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COST-EFFECTIVE ANALYSIS OF INFLUENZA VACCINATION IN THE ELDERLY

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ABSTRACT

We analyzed the cost-effectiveness of vaccinating all elderly persons against influenza A on an annual basis. Our model included direct cost attributable to implementing the vaccination program and the cost of medically treating those who remained vulnerable despite vaccination (30%) and later required treatment for disease-related complications in either the hospital or ambulatory setting. Ten and 30% of those susceptible to influenza A were assumed to be infected with the virus of which 30% were considered to require medical treatment. This was compared to a model where no vaccination was given assuming the same rates of infection and required treatment.

We found significant potential savings resulting from the implementation of an influenza control program in both the community and nursing home setting. Savings were most significant when vaccination prevented hospitalization. When vaccination cost was kept to a minimum, however, savings were also noted when medical treatment was able to be accomplished at least in part outside of the hospital.

INTRODUCTION

The rapidly increasing number and proportion of older individuals in the United States is a major public health concern. In 1988, there were 30.4 million persons 65 years of age and older, representing 12.4% of the population. By 2030, this number is predicted to rise to 66 million, or 21.8% (1).

The majority of older persons have at least one chronic medical condition needing ongoing medical care, with many having multiple chronic conditions. As a consequence, our rapidly aging population will contribute significantly to the growing expenditure of health care dollars. In 1987, those older than 65 years of age accounted for 36% of total personal health care expenditures in the United States. These expenditures totaled $162 billion and averaged $5,360 per year for each older person (1). Approximately $1,500, or one-fourth of the average expenditure, came from direct or out-of-pocket payments. Benefits from government programs, including Medicare ($72 billion), Medicaid ($20 billion), and others ($10 billion) covered approximately two-thirds of the health expenditures of older persons during that year (1).

If there is no change in the morbidity from age-prevalent disease and given the fact that persons are living longer, often with long-standing disability, prevention of disease and promotion of health must receive intensified attention in areas of policy, practice, research, and teaching. Efforts made toward preventing an accelerated aging process and age-prevalent disease can yield important benefits not only for those individuals directly affected, but also for society through potential cost savings.

Influenza is one example of a major illness that commonly affects the elderly and which is largely preventable through a vaccination program. Despite this, many persons choose to remain vulnerable. In addition, little has been written regarding the potential cost savings of a universal vaccination program. This study evaluated a theoretical cost-analysis of a preventive influenza vaccination program for elderly persons based on 1990 cost estimates. Our data suggest that universal influenza vaccination programs are cost-effective.

BACKGROUND

Influenza viruses are large ribonucleic acid (RNA) viruses belonging to the myxovirus group and are transmitted by inhalation. The incubation period ranges from one to three days. Characteristically, influenza spreads with unusual rapidity, commonly as an epidemic, producing fever, headache, myalgia, and malaise. Cough and gastrointestinal symptoms may also be noted. The most common complication of influenza is pneumonia with primary viral pneumonia usually developing within 36 hours of onset. This often is life-threatening, especially in the elderly. Secondary bacterial pneumonia may also develop within three to four days after the onset of influenza.

Influenza viruses have been responsible for a number of major epidemics leading to significant morbidity and mortality in the elderly as well as in persons who are considered to be at high risk due to underlying chronic diseases such as cancer, diabetes mellitus, or pulmonary disorders. During six influenza epidemics from 1972 to 1981, total influenza-associated mortality approached 200,000, with more than 80% of these deaths occurring among persons 65 years of age and older (4).

Mortality appears to be highest following infection with type A influenza where secondary bacterial infection is more likely. Type A influenza also more frequently affects the elderly, a group more at risk for lethal outcome (2).

Two measures are available in the United States to reduce the impact of type A influenza: annual immunoprophylaxis with inactivated (killed-virus) vaccine and prophylaxis with the antiviral drug amantadine. This latter treatment is useful only for those who already have been infected with the influenza A virus who failed to be vaccinated.

