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VALUE IN HEALTH

Economic Costs of Influenza-Related Work Absenteeism

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ABSTRACT

Background: Influenza vaccinations are currently advocated only for individuals over age 50. However, vaccination of all working-age people may be warranted based on reduced absenteeism from work.
Objective: This study aims to quantify the association between lost workdays and influenza, controlling for other factors. A secondary aim of the study is to assess the net benefit of expanded vaccination in a workplace setting.
Research design: Multivariate regression analyses of the 1996 Medical Expenditure Panel Survey Household Component are used to estimate the number of workdays missed because of influenza-like illness (ILI) when controlling for other health, demographic, and employment factors. Mean productivity costs are measured in terms of absences from work and valued in dollar terms. The net benefit of influenza vaccination is estimated using a simple decision analysis.
Subjects and measures: Health, demographic, and employment data for employed individuals between the ages of 22 and 64 years are analyzed.
Results: The average number of workdays missed due to ILI was 1.30 days, and the average work loss was valued at $137 per person. The vaccine strategy was not preferred in the baseline analysis; however, this result was sensitive to assumptions regarding the incidence of influenza, the cost of delivering the vaccine, and the productivity impact of worker absenteeism. Moreover, nonproductivity benefits of vaccination were omitted.
Conclusions: The economic attractiveness of expanded investment in influenza vaccination hinges on employer- and population-specific assumptions. Our analysis provides a simple framework within which competing considerations of disease epidemiology, worker productivity, and economic cost may be weighed.
Keywords: absenteeism, influenza, MEPS, productivity costs.

Introduction

Influenza epidemics occur nearly every year from the late fall through the early spring. In the United States, the disease causes an average of approximately 110,000 hospitalizations and 20,000 deaths per year and imposes a significant economic burden [1]. Treatment and hospitalization occur frequently in high-risk populations, including people 65 years or older and those of any age with underlying chronic respiratory, cardiovascular, metabolic, or renal diseases [2]. Even for healthy adults, the typical symptoms of influenza can restrict daily activities. Kavet [3], in 1977, estimated that the costs of work loss due to influenza ranged from $0.5 to $2.0 billion, using epidemic models for which the incidence of influenza was assumed to range from 11% to 26%.

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The cost-effectiveness of influenza vaccination for elderly and other high-risk populations is well established [4]. Indeed, the Advisory Committee on Immunization Practices has recommended annual vaccination against influenza for individuals older than 50 years and all adults and children with chronic medical conditions [1]. However, whether vaccination is cost-beneficial for the working-age population has not been determined. While recent studies show that vaccination programs reduce health costs in large corporate settings [5–9], the generalizability of these findings to all working-age individuals is not clear. Nichol [10] conducted a cost-benefit analysis of vaccination using a Monte Carlo decision model to adjust for demographic characteristics, year-to-year variability, and vaccine efficacy rates. However, this analysis still relied upon the corporate study results cited above for its base-case estimates of worker absenteeism (base case: 2 days; range: 0.75–4 days).

The present study is motivated by the hypothesis that there are potential societal gains to be

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enjoyed from greater investment in the vaccination of employed, working-age individuals. To that end, we aim to estimate the economic costs of influenza-related absenteeism from work using nationally representative samples and to compare these to the estimated costs of increased vaccination. Such information could help to support revision of current guidelines to include working-age individuals. It could also help both employers and employees to identify the degree to which they would benefit from worker vaccination and the extent to which they might be willing to bear a share of any new vaccination program implementation costs.

Data

Source

The data for this study were taken from the 1996 Medical Expenditure Panel Survey (MEPS). The MEPS is a nationally representative survey of medical care use and expenditures conducted by the Agency for Healthcare Research and Quality (AHRQ) [11]. The Household Component (HC) of the MEPS includes detailed data on demographic characteristics, health conditions, health status, use of medical care services, charges and payments, access to care, health insurance coverage, income, and employment. The MEPS sample was drawn from respondents to the National Health Interview Survey. Data were collected via a preliminary contact followed by a series of six rounds of interviews over a 2.5-year period. The public use data files of the MEPS are available on the Internet at the AHRQ home page (http://www.meps.ahrq.gov [last accessed on May 10, 2002]).

