia (all listed-unduplicated) was attributed to pneumonia, in epidemic as well as nonepidemic years. In order to calculate the average cost per day for a nonsurgical inpatient admission for influenza-pneumonia (as a combined group), a weighted average cost was calculated as follows:

$$\$112.88\ (.20) + \$140.12\ (.80) = \$134.68$$

By using the CPI for hospital service charges, this $134.68 hospital cost per day was updated for inflation to yield a 1978 cost per day of $149.63 ($134.68 x 1.111).

Physician Hospital Visits and Costs

It was assumed that each hospitalized patient would receive one initial comprehensive physician visit *($39.62* in **1978)** and subsequently receive daily routine followup brief hospital visits **($10.51** per visit in *1978)* throughout the hospital stay.

Ambulatory Care Related to Influenza

The content and cost of an ambulatory case of influenza/pneumonia were constructed with data obtained from the National Ambulatory Medical Care Survey (NAMCS), an article by Muller and Otelsberg **(76),** and CPI data from the Department of Commerce.

The construction of a case is described below.

Number of Visits per Case

Calculated on the basis of data from NAMCS, the average number of physician office visits per case of influenza/pneumonia ranged from 1.10 to **3.65,** depending on patient's age and sex and the year of the case. To calculate this number, the total number of visits for influenza/pneumonia (listed as the first diagnosis) as reported in NAMCS was divided by the number of new visits for influenza/pneumonia (listed as the first diagnosis). The number of new visits served as a proxy for the number of ambulatory cases.

‘ These figures were based on data from references (4) and *(76).*

Procedures Ordered or Performed per Visit

Again based on NAMCS data, the following estimates were derived concerning the frequency with which selected procedures were either ordered or performed:

Procedure ordered or performed	*Percent of influenza 'pneumonia visits during which procedure was* ***ordered or*** *performed*
Limited physical examination	72
History/general examination	**15**
Clinical laboratory test	**16**
X-ray	**17**
Drug prescribed recommended.	**75**

A limited physical examination and a history / general examination were interpreted to be a limited office visit for a new condition in an established patient (17,76). NAMCS's categories for examinations changed during the early 1970's.

Cost per Case

Cost estimates for each of the visits and procedures included in an ambulatory case of influenza / pneumonia were based on 1977 medicare data (76), which were updated for inflation using the relevant medical care index from CPI data.

Physician cost of *an ambulatory visit.* —It was assumed that each case would include one initial limited office visit for an established patient at *$13.78* in **1978**[2] and 0.10 to **2.65** routine followup brief office visits (depending on sex and age of patient and year of case) at $10.36 per visit in 1978. Physician costs ranged from $14.82 to $41.23 in 1978.

Cost of *procedures ordered during an office visit in 1978.* —

	Number of procedures per visit	*Cost per procedure*	*cost per visit*
Clinical ***lab test (e.g.,*** complete blood count)	**0.16**	**x $ 7.68**	**"$1.23**
X-ray (e.g., chest)	0.17	**x $15.86**	**"$2.70**
Drug ordered (e.g., antibiotic, decongestant)	0.75	x $4.92[3]	= *$3.69*
Total cost of procedures per visit			*$7.62*

[2]The cost of an initial limited visit for an established patient was calculated in the following manner:

- Calculating the average charge for a routine followup brief office visit as billed by general practitioners and specialists (weighted evenly) to medicare in **1977 (76) and updating that charge to 1978 prices using CPI data; i.e.:**

  $8.63 + $10.48 = $9.56

  $9.56 X[2]*$10.84 "$10.36*

- Multiplying $10.36 by 16/12 (the ratio of values between a limited examination and a brief examination in the 1969 California **Relative** *Value Studies* **(17), i.e., $1036 x 16/12 = $13.78**

[3]**This estimated** cost per drug order was based on data from *Out-of-Pocket* ***Cost*** *and* ***Acquisition of Prescribed*** Medicines United States 1973 **(79). In 1973, the average price of a prescribed medicine** for conditions of the respiratory system (including influenza) **was $3 80; that figure was inflated to 1978 prices by using the CPI** for drugs and prescriptions.

Total cost per ambulatory case. —The total costs per ambulatory case (age-, sex-, and year-specific) were derived by combining the cost of an initial visit with the cost of followup visits (0.10 to **2.65** followup visits per case).