Vaccination of high-risk patients prior to the influenza season is the single most important measure one can take to reduce the potential impact of influenza. Retrospective studies support the vaccine's efficacy in elderly persons and those at high risk (6). A vaccine wellmatched to the virus strain expected to break out has been reported to be 70%-80% effective and greatly reduces the risk of outbreak and provides a high degree of temporary immunity (7), especially when coupled with high rates of vaccination affording "herd immunity" (8). Infrequent vaccination side effects include fever, malaise, myalgia, and other systemic symptoms. Immediate, presumably allergic reactions, such as hives, angioedema, allergic asthma, or systemic anaphylaxis are extremely rare occurrences following vaccination and most likely result from hypersensitivity to residual egg proteins (7).

In September 1989, the U.S. Preventive Services Task Force recommended that influenza vaccine should be administered annually to all persons aged 65 and older, residents of chronic care facilities, and persons suffering from chronic cardiopulmonary disorders, metabolic diseases, hemoglobinopathies, immunosuppression or renal dysfunction. Health care providers were also advised to be vaccinated against the virus (6). Presently, the Immunization Practices Advisory Committee of the Centers for Disease Control has set a minimum goal of vaccinating 80% of high-risk persons each year in order to maximize the effects of herd immunity.

RESULTS

To vaccinate the entire elderly population of 28.5 million living in the community at the public health rate of $5.00 per person would cost $142 million. Using the private physician rate requiring a specially scheduled visit would cost $1.75 billion. If one were to vaccinate the 1.5 million persons living in nursing homes at the reduced institutional rate of $3.21, the cost would be $4.8 million.

Assuming a 70% vaccine efficacy rate, 8.5 million persons in the community and 450,000 persons in the nursing home setting will fail to produce antibodies and will be potentially vulnerable to the influenza virus.

As would be expected, we consistently found that treating complications in the hospital required the greatest expenditure of health care dollars. For example, if 30% of those persons living in the community who were still vulnerable to influenza (9% of the initial population) became infected and required treatment, it would cost $3.92 billion for hospital treatment as compared to $175.73 million for treatment in the ambulatory care setting.

Even if only 10% of persons living in the community who were still vulnerable to influenza (3% of the initial population) became infected and 30% of these later required treatment, it would cost $1.30 billion and $58.58 million to treat complications in the hospital or ambulatory setting, respectively.

For those in the nursing home setting, comparable costs would be $205.80 million and $6.85 million for hospital or nursing home treatment groups, respectively, if one assumed 30% became infected and $68.6 million and $2.83 million if only 10% became infected.

Total cost was defined as the cost of implementing a control program plus the cost associated with treating vaccination failures for those who required subsequent medical care for disease-related complications (see Table 1).

Assuming no vaccination program, if 30% of the 28.5 million community-dwelling elderly were infected with influenza and of these, 30% required treatment in the hospital or ambulatory setting, cost would total $13.10 billion and $585.75 million, respectively. If only 10% of those in the community were to be infected, of which 30% later required treatment in the hospital or ambulatory setting, the cost would be $4.34 billion and $194.87 million, respectively.

Assuming no vaccination and that 30% of the 1.4 million institutionalized elderly were infected with influenza and of these, 30% required medical treatment in the hospital or nursing home setting, the cost would be $686.01 million and $22.83 million, respectively. Even if only 10% of these within the nursing home were to acquire influenza, and of those, 30% required treatment in the hospital or nursing home setting, it would cost $228.67 million and $7.61 million, respectively (see Table 2).