The present study used the following data files: 1) Medical Conditions (HC-006); and 2) 1996 Full Year Consolidated Data File (HC-012). Based on US influenza surveillance data, widespread influenza activity during the 1995–96 seasons started the week ending November 25 and lasted until the week ending March 16 [12]. To enhance the likelihood that we would capture only influenza-related workdays missed, we used survey data collected only during round 1 of the MEPS follow-up interviews from January 1, 1996, to the next field interviews conducted from March through July 1996.

Study Sample

The study sample includes all working, non-self-employed people between the ages of 22 and 64 years. Self-employed individuals were excluded from the analysis because job benefits such as paid sick leave were not specified for these individuals. The HC-012 contains records of 21,750 eligible individuals in Round 1. The data of 10,156 people were excluded because they were either younger than 22 years or older than 65 years during the interview period. The data of 4368 persons were also excluded because they were either self-employed or not employed. Of the 7226 remaining observations, the data of 189 were excluded because of missing information about missed workdays (147 cases) or hourly wage (42 cases). As a result of these various exclusions, the data of 7037 observations were analyzed for this study.

Study Variables

Work loss. This study restricts attention to the work- and productivity-related costs of influenza and influenza-related absenteeism. We adopt this perspective to inform employer and employee decisions regarding vaccination. Our analysis is premised on the assumption that there may be gains to be enjoyed by both workers and employers from greater investment in the vaccination of employed, working-age individuals. We therefore aim to provide information that could help both workers and employers to determine whether they might enhance productivity by funding a vaccination program.

Costs of influenza were measured in terms of absences from work. Loss of life and unemployment due to long-term disability were not considered for this analysis because influenza-related deaths and hospitalizations are relatively rare in the working-age population [13]. Moreover, productivity losses while on the job were not addressed in this analysis because the data related to job performance were limited in the MEPS. The survey asked subjects to specify how many workdays were missed and for what health conditions. A continuous variable (MISSDAYS) indicating how many days an individual missed from work was created from the subjects' responses of missed workdays. All variable names used for this analysis and their descriptions are listed in Table 1. The descriptive statistics for this study population are summarized in Table 2. The average number of health-related missed workdays was 1.81 days. Average hourly wages were $14. We obtained a mean value of 39 usual hours worked per week. However, because data were incomplete on the number of hours worked per time period, we used the median value of 40 hours per week in our analyses.

Table 1 Variable names and their descriptions

Variable	Description
Missed workdays	
MISSDAYS	The number of missed workdays
Wage and hours worked	
HRWG	Hourly wage
HOUR	Usual hours worked per week
Health conditions (HEALTH)	
FLU	Influenza-like illness (ICD-9-CM code 487)
LUNGDIS	Chronic lung disease (ICD-9-CM codes 490–496, 500, 501, 511, 514, and 518)
DIABETES	Diabetes mellitus (ICD-9-CM codes 250, 790, and 791)
HEARTDIS	Chronic heart disease (ICD-9-CM codes 397, 410–414, 424, 428, 429, and 785)
CHRONIC	Other chronic diseases: malignancy (ICD-9-CM codes 140–208), chronic renal disease (ICD-9-CM codes 583, 586, V42, V45, and V56), and HIV infections (ICD-9-CM codes 042, 279, and 795)
Demographic characteristics (DEMO)	
FAMSIZE	Family size
AGE3039	Age 30 to 39 years
AGE4049	Age 40 to 49 years
AGE5059	Age 50 to 59 years
AGE6064	Age 60 to 64 years
FEMALE	Sex female
NONWHITE	Race nonwhite
MARRIED	Being married
EDUNODEG	Education no degree
EDUCOLL	Education bachelor's degree
EDUGRAD	Education master's or doctorate degree
EDUOTHRE	Education other degree
Employment characteristics (EMP)	
SICKPAY	Having sick pay benefits
EMPSIZE2	Number of employees 10–24
EMPSIZE3	Number of employees 25–99
EMPSIZE4	Number of employees 100–499
EMPSIZE5	Number of employees 500 or more
INUNION	A member of a labor union
INDCONST	Employed in construction industry
INDMANUF	Employed in manufacturing
INDTRANS	Employed in transportation, communications, and utilities
INDSALES	Employed in sales
INDFINAN	Employed in financial, insurance, and real estate industry
INDREPAI	Employed in repair services
INDPROFE	Employed in professional services
INDOTHER	Employed in other industries
OCCPPROF	Occupation professional
OCCPMANA	Occupation managerial and administrative workers
OCCPBLUE	Occupation blue-collar workers