	Cost of ***initial visit***	***Cost of each followup*** visit
Physician fees.	$13.78	$10.36
Procedures	7.62	7.62
Total	$21.40	$17.98

Total costs per case ranged from $23.20 to $56.71, depending on patient's sex, age, and year of illness.

Excess Mortality Related to Influenza

The number of excess deaths used in the base case analysis were recently derived by CDC for this report (see tables E-3 and E-4). Excess mortality includes deaths from all causes during CDC-defined influenza epidemics. CDC estimates are calculated from NCHS mortality data.

In the sensitivity analysis, the number of total excess deaths due to all causes among all age groups combined for each year from 1970-71 through 1975 was derived by Dr. David Ailing and his associates at the National Institute of Allergy and Infectious Dis-

Table E-3.—Excess Mortality From All Causes Reported During Influenza Epidemics, 1970-71 Through 1977.78: Used in Base Case Analysis[a] (by age group)

Year	Under 1 year	1-44 years	45-64 years	≥ 65 years	All ages
1970-71	—	—	—		
1971 -72	359	1,640	7,580	22,100	31,679
1972-73	844	606	3,250	24,542	29,242
1973 -74	—	—	—		
1974 -75	173	676	1,270	5,371	7,489
1975-76 ...., ...	508	903	4,850	22,471	28,732
1976-77	—	—	—		
1977 -78., ...	578	1,173	5,200	22,851	29,803
Total deaths by age group	2,462	4,997	22,150	97,335	126,945
Average excess deaths/year	308	625	2,769	12,167	15,868
Average excess deaths/year with excess mortality	492	999	4,430	19,467	25,389
Average percent of total deaths by age groups . . .	2.0 "/0	4.0 "/0	17.0%	77.00/o	100 "/0

a Estimates for each age group for years 1970-71 through 1975-76 were derived by the Center for Disease Control (CDC). The estimates for all ages in 1976-77 and 1977-78 were calculated by CDC in a different fashion (100); the age-specific estimates for those 2 years were calculated by the Office of Technology Assessment.

Table E-4.—Estimated (Expected) Mortality From All Causes Reported During Influenza Epidemics, 1970-71 Through 1977-78: Used in Base Case Analysis[a] (by age group)

Year	Under 1 year	1-44 years	45-64 years	≥ 65 years	All ages
1970-71	—	—	—	—	
1971-72	10,140	28,573	80,234	210,960	329,907
1972-73	18,783	59,800	165,614	428,628	672,825
1973-74	—	—	—	—	—
1974-75	12,801	41,989	117,881	332,386	505,057
1975-76	11,540	40,610	111,466	326,382	489,998
1976-77	—	—	—	—	—
1977-78	17,244	55,353	153,846	420,347	646,791

[a]Estimated deaths for 1970-71, 1973-74, and 1976-77 were not used since there was no excess mortality calculated for those years. Estimates for each age group for years 1970-71 through 1975-76 were calculated by the Center for Disease Control. Estimates for 1977-78 were calculated by the Office of Technology Assessment,

ease. CDC's estimates of excess mortality were used for 1976-77 and 1977-78 (see tables E-5 and E-6).

From these data, "excess mortality rates" for deaths from all causes within four age groups—under 1 year, 1 to 44, 45 to 64, and over 65—were derived. A baseline "force of mortality" was calculated for each year, and an additional force of mortality—varied in accordance with the degree of excess mortality—was programmed for the influenza season in each epidemiologic year from **1970-71** through 1977-78.

Table E-5.—Excess Mortality From All Causes Reported During Influenza Epidemics, 1970.71 Through 1977.78: Used in Sensitivity Analysis[a] (by age group)

Year	Under 1 year	1-44 years	45-64 years	≥ 65 years	All ages
1970-71	—	—	—	—	—
1971 -72	42	188	870	6,800	7,900
1972 -73	1,508	1,083	5,809	19,000	27,400
1973-74	49	191	360	800	1,400
1974 -75					
1975-76	849	1,500	8,056	8,600	19,000
1976-77	—	—	—	—	—
1977 -78	1,307	1,585	8,077	18,834	29,803
Total deaths by age group	3,755	4,547	23,172	54,034	85,503
Average excess deathly ear	469	568	2,897	6,754	10,688
Average excess deaths/year with excess mortality	751	909	4,634	10,807	17,101
Average percent of total deaths by age groups	4.0 "/0	5.0 "/0	270/o	630/0	1000/0

