Estimates of Incidence and Costs of Intestinal Infectious Diseases in the United States

WALLACE E. GARTHRIGHT, PhD
DOUGLAS L. ARCHER, PhD
JOHN E. KVENBERG, PhD

The authors are with the Food and Drug Administration's Center for Food Safety and Applied Nutrition. Dr. Garthright is Chief of the Operations Research Branch, Division of Program Operations. Dr. Archer is Director of the Division of Microbiology. Dr. Kvenberg is Program Manager for Foodborne Biological Hazards of the Division of Microbiology.

Tearsheet requests to Dr. W. E. Garthright, HFF-028, FDA, 200 C St. SW, Washington, DC 20204.

Synopsis

The incidence of acute episodes of intestinal infectious diseases in the United States was estimated through analysis of community-based studies and national interview surveys. Their differing results were reconciled by adjusting the study population age distributions in the community-based studies, by excluding those cases that also showed respiratory symptoms, and by accounting for structural differences in the surveys.

The reconciliation process provided an estimate of 99 million acute cases of either vomiting or diarrhea, or both, each year in this country, half of which involved more than a full day of restricted activity. The analysis was limited to cases of acute gastrointestinal diseases with vomiting or diarrhea but without respiratory symptoms.

Physicians were consulted for 8.2 million illnesses; 250,000 of these required hospitalization. In 1985, hospitalizations incurred $560 million in medical costs and $200 million in lost productivity. Nonhospitalized cases (7.9 million) for which physicians were consulted incurred $690 million in medical costs and $2.06 billion in lost productivity. More than 90 million cases for which no physician was consulted cost an estimated $19.5 billion in lost productivity. The estimates excluded such costs as death, pain and suffering, lost leisure time, financial losses to food establishments, and legal expenses.

According to these estimates, medical costs and lost productivity from acute intestinal infectious diseases amount to a minimum of about $23 billion a year in the United States.

ESTIMATES OF THE INCIDENCE of intestinal infectious diseases (IID) in the United States range from 8 million cases per year, based upon a national survey, to 324 million cases, using a community-based study. Estimates of incidence and costs that reconcile the varying results of available studies are useful to public health planners, administrators, and program analysts involved in determining the economic effects of IID and the resources required to cope with its effects.

The authors compared published community-based studies with unpublished results of national surveys to obtain an estimated incidence rate. The rate was applied to the 1980 population of 216 million persons, excluding active duty military personnel, their dependents, and institutionalized persons. The estimate was extended to these 11 million persons by assuming the same rates as for the nonexcluded population. Medical costs and costs of lost productivity from morbidity (excluding mortality) were calculated on the basis of the total population of the United States.

Definitions

Intestinal infectious diseases considered in this study included bacterial, viral, and protozoan infections (excluding helminthiases) coded 001 through 009 in the International Classification of Diseases, Ninth Revision (*1*). They are cholera, typhoid and paratyphoid fevers, other salmonella infections, shigellosis, other food poisoning (bacterial), amoebiasis, other protozoal intestinal diseases, intestinal infections resulting from other

Table 1. Comparison of three prospective community-based studies of the incidence of intestinal infectious diseases

Characteristic	Cleveland study	Tecumseh study	Charlottesville study
Period	1948–57	1965–71	1976
Number of families	86	850	42
Number of persons	443	4,095	152
Person-years of observation	2,675	4,095	152
Primary emphasis	All illness	All illness	Acute gastrointestinal illness
Acute gastrointestinal episodes per person-year	1.5	1.2	1.5

Table 2. Distribution of United States and study populations by age groups, in percentages

Age (years)	1980 U.S. Census	Tecumseh study	[1]Cleveland study
Less than 5	7	14	32
5 to 9	7	17	20
10 to 14	8	15	4
15 to 19	9	6	0
20 to 24	9	5	0
25 to 39	23	26	44
40 to 49	10	10	0
50 and older	26	6	0

[1]Ages of parents in the Cleveland study were given as a range of youngest (22 years) at entry and oldest (45 years) at completion of 6 years of observation. The 25- to 39-year range includes almost all of the person-year experience of the parents.

organisms, and ill-defined intestinal infections. Symptomatic cases are nearly always characterized by vomiting or diarrhea or both. Excluded from the definition were respiratory diseases, such as influenza, with gastrointestinal symptoms; gastroenteritis; and all extragastrointestinal complications.