Influenza-like illness (ILI) and other health conditions. Information about ILI and chronic conditions that are thought to increase the risks of influenza-related hospitalizations and deaths were taken from the HC-006 using the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) codes. All individuals were asked whether they had any health problems. Individuals who had ILI during Round 1 were identified via self-reports (ICD-9-CM, 487). Approximately 2.5% of the sample reported having ILI in the reporting period. Other health conditions such as chronic lung disease, diabetes mellitus, chronic heart disease, malignancy, chronic renal disease, and HIV infection were also collected from all subjects' responses to the question of medical conditions. These are included to control for other sources of sick days.

Demographics and employment. Demographic and employment variables were taken from the HC-012. For demographic characteristics, a series of dummy variables indicating age, sex, race, marital status, family size, and educational background were created. As for employment characteristics, dummy variables indicating industry type, occupation type, and the number of people employed in the subjects' place of work were included for this analysis. Because sick pay benefits may increase days of absence from work, a variable measuring whether individuals had such benefits was included. Union membership was also included

Table 2 Sample (N = 7037) descriptive statistics

Variable	Mean	SD	Minimum	Maximum
Missed workdays*	1.81	7.36	0	180
Hourly wage	14.09	31.00	0.03	2125
Usual hours worked per week†	39.01	9.54	1	168
ILI	0.03	0.16	0	1
Chronic lung disease	0.04	0.20	0	1
Diabetes mellitus	0.02	0.15	0	1
Chronic heart disease	0.01	0.12	0	1
Other chronic diseases	0.01	0.10	0	1
Family size	3.08	1.52	1	14
Age (years)				
30 to 39	0.33	0.47	0	1
40 to 49	0.28	0.45	0	1
50 to 59	0.14	0.35	0	1
60 to 64	0.03	0.18	0	1
Sex female	0.50	0.50	0	1
Race nonwhite	0.17	0.38	0	1
Being married	0.69	0.46	0	1
Education				
No degree	0.18	0.38	0	1
Bachelor's degree	0.19	0.39	0	1
Master's or doctorate degree	0.08	0.26	0	1
Other degree	0.08	0.28	0	1
Having sick pay benefits	0.65	0.48	0	1
Number of employees				
10–24	0.15	0.35	0	1
25–99	0.26	0.44	0	1
100–499	0.24	0.42	0	1
500 or more	0.17	0.38	0	1
A member of a labor union	0.16	0.36	0	1
Construction industry	0.04	0.20	0	1
Manufacturing	0.19	0.40	0	1
Transportation, communications, and utilities	0.07	0.26	0	1
Sales	0.17	0.37	0	1
Financial, insurance, and real estate industry	0.07	0.25	0	1
Repair services	0.06	0.24	0	1
Professional services	0.26	0.44	0	1
Other industries	0.11	0.32	0	1
Professional	0.19	0.39	0	1
Managerial and administrative workers	0.14	0.35	0	1
Blue-collar workers	0.28	0.45	0	1

*The distribution of the "missed workdays" variable has point mass of 66% on the value 0, 24% on values between 1 and 3, and all but 0.06% of the remainder between 4 and 99. This suggests a high degree of positive skewness and explains our choice of the NB regression model.
†Because the number of hours worked per time period was not available in 126 samples, a value of 40 hours per week was assumed as median value of the study samples.

because greater job security may also increase absences.

Models and Estimations

Number of Missed Workdays

Information on ILI and other chronic health conditions was collected from all subjects, regardless of whether or not they were employed during the survey period. Employed subjects were then asked to report the number of days missed from work related to these health conditions. Unfortunately, there is no direct indicator of how many days lost are due to a specific health condition. Thus, we estimate the number of workdays missed due to ILI controlling for other chronic conditions. We estimate days lost due to ILI as follows:

$$\text{MISSDAYS} = f(\text{ILI, HEALTH, DEMO, EMP}) + \varepsilon, \quad (1)$$

where ILI is a dummy variable indicating the presence of ILI, HEALTH is a vector of variables indicating an individual's health conditions, DEMO is a vector of variables describing demographic characteristics, EMP is a vector of variables describing employment characteristics, and ε is an error term.