Significant potential savings resulted from implementing an influenza immunization program in both the community and nursing home settings. Based on our model and the need to hospitalize 30% of those infected, if every community-dwelling elderly person were to be vaccinated against influenza, assuming a vaccination cost of $5.00 or even $61.46 per person, there would be a potential net savings in hospitalization costs alone of $9.04 billion and $7.43 billion, respectively, assuming a 30% rate of infection. Significant cost savings were noted even when only 10% of vaccinated persons were infected with influenza assuming 30% of those needed to be hospitalized; there was a savings of $2.9 million and $1.29 million, assuming a vaccination rate of $5.00 and $61.46, respectively.

If complications for influenza were able to be treated in the ambulatory care setting, the break-even point for a cost-effective vaccination program was $14.38 per vaccination assuming a 30% infection rate and $4.78 per vaccination assuming a 10% infection rate. Once again, in both cases, 30% of those infected were assumed to require medical treatment. It is of interest that the allowable Medicare cost of a vaccination given during an otherwise scheduled medical appointment is $15.00.

When 30% of those persons vaccinated in the nursing homes acquired the virus and 30% later required treatment for complications in the hospital or nursing home setting, respectively, a potential savings of $475.4 million and $11.17 million was noted. In fact, there was a net savings of $55.26 million when as few as 10% of persons in nursing homes were infected based on our model and the use of the hospital for required medical treatment. It was of interest, however, that if only 10% of persons in nursing homes become infected, vaccination appeared to be cost-neutral.

Table 1. Total cost to implement a universal influenza control program[3].

COMMUNITY — 28.5 million persons

Vaccination cost	Percent acquiring influenza A[4]	Cost of treating influenza A complications[2] site of treatment		Total cost[1] site of treatment	
		Hospital	Ambulatory	Hospital	Ambulatory
$5.00/person	30	$3,922	$176	$4,064	$318
	10	$1,303	$59	$1,445	$201
$61.46/person	30	$3,922	$176	$5,672	$1,926
	10	$1,303	$59	$3,053	$1,808

NURSING HOME — 1.5 million persons

Vaccination cost	Percent acquiring influenza A[4]	Cost of treating influenza A complications[2] site of treatment		Total cost[1] site of treatment	
		Hospital	Ambulatory	Hospital	Ambulatory
$3.21/person	30	$206	$7	$211	$12
	10	$69	$3	$73	$8

[1]Includes cost of vaccination of entire population at given rate and cost of treating the 30% still vulnerable to influenza
[2]Assumes 30% of persons infected will require treatment
[3]All dollars are in millions
[4]Assuming 70% efficacy rate, 9% and 3% of initial population are infected with the virus

Table 2. Total cost to treat influenza A complications in the elderly population receiving no vaccination[2]

COMMUNITY — 28.5 million persons

Persons acquiring influenza A virus	Cost of treating influenza Complications[1] site of treatment	
	Hospital	Ambulatory
30% (8.55 million persons)	$1,310	$586
10% (2.85 million persons)	$4,344	$195

NURSING HOME — 1.5 million

Persons acquiring influenza A virus	Cost of treating influenza Complications[1] site of treatment	
	Hospital	Ambulatory
30% (450,000 persons)	$686	$23
10% (150,000 persons)	$229	$8

[1]assuming 30% require medical treatment for influenza A complications
[2]all dollars are in millions

DISCUSSION

Assuming that a minimum of 3% of persons at high risk require treatment for some influenza-related complication, our data suggest that influenza vaccination programs are cost-effective for persons in both the community and nursing home settings; programs are cost-effective largely due to reduced hospitalization costs. Savings are noted even if all persons at high risk were to be vaccinated privately at a cost as high as $61.46 per person, assuming a considerable number if unvaccinated would later need hospital treatment.

If one were able to treat all complications in the ambulatory care setting, cost effectiveness would be noted only when immunization costs were kept to a minimum.

It is worth noting that in the nursing home setting, vaccination proved to be cost effective regardless of the site of treatment of viral complications due to the relatively low cost of vaccination.