The diseases are contracted from infected persons or animals, or contaminated objects, food, or water. The most effective approach to public health control of IID in the United States has been directed toward breaking the food and water links in the disease cycles. Because the data sources used for this study predate recently described extragastrointestinal complications and chronic sequelae of IID (*2–5*), their incidences and costs were not included in the estimates.

A symptom-oriented definition of IID was used to compare surveys that used the ICD-9 codes with those surveys that did not. The definition specifies acute episodes of vomiting or diarrhea, without plausible noninfectious origin (such as adverse reaction to medication), but without respiratory symptoms. Because respiratory symptoms are frequent in the U.S. population, the definition excludes some IID cases that occur together with respiratory illnesses. Some valid cases of IID that lacked vomiting and diarrhea were unavoidably omitted from our estimates.

Prospective Community-based Studies

Prospective community-based studies of acute illnesses in the home that bear on IID were considered as potential data sources. These were conducted in

- an upper-middle-class suburb of Cleveland, OH (*6*)
- a small town, Tecumseh, MI (*7,8*)
- married graduate student housing in Charlottesville, VA (*9*). This study was not used in compiling our estimates because details on respiratory symptoms and age distribution were not yet published, and the number of person-years was about 2 percent of the total of the other two. However, some of this study's findings are cited for comparison purposes.
- Seattle-King County, WA. This is a significant, rapid followup study completed in 1984, designed to investigate links between contaminated animal feeds and human illness. The study was not used in our estimates because it involved only cases for which an HMO physician had ordered a fecal analysis.

The Tecumseh study, with 4,000 subjects, was the largest by far of the first three studies, although the Cleveland study's long time period increased the person-years of observation to 2,675, compared with 4,095 in Tecumseh (table 1). The 1977–81 continuation of the Tecumseh study was excluded because incidence graphs showed a sharp drop after the first year, when stool sampling began to be requested in all reported cases (*10*); the data suggested a lack of cooperation in reporting; and the number of families involved was much smaller than the original Tecumseh study. All three studies showed similar rates of intestinal illness per person, 1.2 to 1.5 episodes annually.

Adjusting the distribution of ages. The incidence rates in the Cleveland and Tecumseh studies are higher than the national rates probably because both studies had more than a representative share of young children and mothers of young children

(table 2). The study design emphasized selection of families with children living at home and, except for the last 2 years of the Tecumseh study, parents younger than certain ages. Table 2 shows the lower representation of persons older than 50 and the higher representation of children younger than 10 years. Subject selection in both studies was intended to help trace the spread of infections through schools and among the child's siblings and parents. The community-based studies were not intended to represent all age groups.

Table 3 shows the Tecumseh study illness rates applied to the U.S. age distribution. The U.S. rate was derived by multiplying the fraction of the population in each age group by the Tecumseh study incidence rate for that group and adding the products. In each illness category, the U.S. rate was about 17 percent lower than the Tecumseh study rate.