[a]Estimates for th "65" age group and for "all ages" for all years 1970-71 through 1975-76 were derived by Dr. David Ailing and associates at the National Institute of Allergy and Infectious Diseases (2). The estimates for all ages for years 1976-77 and 1977-78 were derived by the Center for Disease Control (100). Age-specific estimates for age groups < 1, 1-44, and 45-64 were calculated by the Office of Technology Assessment

Table E-6.—Estimated (Expected) Mortality From All Causes Reported During Influenza Epidemics, 1970-71 Through 1977-78: Used in Sensitivity y Analysis[a] (by age group)

Year	Under 1 year	1-44 years	45-64 years	≥ 65 years	All ages
1970-71	–	–	–	–	–
1971-72	9,986	28,140	79,017	207,760	324,902
1972-73	18,140	57,754	159,947	413,962	649,804
1973-74	8,186	26,851	75,383	212,554	322,974
1974-75	—	—	—	—	—
1975-76	11,069	38,953	106,917	313,062	470,001
1976-77	—	—	—	—	—
1977-78	17,244	55,353	153,846	420,348	646,791

[a]Alling and associates calculated no excess mortality in 1970-71 and 1974-75 (2), and the Center for Disease Control calculated no excess mortality for 1976-77; therefore, no estimated deaths were used for those years. Estimated deaths for the "all ages" category for years 1970-71 through 1975-76 were calculated by Ailing and associates (2). The Office of Technology Assessment calculated estimated mortality for the age-specific groups ir all years.

Cost of Treating Illnesses in Extended Years of Life

To calculate the cost of treating other illnesses (those not prevented by influenza vaccination) in extended years of life gained by individuals who avoid death from influenza, per capita annual total medical care costs were multipled by the number of years of life generated by vaccination.

Data used to calculate total medical care costs per person were those published by the Health Care Financing Administration (HCFA) **(37,42).** According to HCFA, in **1978,** the average age-specific per capita total medical care expenditures were the following.

Age	*Total per capita expenditure*
Under 19.	$ 286
19-64.	764
65 and over,	2,026
All ages.	753

These averages were weighted for persons 19 years and over to assign higher costs to more specific age groups. Thus, for example, individuals aged 64 were assigned higher costs than individuals aged 20.

Medicare Expenditures

Medicare's portion of expenditures for the treatment of influenza, as well as for all other illnesses, was based on data from (37). In 1977, for persons 65 and older, after copayments, medicare paid for 74.6 percent of all hospital expenditures, 55.6 percent of all physician expenses, and overall 44.1 percent of all medical care expenditures.

Work Loss

"Excess" days of work loss caused by medically attended influenza (8th Revision ICDA codes **470-474)**

and pneumonia (8th Revision ICDA codes 480-486) were calculated by subtracting work loss reported in 1970-71 from work loss reported in each subequent year through 1977-78. Age- and sex-specific work loss data were obtained from the Health Interview Survey at the NCHS. Age- and sex-specific individual mean earnings data were obtained for years 1975, 1976 and 1977 from the Bureau of the Census (15). Earnings for 1978 were derived by multiplying 1977 earnings data by the ratio of the 1978 GNP deflator/1977 GNP deflator, i.e., 152.05/141.70 = 1.0730 (see table E-7). Daily earnings were derived by dividing annual earnings for full-time year-round workers by 260 working days per year. Days of work loss were multiplied by 1978 daily earnings to obtain age- and sex-specific productivity losses.

Values Assigned to Selected Characteristics of the Influenza High-Risk Population

Increased Probability of Dying Within a Given Year

Age-specific probabilities of a high risk person's dying from any cause within a given year were calculated with the following equation:

$$_{P}I = 1 - \exp [\ln(1 - me.) \times 2.2]$$

where

m_{pi} is the mortality for poor-risk patients at age 1 and
m_{GI} is the mortality for good-risk patients at age I.

This is a modified version of an equation developed by Fitzpatrick and associates based on increased probabilities of dying among persons with chronic bronchitis (38).

These probabilities were multiplied by the age-specific estimated death rates (for all causes) for the general population.

