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Burden of four vaccine preventable diseases in older adults

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ABSTRACT

Background: Implementation of additional targeted vaccinations to prevent infectious diseases in the older adults is under discussion in different countries. When considering the added value of such preventive measures, insight into the current disease burden will assist in prioritization. The aim of this study was derive the first estimates of the disease burden in adults aged 50 years or over in the Netherlands for influenza, pertussis, pneumococcal disease and herpes zoster.
Methods: The average annual disease burden for these four diseases in the Netherlands was calculated for the period 2010–2013 using the disability-adjusted life years (DALY) measure. Disease models and parameters were obtained from previous research. Where possible we adapted these models specifically for older adults and applied age-specific parameters derived from literature. The disease burden based on these adapted models and parameters was compared with the disease burden based on the general population models.
Results: The estimated average annual disease burden was from high to low: pneumococcal disease (37,223 DALYs/year), influenza (7941 DALYs/year), herpes zoster (942 DALYs/year), and pertussis (812 DALYs/year). The adaptation of models and parameters specifically for the elderly resulted in a higher disease burden compared to the use of general population models.
Conclusions: Among older adults, the disease burden in the period 2010–2013 was highest for pneumococcal disease, mostly because of high mortality, followed by influenza. Disease burden of herpes zoster and pertussis was relatively low and consisted mostly of years lived with disability. Better information on the course of infectious diseases and long-term consequences would enable more accurate estimation of disease burden in older adults.

1. Introduction

Life expectancy in western countries has increased, resulting in a proportionally larger aged population which will continue to expand over the coming decades. This will result in high disease burden in aged persons and higher medical costs for society [1,2]. Infectious diseases play an important role in the burden of disease in the frail aged [3,4]. The natural deterioration of the immune system caused by ageing that is often called immunosenescence, results in an increased susceptibility for infectious diseases and a decreased ability of aged persons to mount an effective immune response to infections [5]. Immune modelling is relevant for vaccination response. Individual variation that exists in the ability to respond well after vaccination, i.e. some older adults might adequately respond, whereas others – sometimes at younger ages – might fail to mount a protective response [6]. Vaccine-induced immunity as well as naturally acquired immunity can wane over time, allowing for reactivation of viruses such as varicella zoster virus (VZV) [7]. In addition, comorbidity and general frailty, also lead to higher susceptibility of aged persons to many infectious

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diseases [3]. During infection the incidence of serious complications and mortality is often higher in the aged population than in the other age groups [3,8,9].

Vaccines for influenza, pertussis, pneumococcal disease and herpes zoster are available, but currently only influenza vaccination is routinely offered to people older than 60 years of age in the Netherlands. Implementation of additional targeted vaccinations in order to prevent infectious diseases in older persons is under discussion both in the Netherlands and elsewhere [10–12]. In case of pneumococcal vaccination it is relevant to consider the indirect impact on older adults as a result of routine childhood vaccination with conjugated pneumococcal vaccine (2006–2010: 7-valent pneumococcal vaccine; from 2011 onwards 10-valent pneumococcal vaccine [13]). Another option would be to improve secondary prevention, for example by accelerating the response of general practitioners on certain conditions (e.g., prescription of appropriate antibiotics against pneumococcal pneumonia). When considering the added value of preventive measures against infectious diseases, insight into the current burden of these diseases will assist in prioritization. With this objective in mind, the Burden of Communicable Diseases Europe (BCoDE) project developed methodology and software to calculate the burden of infectious diseases [14,15]. This method was used to calculate the burden for 32 infectious diseases in the general population in the Netherlands in the period 2007–2011 [16]. In this study, however, no separate analysis of the disease burden in older adults was performed. Herpes zoster was not included in this study and for pneumococcal disease, only the burden of invasive disease was calculated. Estimation of disease burden in aged persons presents additional challenges due to a higher prevalence of multi-morbidity in this population. In the current study we compute disease burden using a consistent methodological approach, and in the interests of simplicity in model specification and interpretation, we do not address the potential complications of multi-morbidity.