In estimating IID rates, it was necessary to restrict nonrespiratory illnesses to those with either vomiting or diarrhea, or both, and to eliminate respiratory illnesses. Because the age adjustment treated both restrictions similarly, we accepted the fraction of the Tecumseh study incidence that met both restrictions as approximating the same fraction of the age-adjusted incidence. The result of that assumption was an estimate of the U.S. IID rate equal to 0.62 per person-year. The calculations are (*a*) since 27.1 percent (*8a*) of the illnesses that combined respiratory with enteric symptoms involved neither vomiting nor diarrhea, 72.9 percent of the combined symptom cases involved vomiting or diarrhea; (*b*) the U.S. case rate for combined respiratory-enteric symptoms (table 3) is

$$1.00 - 0.74 = 0.26$$

therefore,

$$0.26 \times 72.9 \div 100 = 0.19$$

is the incidence rate of U.S. cases that combine respiratory symptoms with vomiting or diarrhea. This rate was subtracted from the U.S. rate for vomiting or diarrhea to obtain the rate of nonrespiratory vomiting or diarrhea episodes (table 3)

$$0.81 - 0.19 = 0.62$$

If the Tecumseh study were representative of the IID experience in the United States, its findings would imply that in 1980 the population experienced about 130 million episodes of IID among the 216 million civilian, noninstitutionalized population, or an approximate total of 140 million episodes in the total population.

Table 3. Age-dependent Tecumseh study intestinal infectious diseases incidence rates applied to the U.S. age distribution

Age (years)	1980 U.S. Census (percent)	Illnesses per person-year: All GI	Vomiting or diarrhea	GI, nonrespiratory
Less than 5	7.22	1.95	1.87	1.21
5 to 9	7.37	1.46	1.19	1.07
10 to 14	8.05	0.98	0.74	0.77
15 to 19	9.34	0.86	0.61	0.67
20 to 24	9.41	1.25	1.01	0.95
25 to 29	8.62	1.26	0.97	0.95
30 to 39	13.91	1.13	0.88	0.87
40 to 49	10.05	0.73	0.56	0.56
50 and older	26.03	0.51	0.43	0.40
All ages combined:				
Tecumseh study		1.20	0.98	0.87
National estimate		1.00	0.81	0.74

NOTE: GI is gastrointestinal.

Table 4. Comparison of age-dependent intestinal infectious diseases incidence rates of two community-based studies

Cleveland study[1]		Tecumseh study	
Age (years)	Cases per person-year	Age (years)	Cases per person-year
Less than	1.9	Less than 5	2.0
5 to 9	2.1	5 to 9	1.5
10 to 14	1.2	10 to 14	0.98
15 to 21	(1)	15 to 19	0.86
22 to 31	1.07	20 to 29	1.26
32 to 41	1.19	30 to 39	1.13
42 to 51	0.80	40 to 49	0.73

[1](*6a*) The Cleveland study had no participants aged 15 to 21 years.

Comparison of the Tecumseh and Cleveland studies. The Cleveland study sampled a narrower and younger range of ages than the Tecumseh study, accounting for the apparently higher incidence rate for all forms of acute enteric illness in Cleveland (1.5 to 1.2). If Tecumseh's age-specific rates (table 3) are replaced by those for Cleveland (table 4), retaining the Tecumseh study's rates for ages 15 to 19 and 50 and older, the age-adjusted U.S. estimate increases from 1.00 to 1.04. Therefore, the Cleveland results are very close to Tecumseh's when adjusted for age differences. The narrowing of cases to nonrespiratory cases with vomiting or diarrhea gives similar results. Nonrespiratory cases

Table 5. Comparison of three national health surveys

Characteristic	NHIS	NMCUES	NHDS
Period	1979–81	1980	1983
Number of households	120,000	6,000	. . .
Number of persons	320,000	17,600	206,000
Time span of recollection	2 weeks	3 to 4 months	. . .
Person-years included	12,000	17,600	. . .
Primary emphasis	Underlying health status	Expenditures and insurance	Utilization of hospitals
IID cases (with at least 1 day of restricted activity) per person-year	0.049	0.028	. . .