The elderly often have multiple underlying health conditions making them more susceptible to influenza. They are more likely hospitalized for complications of an illness rather than treated on an ambulatory basis or in the nursing home setting. Also, the severity of illness may be more extreme at this time of life, increasing hospital length of stay. Since the elderly population are most susceptible to influenza, and given the elderly population will continue to grow in the future, one can predict a greater number of persons potentially infected with influenza virus, leading to an ever-increasing expenditure of health care dollars.

Immunization surveys have shown that approximately 20% of elderly persons living in the community and 55% to 60% of nursing home residents are vaccinated against influenza each year (4). It is important to remember, however, that the chance of success is partially dependent on the rate of vaccination in any given community, with best results occurring in those populations having the highest rates of vaccination (24).

Although the principal goal of preventive medicine is to improve and maintain the health of its recipients, any evaluation of a prevention program must compare resources spent and the outcome obtained. The "cost", however, must be considered to be more than dollars and cents and must take into account quality of life issues for those affected.

In the case of influenza vaccination, the economic outcome appears to be favorable and the potential savings substantial. In the absence of community vaccination programs, health professionals are encouraged to vaccinate patients during regularly scheduled visits if at all possible.

Depending on one's point of view, however, preventive practices may save money in the short term but also prolong years of life. This may necessitate an even greater expenditure for health care and retirement benefits for elderly persons in the long term. Clearly, the choice to vaccinate is a personal one; however, health officials and economic planners may need to make a choice as well.

RESEARCH METHODS

We analyzed the cost of vaccinating all elderly persons on an annual basis, assuming that the vaccination provided 70% efficacy. This model included direct costs attributable to implementing a control program and the cost of medically treating those vulnerable persons who developed complications. Based on prior studies, we chose 10% and 30% as the total number of vulnerable persons who were infected with the virus; 30% of this latter number were considered to require subsequent medical care. The total cost of vaccination plus treatment for those who still developed influenza-related complications was compared to the cost of treating the medical consequences resulting from an influenza infection in the absence of prior vaccination, once again using 10% and 30% as figures representing those infected with the virus, of which 30% later required medical treatment. All costs were based on 1990 data.

An annual vaccination cost per person based on 1990 wholesale pharmaceutical prices for vaccine, materials, and associated labor costs were set at $5.00 for a public health program rate and $3.21 for a nursing home rate. If vaccinations were given by private physicians, the cost per person, including cost of vaccine and administration, was set at $61.46. This included $15.00 for the vaccine and materials and $46.00 for a brief office visit as defined by average allowable Medicare rates.

Although mild side effects were noted in approximately 5% of those who receive a vaccination (10), no additional cost has been assigned to this due to their minor effect.

Physician fees for a brief medical visit were set at $46.00 per visit, based on the average allowable rate under Medicare. In 1990, the average daily cost of a hospital day nationwide was $581.07 (9). Ancillary cost was determined for the following: complete blood count (CBC), chest roentgenogram and broad-spectrum antibiotics. Ancillary costs for a complete blood count (CBC) and chest roentgenogram were derived from an average of several community facilities offering these services. Broad spectrum antibiotic costs were derived from an average of three commercial vendors using 1990 wholesalep pharmaceutical cost, not including potential price mark-up.

The cost of treating influenza within the hospital setting was therefore established at $5,081.53 per episode. This was based on a patient requiring seven days of hospitalization at $4470.02 (DRG #089), usual allowable physician visits (initial @ $175.00 and six follow-up @ $46.46) totaling $453.76, and ancillary costs ($157.75).

If an individual required medical attention for influenza on an ambulatory basis, the cost was substantially lower than for persons requiring a hospital stay, or $227.92. This cost includes two ambulatory physician visits at $92.00 (2x @ $46.00) and ancillary costs of $135.00.

The cost of treating a nursing home resident for influenza complications was set at $169.12 per episode. This cost includes two brief physician visits @ $46.46 and ancillary costs totaling $76.20. It is assumed the patient is already placed in the nursing home and ancillary services are provided on the premises.

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