Thus, the aim of the present study was to provide preliminary estimates of the disease burden in adults aged 50 years or over for influenza, pertussis, pneumococcal disease and herpes zoster, with the goal of making comparisons between the disease burden of these four vaccine-preventable diseases in the older adult population. Rather than emphasizing absolute estimates of disease burden, our study focusses on comparing the relative burden due to these diseases by using disease models and parameters that are similar in completeness. Furthermore, we investigated whether the use of age-specific parameters, as opposed to parameters based on the general population, gives rise to a difference in the estimated disease burden.

2. Materials and methods

2.1. Study population and data sources

The population for which disease burden was estimated consisted of all cases of incident infection (of each of the four diseases considered) estimated to have occurred within the period 2010–2013 in the Netherlands, restricted to persons aged 50 years or older.

Data on the incidence of the various diseases were obtained from the NIVEL Primary Care Database [17,18] of the Netherlands Institute for Health Services Research (NIVEL), which is based on GPs' clinical diagnosis (herpes zoster, pneumonia, pertussis), the Dutch registration system for notifiable diseases (OSIRIS) with case definitions including a specific clinical definition as well as laboratory confirmation (pertussis), and the Netherlands Reference Laboratory for Bacterial Meningitis (NRBM), which includes laboratory data of *S. pneumoniae* isolates from blood and cerebrospinal fluid, i.e., invasive pneumococcal disease (Table 1). The incidence data for influenza, herpes zoster and non-invasive pneumonia (we assumed that 30% of all pneumonia is caused by *S. pneumonia* based on previous research [8,19]) were obtained from the primary care setting, and the incidence data for invasive pneumococcal disease from the hospital setting. Incidence data for pertussis were obtained both from primary care and from the hospital setting. For influenza, the annual incidence of influenza-like illness (ILI) from sentinel GP data was used as a proxy, which was adjusted for the estimated proportion of ILI that is virologically confirmed influenza.

2.2. Burden of disease estimation

The Disability Adjusted Life Year (DALY) was used as a composite measure to express the burden of disease. DALYs consist of years of life lost because of premature death (YLL = Years of Life Lost) and of

Table 1
Reported number of new cases in the years 2010–2013, multiplication factors (MFs) chosen to adjust for under-estimation, and the estimated annual number of symptomatic cases (averaged over the period 2010–2013 and adjusted for under-estimation), per disease.

Disease		Reported number of new cases*				MF(s) chosen	Estimated annual number of symptomatic cases
		2010	2011	2012	2013		
Influenza	All ages	18,868	93,225	50,349	158,441	Uniform [4.12–5.13] (1)	371,061
	≥50	3645	19,166	14,949	57,560		110,213
Pertussis	All ages	3733	5450	13,853	3422	0–9 year: 21.9 (1)	162,309
	≥50	658	931	3008	938	≥9 year: 25 (1)	34,593
IPD	All ages	2496	2472	2592	2152	Uniform [1.05–1.20] (1)	2760
	≥50	2000	2088	2092	1788		2249
(N)IPD	All ages	58,984	69,051	71,548	69,596	IPD: Uniform [1.05–1.20] (1)	67,627
**	≥50	35,268	38,759	43,328	45,581	NIPD: 1	40,917
Herpes zoster	All ages	79,986	81,973	85,917	84,829	0.9 (2)	74,858
**	≥50	50,285	52,197	54,876	55,050		47,764

IPD = invasive pneumococcal disease, NIPD = non-invasive pneumococcal disease, (N)IPD = (non-)invasive pneumococcal disease or all pneumococcal disease.
* Data sources:
– Netherlands Institute for Health Services Research (NIVEL): influenza, non-invasive pneumococcal disease (NIPD; we assumed that 30% of all pneumonia is caused by *S. pneumoniae*), and herpes zoster.
– Netherlands Reference Laboratory for Bacterial Meningitis (NRBM): invasive pneumococcal disease (IPD).
– Dutch registration system for notifiable diseases (OSIRIS): pertussis.
** For NIPD and herpes zoster it concerned number of new episodes and not number of new cases.
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