NOTE: NHIS is National Health Interview Survey. NMCUES is National Medical Care Utilization and Expenditure Survey. NHDS is National Hospital Discharge Survey. IID is intestinal infectious diseases.

were 80 percent of the total, with vomiting or diarrhea in 85.4 percent of those. Therefore, the estimated IID rate for the 1980 U.S. population (based on Cleveland) would be

$$1.04 \times 0.80 \times 0.854 = 0.71 \text{ cases per person-year}$$

Both the Cleveland and Tecumseh studies suggest significant incidence rates for IID. Both studies support each other and are supported by the smaller Charlottesville study. These rates can be reconciled with major retrospective health surveys, with only a few major assumptions, noted subsequently.

Activity restriction in Tecumseh. Because the national surveys counted only cases in which normal activity was restricted for at least a full day, they could be compared only to similar portions of the community-based studies. The Tecumseh study included this statistic, but the Cleveland study did not. In the Tecumseh study, 48.2 percent of those with enteric but no respiratory symptoms had at least 1 full day of restricted activity. The enteric illnesses without respiratory symptoms were divided into two subsets, those with vomiting or diarrhea, and those with only nausea or upset stomach. Because the study found that those in the first subset had longer durations of illness, their activity restriction rate must have been greater than 48.2 percent. Moreover, by calculating from table 3 and (*8a*) that illnesses in the first subset were 84 percent of those with enteric but no respiratory symptoms, the restricted activity rate could not be more than

$$48.2 \div 0.84 = 57.4 \text{ percent}$$

Because the restricted activity rate for the entire study, 52 percent, was nearly midway between the upper and lower bounds (48.2 and 57.4 percent), it was adopted as the estimated restricted activity rate for the Tecumseh study. That rate implies an incidence for IID with at least 1 full day of restricted activity of

$$0.52 \times 0.62 = 0.32 \text{ per person-year}$$

Physician consultation in Tecumseh. Further comparisons of these studies with recent national surveys required estimates of the percent of cases in which a physician was consulted. In the Tecumseh study, 8.6 percent of the persons with nonrespiratory, enteric symptoms sought consultation with a physician. Omitting the less severe cases, those with neither vomiting nor diarrhea, provided an estimated 10 percent rate of consultation for IID. Because the Tecumseh sample was biased toward young children, who require consultation more frequently than adults, age adjustment may be expected to scale down this estimate by about the same factor as the reduction in the overall IID rate, 17 percent. The implied age-adjusted rate of physician consultation for IID is then 8.3 percent.

This rate is comparable to a Centers for Disease Control estimate of 25 percent consultation for symptomatic cases of shigellosis (*11*), which has more disturbing and less familiar symptoms, such as bloody stools, than most other IID. Experience in Colorado led that State's public health officials to estimate the reporting rate for salmonellosis, even in a highly publicized citywide outbreak, at 0.7 percent (*12*). This rate is consistent with a low rate of medical consultation for salmonellosis, and public health authorities assume a low rate of consultation for IID in general (*13*). The authors' personal opinion is that the medical consultation rate is even lower than 8.3 percent, although the awareness of public scrutiny caused by the meth-

ods of the Tecumseh study could have inflated the consultation rate. However, we used the 8.3 percent estimate for these comparisons.

National Health Surveys

Unpublished data from federally sponsored national health surveys conducted in 1979, 1980, and 1981 generally reinforce the prospective study estimates of the rate of physician consultations, but do not agree with the estimates of nonconsultation cases. Table 5 presents characteristics of the National Medical Care Utilization and Expenditure Survey (NMCUES) (*14*), the National Health Interview Survey (NHIS) (*15*), and the National Hospital Discharge Survey (NHDS) (*16*). (The National Ambulatory Medical Care Survey, of the National Center for Health Statistics, has estimates comparable to those of the surveys listed, but its restrictions, such as the exclusion of nursing staff consultations and clinic visits, preclude its use in our estimates). NHDS has been included as a cross-validation of NMCUES and because hospitalized cases are especially severe.