Probability of Dying From Influenza or Pneumonia Within a Given Year

Age-specific probabilities of a high-risk person's dying from influenza or pneumonia within a given year were derived from data displayed in table E-8. From these data, age-specific death rates for pneumonia in persons with medically attended heart disease were calculated (see table E-9). Heart disease was used as a proxy for all influenza high-risk conditions. Age-specific probabilities and relative risks of dying from influenza or pneumonia are displayed in table E-10. To derive high-risk mortality rates, these relative risk values were multiplied by the excess mortality rates for influenza and pneumonia calculated for the general population.

Although the mortality rates for both pneumonia and heart disease have changed since the 1950's, it was assumed that the ratio between the pneumonia mortality rate in the general population and the pneumonia mortality rate for those persons with heart disease has remained fairly constant over the past 25 years.

Table E-7.—Annual Individual Mean Earnings for Full-Time, Year-Round Workers, by Age and Sex, 1977-78

	18-24 years	25-34 years	35-44 years	45-54 years	55-64 years	≥ 65 years	All ages
Annual earnings							
1977[a]							
Both sexes	$ 8,564	$13,092	$15,739	$15,729	$14,506	$12,661	$13,856
Male	9,497	14,775	18,436	18,517	16,968	14,649	16,171
Female	7,338	9,555	9,587	9,597	9,241	6,604	9,133
1978[b]							
Both sexes	$ 9,189	$14,048	$16,888	$16,877	$15,565	$13,585	$14,867
Males	10,190	15,854	19,782	19,869	18,207	15,718	17,351
Female	7,874	10,254	10,287	10,298	9,916	8,159	9,800
Daily earnings							
1978							
Both sexes	$ 35	$ 54	$ 65	$ 65	$ 60	$ 52	$ 57
Male	39	61	76	76	70	60	67
Female	30	39	40	40	38	31	38

[a]Data for 1977 were obtained from the Bureau of the Census, *Current Population Reports*, Series P-60 (15).
[b]Earnings for 1978 were derived by multiplying 1977 data by the ratio of 1978 GNP deflator/1977 GNP deflator, i.e., 152.05/141.70 = 1.0730.

Table E.8.—Data Relating to Pneumonia Deaths in the 1950's, by Age Group

	≤ 44 years	45-64 years	≥ 65 years	All ages
Number of pneumonia deaths (underlying cause) in the general population	13,166	6,590	22,417	42,173
Estimated population of U.S.	116,865,000	33,359,000	14,079,000	164,303,000
Number of pneumonia deaths (underlying cause) among persons with medically attended heart disease	580	1,651	6,602	8,833
Estimated population with medically attended heart disease	579,000	1,341,000	1,677,000	3,598,000
Number of pneumonia deaths (underlying cause) in persons without medically attended heart disease	12,586	4,939	15,815	33,340
Estimated population without medically attended heart disease	116,286,000	32,018,000	12,402,000	160,705,000

SOURCES: (1) Vital *Statistics of the United States 1955*. National Office of Vital Statistics, Washington, D.C.: U.S. Department of Health, Education, and Welfare. Volume 1, p.LIX, table L., 1957 (82).
(2) Ibid. *Supplement*, p. 110, table 8, 1965 (83).
(3) *Heart Conditions* and High *Blood Pressure United States, July 1957-June 1958*. U.S. National Health Survey, Series B-No.13. Washington, D.C.: U.S. Department of Health, Education, and Welfare, Table 5, p. 17, February 1980 (78),

Table E-9.—Age-Specific Death Rates (Deaths/100,000) From Pneumonia in the 1950's, by Age Group

	≤ 44 years	45-64 years	≥ 65 years	All ages
Death rate from pneumonia (as underlying cause) among the general population	11.27	19.75	159.22	25.67
Death rate from pneumonia (as underlying cause) among persons with medically attended heart disease	100.2	123.1	393.7	245.5
Death rate from pneumonia (as underlying cause) among persons without medically attended heart disease	10.82	15.43	127.52	20.75

SOURCES: (1) *Vita/ Statistics of the United States 1955*. National Office of Vital Statistics, Washington, D. C.: U.S. Department of Health, Education, and Welfare. Volume 1p.LIX, tableL., 1957 (82).
(2) Ibid. *Supplement*, p. 110, table 6, 1965 (83).
(3) Heart Conditions *and High Blood Pressure: United States, July 1957-June 1958*. U.S. National Health Survey, Series B-No.13. Washington, D. C.: U.S Department of Health, Education, and Welfare. Table 5, p. 17. February 1960 (78),

Increased Probability of Either Being Hospitalized or Visiting a Physician's Office for Influenza/Pneumonia

Barker and Mullooly calculated age-specific hospitalization rates among the general population and among high-risk populations during two epidemic and one nonepidemic periods in a large health maintenance organization in Portland, Ore. (9). Using these data, OTA compared age-specific excess hospitalization rates among high-risk persons to rates among the general population during an epidemic (see table E-II).