The dependent variable, missed workdays, did not satisfy the basic OLS normality assumption [14]. The distribution was skewed with two-thirds of the sample having no day missed, approximately 24% of the sample with 1–3 days missed, and 0.06% of the sample with more than 100 days missed. We therefore used the negative binomial

(NB) regression instead, because it is often more appropriate to analyze non-negative, left-skewed count data. The NB model is an extension of the Poisson model and adds an extra parameter to permit the mean to differ from the variance, as it does in this case [15]. All statistical analyses were conducted using STATA version 6.0 (Stata Corporation, College Station, TX).

Our aim was to calculate the incremental number of workdays missed due to ILI, holding all else constant. In the NB model, calculating the partial derivative of the impact of the change in ILI on days missed is more complicated than it would be for OLS. We calculated the incremental effect of ILI on the number of workdays missed (Δdays) using the following the method: We first assumed all individuals suffered from ILI (i.e., set ILI = 1) and then estimated the number of workdays lost under these conditions ($\hat{y}_{Ai}$). We then supposed that no individuals suffered from ILI (set ILI = 0) and estimated the lost workdays ($\hat{y}_{Bi}$) attributable to each individual. Comparing these two findings yielded an estimate of the impact of ILI on work loss days:

$$\Delta\text{days}_i = (\hat{y}_{Ai}) - (\hat{y}_{Bi}) = \exp(x_{Ai}\beta) - \exp(x_{Bi}\beta) \quad (i = 1, 2, \ldots, n) \qquad (2)$$

Costs of Absenteeism

Costs of lost workdays were calculated by multiplying the estimated number of workdays missed by the daily wage attributable to each individual. The availability of individual-specific hourly wages and usual hours worked per week is an advantage over previous studies [16]. However, because ILI is reported in days lost, we converted data on hours worked per week and hourly wage rates to income per week. To obtain a daily rate, we divided by days worked. Unfortunately, we did not have data on the number of days worked. Instead, we assumed that all individuals worked 5 days per week. This seems to be a good estimate because approximately 85% of the sample reported that they usually worked between 30 and 50 hours per week.

Using this method we calculated an estimate of the mean productivity costs (MPC) associated with influenza:

$$\text{MPC} = \frac{1}{n}\sum \Delta\text{days}_i \times \frac{\text{hr}_i \times \text{wage}_i}{5} \quad (i = 1, 2, \ldots, n) \qquad (3)$$

where Δdays_i is the estimated number of days lost due to ILI, wage_i indicates the hourly wage ($/hr), hr_i indicates usual working hours per week, and n indicates the number in the sample.

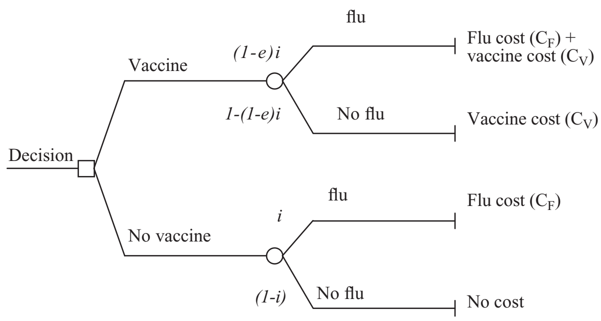

Figure 1 Decision tree for net benefit to vaccination.

Decision Analysis for Evaluating Net Benefit of Vaccination

The net benefit of vaccination cannot be evaluated simply by comparing the cost of ILI with the cost of vaccination. The comparison must be made between total expected costs with and without the vaccine, taking into account the incidence of infection and both the costs and the efficacy of vaccination. We developed a simple decision model to evaluate the net benefits, as shown in Fig. 1. The decision is simply to vaccinate or not. The incidence of ILI is given by variable *i*. The efficacy of the vaccine (measured as a percent reduction in the incidence of infection) is given by variable *e*. Thus, the incidence of ILI for those who are vaccinated is $(1 - e)i$. The per-person cost of vaccination is C_V. The value of all wages forgone (which we use as a proxy for the costs of getting the flu) is C_F. We acknowledge that this is an underestimate of the true cost and consider adjustments to this in our discussion of sensitivity analysis, below. Averaging out gives us the expected cost of the "vaccine" strategy,

$$C_V + C_F(1-e)I, \qquad (4)$$

and the expected cost of the "no-vaccine" strategy,

$$C_F * i. \qquad (5)$$

A simple decision rule would be to vaccinate whenever the expected cost of doing so is less than the expected cost of failing to vaccinate, a condition given by the following expression:

$$C_V + C_F(1-e)i > C_F * i \Rightarrow C_V / C_F < ie. \qquad (6)$$

Results

Estimation of the Number of Missed Workdays

Table 3 presents the regression coefficients of missed workdays. The NB model indicates a greater number of workdays missed for people who had