Cases with at least 1 full day of restricted activity. The surveys reported rates of IID cases with at least 1 full day of restricted activity of 0.028 and 0.049 per person-year (table 5), about an eleventh to a seventh as often as the 0.32 rate of the Tecumseh study. A better argument may be made for underreporting IID in the surveys than for overreporting or nonrepresentation in the Tecumseh study.

The probability of underreporting in the national surveys, primarily those cases in which a physician was not consulted, is indicated in table 6. The rates were derived from unpublished computer tabulations provided by the National Center for Health Statistics. The IID incidence rate for NMCUES (*14*) was 57 percent of that in the NHIS sample (*15*). A possible reason for the difference is that NMCUES subjects were asked to recall information 3 to 4 months in the past, compared with the 2-week recall period of NHIS.

Another reason for the difference in incidence could be the likelihood that a NMCUES respondent would have had to report other illnesses, especially respiratory, occurring in a household during a 3- to 4-month reporting period. NMCUES emphasized insurance, family income, cost data, and the reasons for preferring a particular medical care setting, which added to the reporting burden. It is difficult to account for the difference between NHIS and Tecumseh study results on a survey question as definite as a consultation with a physician in the preceding 2 weeks. Responsible factors could be consultation differences between 1965–71 and 1980, demographic differences between the town of Tecumseh and the nation, and differing survey designs.

Table 6. Projections of IID and CNGC incidence from a community-based, long-term study and two national surveys

Cases	Cases per person-year		
	Tecumseh	NHIS	NMCUES
IID with consultation by physician	0.051	0.021	0.012
IID without consultation, with more than 24 hours of restricted activity	0.270	0.027	0.016
IID with neither	0.300	(1)	(1)
CNGC[2] with consultation	(3)	0.026	0.015
CNGC without consultation, with 24 or more hours restricted activity	(3)	0.003	0.010
CNGC with neither	(3)	(1)	(1)

[1]NHIS and NMCUES omit cases with less than 24 hours of restricted activity.
[2]In NMCUES, CNGC is approximated by ICD code 558, noninfective enteritis and colitis; in NHIS, special codes for chronic illness include gastritis and duodenitis, chronic enteritis and colitis, intestinal condition, and stomach trouble not otherwise specified.
[3]Study design would have excluded most chronic conditions, except that initial episodes of allergic symptoms in infants and some other noninfective diseases could have been included in the acute IID incidence.
NOTE: IID is intestinal infectious diseases. CNGC is chronic or other noninfective gastroenteritis and colitis. NHIS is National Health Interview Survey. NMCUES is National Medical Care Utilization and Expenditure Survey.

Cases with both restricted activity and physician consultation. Two structural differences could have contributed to the differences in rates between NHIS and the Tecumseh study with regard to restricted activity and consultation with a physician. First, NHIS looked primarily at health status. In that context, a mild, nonreportable, acute illness might have appeared unimportant. To have been remembered and mentioned, the diarrhea must have been significant to a respondent who also was being asked about the medical histories of several persons; their chronic conditions, such as cancer, heart disease, and disabilities; about their fertility and injuries; and for demographic information.

Second, some acute cases possibly were classified as chronic (such as under ICD-9 code 558) by this oral interview technique. If this happened, the IID rate would have been underestimated. The definitions of NHIS terms used in the analysis (*17*) included gastroenteritis and colitis (with exceptions) among "conditions always classified as

Table 7. Estimates of intestinal infectious diseases incidence after synthesis of estimates from community-based studies and national surveys

Cases	1980 rate per person-year	Cases in 1980 U.S. population (millions)
With consultation by a physician	0.036	8.2
No consultation, with at least 1 full day of restricted activity	0.190	43.1
With neither	0.210	47.7
Total	0.436	99.0

chronic regardless of the onset." The chronic illness rate for these conditions, restricted to those with consultation with a physician, was 0.026, more than the estimate for acute incidence, and the opposite of what might have been expected. Structural differences in the surveys may have been responsible for some of this difference.