It was assumed in OTA's analysis that the excess probability of a high-risk person's visiting a physician's office for influenza or pneumonia was the same as the excess probability of a high-risk person's being hospitalized for influenza or pneumonia. To derive

Table E-10.—Probabilities of Dying From Pneumonia in the 1950's, by Age Group

	≤ 44 years	45-64 years	≥ 65 years	All ages
Probability of dying from pneumonia among persons with medically attended heart disease	0.00100	0.00123	0.00394	0.00245
Probability of dying from pneumonia among the general population	0.00011	0.00020	0.00159	0.00026
Probability of dying from pneumonia among persons without medically attended heart disease	0.00011	0.00015	0.00128	0.00021
Increased probability of dying from pneumonia for persons with medically attended heart disease over the general population	0.00089	0.00103	0.00235	0.00219
Increased probability of dying from pneumonia for persons with medically attended heart disease over those without medically attended heart disease	0.00089	0.00108	0.00266	0.00224
Relative risk of dying from pneumonia in persons with medically attended heart disease over the general population	9.09	6.15	2.48	9.42
Relative risk of dying from pneumonia in persons with medically attended heart disease over persons without medically attended heart disease	9.09	8.20	3.08	11.67

SOURCES: (1) *Vital Statistics of the United States* 1955 National Office of Vital Statistics Washington, D.C. U.S. Department of Health, Education, and Welfare Volume 1, p LIX, table L., 1957 (82).
(2) Ibid Supplement, p 110, table 6, 1965 (83)
(3) *Heart Conditions and High Blood Pressure United States, July 1957-June 1958* U.S. National Health Survey, Series B-No. 13. Washington, D.C U S. Department of Health, Education, and Welfare Table 5, p. 17 February 1960 *(78).*

Table E-n .—Increased Probability of a High-Risk Person's Being Hospitalized for Pneumonia or Influenza During an Influenza Epidemic

Age group	Excess hospitalization rates[a] (persons hospitalized/100,000) Within the high-risk population	Within the hospitalized eve-r a general person in the general population	Increased probability of a high-risk person's being
15-44 years	83	26	83)26 = 3.19
45-64 years	514	95	514195 = 5.41
≥ 65 years	556	481	556/481 = 1.16

[a] Excess hospitalization rates are derived by subtracting hospitalization rates during a nonepidemic Influenza year (1970-71) from average rates during two epidemic Influenza years (1968-69 and 1972-73)

SOURCE. The Office of Technology Assessment's Interpretation of data from Barker and Mullooly (9).

rates of hospitalization and ambulatory cases among high-risk populations, these probabilities were multiplied by the hospital discharge rate and the ambulatory case rate (for influenza or pneumonia) in the general population.

Average Length of Hospital Stays and Number of Physician Office Visits/Ambulatory Case

The Hospital Discharge Survey of NCHS supplied length-of-stay data for persons hospitalized with pneumonia (any listed) who also had one or more of the following types of medical problems: cardiovascular, bronchopulmonary, renal, diabetes, or sickle cell disease. For high-risk populations, age-specific ALOS were calculated and compared to ALOS for a hospital case of pneumonia among the general population (see table E-12).

Likewise, the age-specific numbers of physician office visits per ambulatory case of influenza/pneumonia in the general population were multiplied by the age-specific ratios of:

$$\frac{\text{ALOS for high risk persons}}{\text{ALOS for the general population}}$$

Total Medical Care Costs

It was assumed that the total medical care costs in any extended year of life for a high-risk person were

Table E-12.—Average Length of Stay (ALOS) for a Hospital Case of Pneumonia Among Persons With One or More High-Rlsk Conditions,' 1976

Age group	Number of discharges	Total number of hospital days	ALOS (in days)	ALOS for high-risk persons/ ALOS for general population
0-1 years . . .	8,663	62,527	7.2	1.22
2-24 years . .	11,143	69,424	6.2	1.15
25-44 years .	16,615	130,886	7.9	1.00
45-64 years .	44,528	489,264	11.0	1.12
≥ 65 years . .	119,324	1,564,430	13.1	1.08
All ages	202,293	2,316,553	11.5	1.30

[a] High.risk conditions include the following types of medical problems: cardiovascular, bronchopulmonary, renal, and diabetes.

