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Economic burden of seasonal influenza in the United States

Wayan C.W.S. Putri [a,b], David J. Muscatello [a], Melissa S. Stockwell [c], Anthony T. Newall [a,*]

[a] The School of Public Health and Community Medicine, University of New South Wales, NSW 2052, Australia
[b] Department of Public Health and Preventive Medicine, Faculty of Medicine, Udayana University, Jl. P. B. Sudirman, Denpasar, Bali 80233, Indonesia
[c] Department of Pediatrics, and Department of Population and Family Health, Columbia University, New York, NY 10032, USA

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ABSTRACT

Background: Seasonal influenza is responsible for a large disease and economic burden. Despite the expanding recommendation of influenza vaccination, influenza has continued to be a major public health concern in the United States (U.S.). To evaluate influenza prevention strategies it is important that policy makers have current estimates of the economic burden of influenza.
Objective: To provide an updated estimate of the average annual economic burden of seasonal influenza in the U.S. population in the presence of vaccination efforts.
Methods: We evaluated estimates of age-specific influenza-attributable outcomes (ill-non medically attended, office-based outpatient visit, emergency department visits, hospitalizations and death) and associated productivity loss. Health outcome rates were applied to the 2015 U.S. population and multiplied by the relevant estimated unit costs for each outcome. We evaluated both direct healthcare costs and indirect costs (absenteeism from paid employment) reporting results from both a healthcare system and societal perspective. Results were presented in five age groups (<5 years, 5–17 years, 18–49 years, 50–64 years and ≥65 years of age).
Results: The estimated average annual total economic burden of influenza to the healthcare system and society was $11.2 billion ($6.3–$25.3 billion). Direct medical costs were estimated to be $3.2 billion ($1.5–$11.7 billion) and indirect costs $8.0 billion ($4.8–$13.6 billion). These total costs were based on the estimated average numbers of (1) ill-non medically attended patients (21.6 million), (2) office-based outpatient visits (3.7 million), (3) emergency department visit (0.65 million) (4) hospitalizations (247.0 thousand), (5) deaths (36.3 thousand) and (6) days of productivity lost (20.1 million).
Conclusions: This study provides an updated estimate of the total economic burden of influenza in the U.S. Although we found a lower total cost than previously estimated, our results confirm that influenza is responsible for a substantial economic burden in the U.S.

1. Introduction

Seasonal influenza is a highly pathogenic viral infection. It occurs annually in the United States (U.S.) typically from late fall through early-mid spring [1,2]. Influenza infection is common in all age groups, with children infected most frequently. In most cases, influenza infection is a self-limiting disease from which individuals will recover without serious complications; however, it can result in severe illness and death [3,4]. Influenza also results in a substantial economic burden, due to both medical care costs and productivity loss [5].

While the U.S. Advisory Committee on Immunization Practices (ACIP) recommends influenza vaccination to all person aged ≥6 months, less than half the population are vaccinated for influenza each year [6]. Populations at high-risk of severe illness from infection include children, pregnant women, adults aged over 50 years, and patients with comorbidities (e.g. cardiovascular disease, asthma, metabolic disorders) [3]. Some high-risk groups have higher uptake in the U.S., for instance, in 2015 coverage was 59.3% in children aged 6 months to 17 years and 63.4% in adults aged ≥65 years [6].

Molinari et al. estimated that, in the U.S., seasonal influenza is associated with approximately 10 million individuals seeking outpatient care, 300,000 hospitalizations, and 41,000 deaths annually based on the 2003 demographic profile [5]. The associated direct medical costs in $US2003 were estimated to be $10.4 billion, with lost productivity due to illness and death estimated to be

* Corresponding author at: School of Public Health and Community Medicine, Faculty of Medicine, The University of New South Wales, Sydney, NSW 2052, Australia.
E-mail address: a.newall@unsw.edu.au (A.T. Newall).

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$16.3 billion. These past estimates of the economic burden of influenza have been critical in understanding the importance of influenza in the U.S. but are now over a decade old and new influenza outcome estimates have emerged.

To be able to evaluate intervention programs around influenza prevention, it is important for policy makers to understand the current influenza burden including the economic burden. This study aims to provide an updated estimate of the average annual economic burden of seasonal influenza in the U.S. population (using the 2015 demographic profile, reporting in 2015 US$), including both direct medical and productivity costs. These estimates are calculated in the presence of vaccination and other preventive efforts within the U.S. setting.