The NHIS incidence rate was only 40 percent of the Tecumseh study rate; NHIS may have picked up a smaller percent of IID consultations with physicians because of survey structure. The finding of a lower rate by NHIS suggests that the Tecumseh study rate for cases with physician consultation may have been higher than the national average. As a working estimate, the authors recommend 0.036, the midpoint between 0.051 (Tecumseh) and 0.021 (NHIS). This assumes

- Some part of NHIS's 0.026 incidence of chronic gastroenteritis and colitis was actually acute IID;
- Some respondents underreported IID in the context of a far-ranging and lengthy NHIS survey that does not focus on mild, nonreportable, acute illness;
- Some of Tecumseh's incidence was noninfectious, acute illness or early-stage chronic disease, instead of acute IID; and
- The attention focused by the Tecumseh study interviews could have motivated a higher than normal rate of physician consultation.

The assumptions are arguments for the reasonableness of using the midpoint as an estimate rather than conclusions implied by the difference in the rates.

Cases with restricted activity but no consultation with a physician. The cases without consultation (table 6) present another disparity. The reasons NMCUES rates for consultation with a physician are only 60 percent of the NHIS rates may apply to cases without consultation with a physician. Therefore, what needs to be considered is the 10-fold difference in rates between the Tecumseh study and NHIS.

First, compare rates of illnesses for which a physician was consulted with those for which there was no consultation. The rates were obtained by an interviewer asking a household resident whether medical care had been obtained for a sick child. That the interviewers obtained as many responses of no consultation as they did credits their skill and training. The Tecumseh study population had large numbers of young children. Even for Tecumseh cases with at least 1 full day of restricted activity, only 16 percent led to consultation.

The NHIS results suggest that a physician was consulted for 45 percent of the restricted activity illnesses. The structural reasons for underreporting of IID in NHIS, however, had even stronger effects on the numbers of illnesses that did not involve physicians than on those that did. Because such increased underreporting would inflate the relative rate of consultation, and because widespread public health experience shows much lower consultation rates (*12,13*), the lower consultation percentage of the Tecumseh study is more likely, and lends credence to Tecumseh's higher incidence of nonconsultation cases.

Second, consider that the 1979–81 NHIS survey omitted all nonconsultation cases with less than a full day of restricted activity. Some reporting effort was spared if the NHIS interviewer and the respondent could agree that the restriction was less than a full day. (Tecumseh recorded the extent of restricted activity, but the amount of reporting required was independent of it.) There was an extra structural opportunity in NHIS to bypass those illnesses with no consultation. Both the length of the survey and its focus on the underlying state of health supplied motives for omission. Many of the illnesses with no consultation may have been excluded from the survey, even if they were remembered, because their period of restricted activity was underestimated.

Another uncertainty involves the possibility that the Tecumseh study illnesses with no consultation included chronic or other noninfectious gastroenteritis or colitis (CNGC). Both NHIS and NMCUES show such low rates of CNGC nonconsultation as to indicate that most such illnesses get medical attention. Because they do not

Table 8. Cost estimates for medical expenses and value of lost productivity from intestinal infectious diseases, U.S. population, in 1985 dollars

Cases	Number of U.S. cases in 1980	Medical cost per case (dollars)	Lost productivity value per case (dollars)	Medical cost (dollars in millions)	Lost productivity value (dollars in millions)	Combined cost (dollars in millions)
Hospitalized with consultation by physician	250,000	$2,255	$783	$560	$200	$760
Nonhospitalized, with consultation by physician	7,900,000	87	261	690	2,060	2,750
No consultation by physician	90,800,000	0	215	0	19,500	9,500
Total (rounded)	...	...	...	$1,250	$21,800	$23,000

NOTE: Dollar values were projected to 1985 to facilitate their use in health program analyses.

necessarily obtain consultation at first occurrence, however, some nonconsultation first occurrences of chronic diseases probably were included in Tecumseh study figures. To allow for this uncertainty in our analyses we reduced the estimated incidence by 30 percent (the same percentage by which the consultation estimate was reduced) to give a rate of 0.19 cases per person-year.