Table 3 Regression analysis predicting the number of missed workdays

Variable	NB model Coefficient	SE
ILI	0.535†	0.192
Chronic lung disease	0.834†	0.150
Diabetes mellitus	−0.033	0.212
Chronic heart disease	1.286†	0.256
Other chronic diseases	1.428†	0.302
Family size	−0.005	0.022
Age (years)		
30 to 39	0.305†	0.086
40 to 49	0.230*	0.092
50 to 59	0.379†	0.109
60 to 64	0.988†	0.195
Sex female	0.490†	0.069
Race nonwhite	−0.042	0.083
Being married	−0.260†	0.074
Education		
No degree	0.076	0.091
Bachelor's degree	−0.195*	0.098
Master's or doctorate degree	−0.434†	0.145
Other degree	−0.062	0.117
Having sick pay benefits	0.204†	0.074
Number of employees		
10–24	−0.160	0.111
25–99	0.160	0.097
100–499	0.308†	0.104
500 or more	0.548†	0.111
A member of a labor union	0.231*	0.090
Construction industry	0.154	0.258
Manufacturing	−0.108	0.225
Transportation, communications, and utilities	0.136	0.241
Sales	0.220	0.230
Financial, insurance, and real estate industry	−0.163	0.255
Repair services	0.152	0.249
Professional services	0.179	0.230
Other industries	0.089	0.238
Professional	−0.176	0.106
Managerial and administrative workers	−0.163	0.107
Blue-collar workers	0.360†	0.097
Intercept	−0.348	0.256

*Significant at $P < .05$.
†Significant at $P < .01$.

health conditions other than diabetes, were 30 years or older, were female, had sick pay benefits, worked at a large company, were union members, or were blue-collar workers. Those who were married or had college or higher degrees missed fewer days of work.

From the NB model, the incremental effect of ILI on the number of days missed was calculated using the equation $(\hat{y}_{Ai}) - (\hat{y}_{Bi})$, as described previously. The results suggested that an individual who had ILI missed 1.30 days more compared to one who did not have ILI. We interacted the impact of ILI and chronic conditions; however, there were no significant interaction effects to report here.

Costs of Absenteeism

Mean absenteeism costs because of ILI are estimated to be $137 per person in 1996 dollars.

Net Benefit to Vaccination

To calculate the net benefits to vaccination, we start with baseline values. We then use alternative values to determine how sensitive the conclusions are to the initial values.

Baseline Analysis

We set the following values for the baseline analysis: $C_V = \$16.70$; $C_F = \$137$; $i = 2.5\%$; and $e = 80\%$. We use the influenza prevalence rate reported in the MEPS as our baseline incidence estimate (i). As our proxy for the cost of influenza (C_F), we use our calculation for lost wages. We use a value of 80% for the vaccine efficacy (e) based on the information that the vaccine is estimated to be between 70 and 90% effective in preventing illness of healthy persons younger than 65 years when there is a good match between the vaccine and the circulating viruses [17]. As for the cost of delivering the vaccine, we use the value reported by Nichols [10] that includes direct and indirect medical costs as well as costs of potential side effects. Thus, our vaccine delivery cost includes both direct and indirect components, while our measure of the savings to be enjoyed by averting a case of influenza includes only indirect effects. Given that our purpose is to portray the net value of vaccination, this represents a conservative approach. Using these baseline numbers, we estimate that $C_V/C_F = \$16.70/\$137 = 0.1219$ and $ie = 0.025 \times 0.80 = 0.020$, suggesting that the expected cost of the decision to vaccinate exceeds the expected cost of not vaccinating.

One-Way Sensitivity Analysis

Specific parameter values will vary across both employers and worker populations. Employee age, sex, education, socioeconomic status, and other variables may all greatly influence rates of influenza incidence. The probability of flu-associated hospitalizations and outpatient visits, which are important cost outcomes, would be substantially higher in persons with chronic conditions than among healthy persons. Moreover, the incidence of influenza varies yearly, making it difficult to compare across years and thus across studies [18]. In a study conducted more than 20 years ago, the incidence was approximately 5 to 10 times higher than that observed in our study [3]. A review by Bridges et al. [6] reported that influenza incidence varied between 1 and 26% among people aged 18 to 64 years depending on influenza seasons and the demographic characteristics of the study populations.