[b] ALOS for a hospital case of pneumonia (first-listed diagnosis) for the general population:

Age	ALOS
0-1 years, ...	5.9
2-24 years.	5.4
25-44 years	7.9
45-84 years ., . .	9.8
>=65 years.	1 2,1
All ages ., ...	8.9

SOURCE: Unpublished data, Hospital Discharge Survey, t976, National Center for Health Statistics, Hyattsville, Md.

twice those for a person in the general population. No known data exist regarding the extent to which total expenditures for medical care of a high-risk person exceed those of an average person.

The sensitivity analysis tested the effect of including total medical costs in extended years of life.

Treatment Costs for a Case of Influenza/Pneumonia

The cost of a day of hospitalization for influenza / pneumonia was not increased for high-risk persons. Total hospitalization costs related to influenza / pneumonia in the high-risk population increased, however, because of the steps described above, which increased the probability of being hospitalized and the average length of stay.

Likewise, the cost of a physician office visit for influenza / pneumonia was not increased for high-risk persons. Total ambulatory care costs related to influenza / pneumonia in the high-risk population, increased, however, because of the steps described above.

Disability Days

Bed and nonbed days of disability among high-risk persons were calculated in the following manner.

First, restricted activity days and bed disability days related to selected high-risk conditions were obtained from publications of NCHS (see table E-13). Nonbed disability days were calculated by subtracting bed disability days from restricted activity days. Weighted averages for all selected types of conditions combined were calculated.

Second, total days of bed and nonbed disability among high-risk persons were calculated by using the following equation:

[population' X percent with high-risk conditions x disability days for high-risk person'] +
[low-risk population' x disability days forlow-riskperson] =
[population' x disability days for average-risk person]

Discount Rate

It is generally accepted that streams of costs occurring over time should be discounted (86,89). The process of discounting involves the application of a rate—i. e., the discount rate—to outcomes to be realized over time. The magnitude of future outcomes is thereby changed to a present value.

Discounting has two theoretical bases. One is the fact that funds can be invested in alternative ways.

'Any age- or sex-specific population.
'Disability days are those calculated in table E-13.

Table E-13.—Disability Days Caused by Selected High-Risk Conditions

Type of high-risk condition	Prevalence	Restricted activity days per condition per year	Bed days per condition per year	Non bed days per condition per year
Heart condition	**10,291,000**	**30.2**	**12.6**	**17.6**
Chronic bronchitis.	6,526,000	7.5	3.6	3.9
Emphysema.	1,313,000	35.8	14.5	21.3
Asthma. ., ...	6,031,000	15.0	5.8	9.2
Total	24,161,000	—	—	—
Average	—	20.6	8.57	12.0

SOURCES: (1) Prevalerrce of Chronic *Circulatory Comditions: United* States, *1972,* Washington, D. C.: National Center for Health Statistics, 1975 (80).
(2) Prevalence of *Selected* Chronic Respiratory Conditions: United States, 1970, Washington, D. C,: National Center for Health Statistics, 1973 (81).

The discount rate approximates the yield that is foregone by investing in the project under consideration instead of using the funds in other ways. The other reason for discounting is that people prefer to realize benefits now rather than to postpone them to some future date. OTA's analysis of influenza vaccination discounts health effects, as well as costs, occurring over time (86,126).

It is important to note that discounting concerns time and is distinct from inflation, which concerns the level of prices. OTA's analysis takes account of changes in the price level by expressing all costs in terms of **1978** dollars.

The discount rate used in the base case is 5 percent, the rate generally used in recent analyses of medical programs (125). The rate considered appropriate for society's perspective is lower than that considered appropriate for an individual's perspective, because society would likely value more highly than an individual programs yielding benefits that stretch into the future, perhaps across generations. Although actual money market rates are the result of many factors **and do not represent true discount rates, it is noteworthy that U.S. bond yields during the 1950's and early 1960's,** when inflation rates were low, ranged from **2** to 4 percent **(34).** The sensitivity analysis substitutes a discount rate of zero to test the direction of the effect of a lower rate.