Cases with less than 1 full day of restricted activity. The Tecumseh study showed that the number of illnesses for which there was no consultation, with less than 1 full day of restricted activity, was almost half of the incidence of IID. Infants and preschool children were probably heavily represented in this statistic, because definitions of usual activity are vague for the very young. For the reasons expressed previously, we reduced this rate by 30 percent to 0.21.

Reconciled Estimates

Table 7 summarizes our estimates of IID for the United States. The rates are expressed in terms of the expected number of cases per person-year. For example, the 0.44 estimated total rate means that we could expect 44 cases in 1 year among a random sample of 100 persons. Almost half of those 44 cases would involve neither consultation with a physician nor a full day of restricted activity. The physician consultation rate of 0.036 implies that a person might expect to see a physician for IID once in 25 to 30 years, typically as two physician visits in childhood and none as an adult. As these figures are statistical expectations, actual experiences are likely to vary widely. Table 7 shows these rates multiplied by the 1980 population estimate and rounded. The case total of 99 million may appear large to those accustomed to evaluating only foodborne IID. Our analysis included IID spread by all vectors, much of it of unknown etiology.

The incidence of hospitalization was estimated for the cost analysis. NMCUES estimated 260,000 IID hospitalizations in 1980, from a statistical base of 17,600 persons. This reinforces the NHDS estimate in 1983 of 237,000 for all listed diagnoses for IID, from a statistical base of 206,000 hospital discharge records of short-stay, nonfederal hospitals (*16*). A rough estimate of 250,000 for the entire population would be suggested by these two estimates.

Cost Estimates for IID

In estimating the social cost of IID, we have omitted from our analyses several concepts of costs which are not sufficently accepted or understood at this time. One is loss of leisure time. Curtin (*18*) stated that loss of leisure time from acute illnesses should be counted as a public cost because the activity restriction continues through working and leisure time. He used a ratio of 1.6:1.0 of interchangeable leisure time to work time to suggest that, on average, 1.6 hours of leisure time are lost for every hour of work time. While he valued leisure time at the working wage rate or the household work rate, there are arguments for both higher and lower rates. Using Curtin's wage-equality position would add $35 billion in costs of lost leisure time to the annual losses from IID.

Another example of a valid cost is pain and worry caused by illness. Additionally, significant costs could be ascribed to chronic sequelae if their extent were better known. Self-medication, if frequent, would be a sizeable cost, but data are not available.

In this analysis, only two costs of acute episodes were estimated, namely, medical expenditures, in-

sured or not, and lost productivity of the sick person and family care providers. Productivity was evaluated at the daily wage rate.

NMCUES has the most significant data base on medical costs in the United States. The study data indicate that the average medical costs per IID case in 1980 were $1,342 per hospitalization and $52 per nonhospitalized case with consultation by a physician.

In a study of a Denver, CO, salmonellosis outbreak (*12*), lost productivity costs in 1976 were (*a*) $455 per case requiring hospitalization ($1,750 total cost, minus $1,295 medical cost), (*b*) $152 per case requiring consultation by a physician and without hospitalization ($222 total cost, minus $70 medical cost [telephone communication, M.L. Cohen, MD, Deputy Director, Division of Bacterial Diseases, Center for Infectious Diseases, CDC, January 14, 1986]), and (*c*) $125 per case without consultation by physician. Factor (*c*) was applied to all nonconsultation illnesses, including those with less than a full day of restricted activity.

Although the preceding estimated cost of an average illness with less than a full day of restricted activity is probably high, it could be low for an average IID illness with more than a full day of restricted activity. Cost factor *c* approximates the average for the whole set of nonconsultation cases, but not for either subset.