We adopted a conservatively low 2.5% incidence

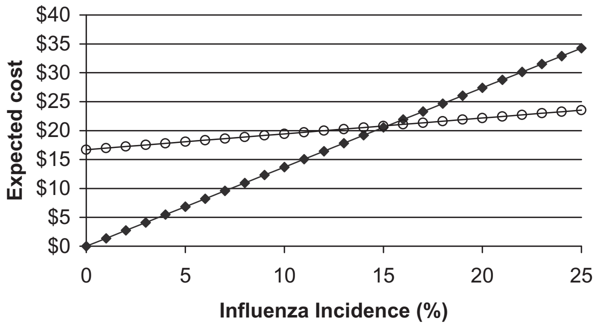

Figure 2 Sensitivity analysis: impact of incidence. (◆) No vaccine; (○) vaccine.

value for our baseline assumption. The one-way sensitivity analysis depicted in Fig. 2, however, considers the impact of alternative incidence assumptions on the optimal decision. We hold variables C_V, C_F, and e at their baseline values and consider the changes in incidence variable, i ranging from 0% to 25%. When $i = 0$, there is no influenza and (not surprisingly) the expected cost of the no-vaccine strategy is $0; the expected cost of the vaccine strategy is simply the cost of the vaccine itself ($16.70). Rising incidence levels cause the expected costs of both strategies to rise; however, the cost of the no-vaccine strategy rises more steeply. At an incidence level of 15.2%, the two strategies have equal expected costs, suggesting that this is the population incidence level at which a cost-minimizing decision maker would be indifferent between vaccinating and not vaccinating, given our assumptions.

The 15.2% incidence threshold will vary, depending on what is assumed about the efficacy of vaccination. Our baseline efficacy assumption of 80% is the figure cited in the literature for vaccines against serologically confirmed influenza illness in healthy persons. However, actual vaccine efficacy against ILI may be substantially lower for a number of reasons. First, the influenza vaccine does not protect against flu-like illnesses; Demicheli and coworkers [19], for example, have obtained estimates of vaccine efficacy as low as 24% in studies where the diagnosis of influenza was based on clinical findings but not confirmed serologically. Second, vaccine efficacy may be lower for persons with chronic conditions. Vaccine efficacies ranging from 30% to 60% have been reported among elderly patients [20–22]. Finally, poor matches between the vaccine and circulating viruses are always a concern. Not surprisingly, the vaccine strategy's attractiveness is reduced when a lower vaccine efficacy is assumed. By way of illustration, if we assume the vaccine efficacy to be 50% rather than 80%, the incidence threshold that leaves decision makers indifferent between vaccinating and not vaccinating would rise from 15.2% to 24.4%. Further reducing the vaccine efficacy to the value of 24% reported by Demicheli et al. [19] produces an incidence threshold of 50.8%.

Similar threshold points of indifference (holding all other variables at their baseline values) can be obtained for each of the other parameters in this analysis. For example, the threshold cost of the vaccine is C_V = $2.74. This suggests that an employer who can take advantage of scale or other economies to drive the costs of the vaccine below $2.74 may, all other things being equal, find it attractive to vaccinate employees. The threshold per-case cost of influenza is C_F = $835. Employers who assign high values to lost productivity due to worker absenteeism can use this figure as a basis by which to measure the value of vaccinating their employees. Employees who wish to consider factors other than the value of lost wages, such as any pain and suffering, lost leisure, or likelihood of spreading the flu to their family, may use a much higher figure as their expected losses and may find the vaccine to be cost-beneficial. In an employee's private decision to get vaccinated, the cost of the vaccine may be zero because of either health insurance coverage or direct provision by the employer.

The following combination of parameter values represents a plausible scenario that portrays the decision to vaccinate in a favorable light: C_V = $8.35 (half of baseline); C_F = $274 (double baseline); i = 5.0% (double baseline); and e = 80%.

Using these numbers, $C_V/C_F = 0.0305$ and $ie = 0.0400$ and, hence, the vaccine strategy is preferred.

