Social contact patterns and control strategies for influenza in the elderly

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A B S T R A C T

Despite dramatic increases in influenza vaccination coverage in the elderly population over the past 30 years, influenza mortality rates have remained static in this age group. Children are believed to be the primary spreaders of diseases such as influenza due to their high degree of inter-contact in school settings, and several studies have examined control of influenza in the entire population, including the elderly, via targeted vaccination of school children. However, such vaccination programs are expensive, and fraught with difficulties of public perception of what may be seen as an unnecessary vaccination against a disease that is normally mild in the children themselves.

In the study presented here, we examine the control of influenza in the elderly using simple social distancing measures during an influenza epidemic. The recent work of Glasser et al. characterizes daily contact interactions within the population in terms of preferential mixing between age group peers, co-workers, and parents and children. We expand upon this to include interactions between grandparents and grandchildren, and fit the parameters of this formulation to the recently published social contact survey data of Mossong et al. Using this formulation, we then model an influenza epidemic with an age-structured deterministic disease model and examine how reduction in contacts between grandchildren and grandparents affects the spread of influenza to the elderly.

We find that over 50% of all influenza infections in the elderly are caused by direct contact with an infected child, and we determine that social distancing between grandparents and grandchildren is remarkably effective, and is capable of reducing influenza attack rates in the elderly by up to 60%.

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Introduction

Influenza, a seasonal viral disease, presents a significant morbidity and mortality burden on the population, with a typical seasonal influenza epidemic in the United States killing around 40,000 people per year [1]. Most of the hospitalization and mortality burden is carried by people aged over 65 years (the influenza mortality and hospitalization rates of elderly people are 100 and 20 times higher than those of people aged 5–49, respectively [2,3]), and the direct cost of influenza hospitalizations in the elderly in the U.S. approaches half a billion dollars each year [4].

Because of the high morbidity and mortality burden in this age group, attempts have been made in recent decades to increase the vaccination rates among the elderly, and indeed vaccine coverage is highest in this age group, at a current level of 65%, compared to 20% for children age 5–19 years [5]. Despite a rise in elder vaccination rates from 15% to 65% between 1985 and 2000, however, elderly influenza mortality rates remained largely unaffected [6], likely due to low vaccine efficacy among people aged 65 and older [7,8].

Children are thought to be the primary spreaders of diseases like influenza within a population because of their high contact rate with their peers in school settings [9], and it has been shown that optimal influenza control in the entire population, including the elderly, can thus be achieved if vaccines are preferentially distributed to children [10–13]. However, such vaccination programs are expensive, and also can be fraught with particular difficulties of public acceptance when children are involved. Ref. [14] discusses the issue of individual perspectives often being at odds with those of policy makers when it comes to vaccinations, and notes the ‘need for improved, less expensive systems for protecting individuals against influenza.’ In this analysis, we thus explore the efficacy of reduction of influenza in the elderly by perhaps the cheapest means possible; simple social distancing.

The types of social contacts people preferentially make each day depend on age, but most can be approximately categorized as peer-to-peer interactions (i.e., interactions with people of approximately one’s own age), parent/child interactions, grandparent/grandchild interactions, and co-worker interactions [15]. Since children are the primary spreaders of influenza in a population, the social distancing measures we examine here are reduction of grandparent/grandchild interactions.

The simplest parameterization of the preferential contacts amongst members of a population includes only the dominant