An adjustment for 1985 dollars was made. Inflation of the value of lost productivity was approximated by the inflation factor for average earnings of production or nonsupervisory workers on private nonagricultural payrolls. According to the Department of Labor, that factor increased by 72 percent from 1976 to 1985; from 1980 to 1985, hospitalization costs per day rose 68 percent and physician fees increased 48 percent (*19,20*). The 1985 cost model in table 8 was derived by applying these inflation rates.

Conclusions

The authors recommend the estimates shown in table 8 as appropriate bases for public health planning and economic studies and evaluation concerning IID. We estimate annual incidence rates for IID of 250 thousand hospitalizations; 7.9 million cases with consultation by physician and without hospitalization; and 90.8 million cases without consultation by physician, of which 47.7 million experienced less than a full day of restricted activity.

We estimate $1.25 billion in medical costs and $21.8 billion in lost productivity costs (table 8).

We recommend that economic theorists who are performing health cost analyses apply their cost methodologies and data to the IID estimated incidence rates and lost productivity costs shown. We believe that further analyses will show that the social cost of IID to the national economy substantially exceeds the $23 billion we have estimated for 1985.

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Employee Smoking Behavior Changes and Attitudes Following a Restrictive Policy on Worksite Smoking in a Large Company

LYLE R. PETERSEN, MD
STEVEN D. HELGERSON, MD, MPH
CAROL M. GIBBONS, MS
CHANELLE R. CALHOUN, MPH
KATHERINE H. CIACCO, MPH
KAREN C. PITCHFORD, MPH

Dr. Petersen is a Preventive Medicine Resident with the AIDS Program at the Centers for Disease Control. He is a former Epidemic Intelligence Officer with the Connecticut State Department of Health Services. Dr. Helgerson is a Senior Epidemiologist with the Indian Health Service, Public Health Service. Ms. Gibbons is the Fitness Program Director of the Connecticut Mutual Life Insurance Company. Ms. Calhoun, Ms. Ciacco, and Ms. Pitchford were graduate students at the Department of Epidemiology and Public Health, Yale University School of Medicine.

Tearsheet requests to Dr. Steven D. Helgerson, Indian Health Service, 7900 South "J" Stock Rd., Tucson, AZ 85746.

Synopsis

A Connecticut insurance company adopted a policy prohibiting smoking in all work areas. Three months later, the authors assessed smoking behavior changes and attitudes of a sample of 1,210 employees, 56.6 percent of the total.

The survey showed that the policy of no smoking in the work areas did not markedly affect smoking cessation, that it reduced cigarette consumption for those who continued to smoke, that those who previously smoked most were most likely to reduce consumption, and that despite negative feelings about the policy by smokers, only 29 percent of smokers and 4 percent of nonsmokers wanted a worksite smoking policy eliminated.

During the 1-year prepolicy period, smoking prevalence decreased from 25.2 percent to 23.6 percent of the sample. During the 3-month postpolicy period, smoking prevalence decreased to 22.0 percent. During the prepolicy period, consumption did not change significantly (from 0.99 to 0.95 packs per day) and few smokers increased (11 percent) or decreased (13 percent) consumption. During the postpolicy period, consumption decreased by 32 percent to 0.67 packs per day, and 12 times as many smokers decreased (44 percent) as increased (3.5 percent) consumption. Of those who smoked at least two packs per day, 93 percent smoked less after the policy. Among nonsmokers, 70 percent thought the policy had a positive overall effect on the work environment, compared with 19 percent of smokers.

CIGARETTE SMOKING is considered the largest cause of preventable premature death and disability in our society. It is 1 of the 15 health priority areas spotlighted by the Public Health Service's Objectives for the Nation initiative (*1,2*). The increasing awareness of the health consequences of smoking, particularly the possible danger of passively inhaled smoke by nonsmokers, has focused attention on smoking in the workplace (*3,4*).

Legislation regulates smoking in the workplace in 22 or more States. Three recent surveys indicate that 32 to 36 percent of businesses have enacted