Discussion

Net Benefit to Vaccination

This study demonstrates that ILI accounts for millions of days lost from work and causes substantial economic losses to employers via lost productivity. Although our baseline analysis would appear not to favor vaccination as an economically attractive option, this finding is highly sensitive to employer- and population-specific parameter values and includes only some of the relevant benefits. Even small reductions in the cost of delivering the vaccine and/or plausible increases in the incidence of infection, the cost per case, or the benefits of vaccination could reverse our conclusion. For example, there may be ways of reducing the marginal cost of administering the vaccine. These would include delivering the vaccine at the time of a medical visit for another purpose, using a work site location to administer vaccines thus reducing time costs [10], and taking advantage of economies of scale and/or lowering overhead by having a "vaccine day" at work. Furthermore, our incidence rate, 2.5%, may be at the low end of the range—partly because our study focused on only one influenza season (limited data collected from January through June 1996) and possibly because we selected a healthier study population (namely, employed individuals aged 22–64 years). In addition, some individuals in our sample may have received the influenza vaccine, which would again have the effect of biasing our estimates of the benefits in a conservative direction.

Underestimates of ILI Costs

Our estimated cost of ILI to the individual would likely underreport the true costs because of the following reasons: First, days lost from work capture only some of the costs of ILI that could be averted. Other costs include reductions in home productivity, loss of leisure, pain and suffering, and the possibility of spreading the contagious disease to others at home and at work. Second, the costs of physician visit as well as prescription and over-the-counter medications for treatment of influenza symptoms are not included. Finally, because our calculations include the Christmas and New Year's holiday season, we may not capture some workdays lost because of preplanned vacations.

Limitations of the Research Design

Despite the advantages of using data from a nationally representative survey, our study design entails several limitations and our findings must be interpreted with caution. One limitation is that the data on health conditions in the MEPS are poorly defined and based on self-reported—rather than clinically verified—information. There are no clinically verified data on influenza in a large, population-based sample. Even if such data were available, however, it is not clear how useful they would be in light of the fact that not everyone sees a physician when they suffer from influenza. Further, because of interactions with chronic diseases, attribution to flu alone may be difficult. The risk with self-reported data is that some people may be unable to discern whether they had influenza or other respiratory illness. Thus, the impact of influenza on absenteeism might be either underestimated or overestimated. We have tried to adhere to previously published practice, in this regard. Mauskopf and colleagues [23], for example, developed a pharmacoeconomic model of influenza treatment that assumed an equal number of days to alleviate major symptoms in both influenza-positive and ILI patients. Moreover, broad case definitions of influenza have been used in several influenza vaccination studies [5,7]. For example, the US Influenza Surveillance System defines ILI as fever (temperature of >100°F) plus either a cough or a sore throat [12]. Therefore, even though the proportion of ILI that is attributable to influenza versus other conditions with similar symptoms could vary from year to year, our estimate of missed workdays due to ILI, based on 1996 MEPS data, may be generalizable to other settings.

Our estimate of influenza-related workdays missed is smaller than those reported by most other studies. For example, a study conducted in a large pharmaceutical company in the UK reported a mean of 2.8 workdays missed because of influenza-like symptoms [8]. Another study conducted in six Kayser-Roth textile plants in North Carolina reported that participants who had at least one event of ILI lost an average of 1.5 workdays [7]. Possible explanations for these differences in the impact of influenza on absenteeism might have to do with employment characteristics, the severity of the flu season, and the percentage vaccinated. Most previous studies evaluated samples drawn from large companies with generous sick leave benefits, which may result in more days absent. One exception is the study conducted among Ford Motor Company employees, which reported only 0.8 days absent per episode of ILI [6]. But, 35% of our study sample had no sick benefits. Therefore, our findings might be more generalizable to the civilian, noninstitutionalized population in the United States than studies of only workers in large corporations. The discrepancy may also occur because of differences in control variables; we controlled for other health problems that may result in work loss days. Failing to control for other health effects may falsely attribute extra days lost to ILI.

Conclusion

The economic attractiveness of investing in influenza vaccine depends greatly upon the costs of vaccine, the costs of lost time, and the incidence of influenza in a specific population. The simple decision rule we have developed could be useful to decision makers in weighing these competing considerations and tailoring the vaccine decision to the characteristics of specific employers and at-risk employee populations.

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