2. Methods

This study adopted a societal perspective (including direct healthcare costs and indirect productivity costs related to absenteeism from paid employment) but also reported results for direct healthcare costs only. The direct medical costs were calculated from the estimated age-specific average annual number of events (e.g. influenza hospitalizations) multiplied by the unit cost for a given outcome (e.g. cost of influenza hospitalization). In line with best practice, where possible, we avoided the use of charges and rather used the cost (e.g. estimated to the hospital) or the amount paid for the event (e.g. reimbursement and patient co-pay) [7,8]. Indirect costs were calculated by the estimated total days/hours of lost (paid) work due to influenza multiplied by value of a lost time (i.e. the human capital approach) [9].

We considered five categories of outcomes due to influenza: (1) ill but not medically attended; (2) office-based outpatient visit; (3) emergency department (ED) visit (4) hospitalization; and (5) death. We analyzed the data by each single year of age from 0 to 100 years, which were then aggregated for illustration purposes into the age groups: <5 years, 5–17 years, 18–49 years, 50–64 years, and ≥65 years. All analyses were conducted in Excel Version 15.19.1.

2.1. Estimation of number of outcomes

In each age group, we estimated the number of health outcomes by multiplying estimated average age-specific population rates of each outcome by the age-specific size of the 2015 U.S. population [10]. We obtained the rates for each health outcomes from published U.S. sources which were estimated in the presence of influenza vaccination (see Table 1). The exception to this was the estimation of ill but not medically attended rates, which were derived by subtracting rates of all other outcomes (combined) from the estimated age-specific symptomatic influenza rate in unvaccinated individuals. Where sources provided estimates over more than 6 years we used the average estimate over the 6 most years in base case Table 2.

Age-specific symptomatic attack rates for seasonal influenza were estimated from a recent U.S. study [11]. Estimates of influenza office-based outpatient and ED visits (in children ≤7 years) were derived from studies that included laboratory confirmation of influenza infection (in at least a subset) individuals presenting with either influenza-like illness [12] or acute respiratory symptom/s [13], respectively. Estimated rates of hospitalization [14], death [15] and ED visits (in adults [16]) were derived from studies that applied time series statistical modelling methods to population level data. The types of methods applied in these studies have been widely used to quantify the disease burden from influenza where laboratory testing is not routine [17,18]. These models examine the relationship over time between available influenza surveillance time series and broad population outcome categories such as hospitalizations for respiratory and/or circulatory illness [19]. Detail on the age-specific disease rates are provided in Table 1 and Appendix.

The number of days or hours loss associated with each health outcome was obtained from published sources (see Appendix Table A1) [5,20–24]. In cases where estimates were of the total

Table 1
Estimated annual average attack rates and health outcome rates per 1000 people* for base case and sensitivity analysis.

Variable	Age group (years)	Mean	Range		Source
			Lower limit	Upper limit	
Overall attack rates	0–17	93.000	82.000	111.000	[11]
	18–64	89.000	82.000	99.000	
	≥65	39.000	34.000	42.000	
Office-based outpatient visit rates	0–1	14.330	11.730	17.000	[12]
	2–4	31.130	27.200	35.200	
	5–17	31.600	29.530	33.600	
	18–24	8.530	7.730	9.400	
	25–49	7.600	6.930	8.470	
	50–64	5.000	4.200	6.070	
	≥65	3.330	2.800	4.200	
Emergency department visit rates	0–7	10.200	4.000	26.400	[13]
	8–49	0.410	0.270	0.550	[16]
	50–64	2.110	1.690	2.520	
	≥65	2.450	2.030	2.880	
Hospitalization rates	<1	1.988	1.053	6.596	[14]
	1–4	0.537	0.241	2.132	
	5–49	0.184	0.098	0.584	
	50–64	0.654	0.350	2.700	
	≥65	3.226	1.860	11.037	
Death rates	0–17	0.004	0.002	0.006	[15]
	18–49	0.011	0.006	0.015	
	50–64	0.061	0.059	0.084	
	65–74	0.219	0.221	0.305	
	≥75	1.221	1.183	1.638	

* Note that all values presented are estimates in the presence of vaccination in the U.S.

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