

Incidence, direct costs and duration of hospitalization of patients hospitalized with community acquired pneumonia: A nationwide retrospective claims database analysis



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ABSTRACT

Background: Community-acquired pneumonia (CAP) is one of the most common acute infections associated with a substantial clinical and economic burden. There have been few studies assessing incidence rate, duration of hospitalization, and costs of hospitalized CAP by age and care-setting.

Methods: A retrospective study was conducted using a nationwide Dutch database containing healthcare claims data of 16.7 million inhabitants. Patients with at least one claim with a discharge diagnosis of CAP between January 2008 and December 2011 were selected. The main outcome measures considered were the incidence rate, duration of hospitalization, and the direct costs of hospitalized CAP stratified by age and care-setting.

Results: In total, 195,372 CAP cases were included in the analysis resulting in an average incidence of 295 per 100,000 population per year. Sixty-three percent (123,357) of the included patients were hospitalized for 1 or more nights, of which 5.9% ($n = 7241$) spent at least one night in the Intensive Care Unit (ICU). Overall, these 123,357 patients spent 824,985 days in the hospital of which 48,324 were spent on the ICU. The mean duration of hospitalization of ICU patients and general ward patients was 15.2 days and 6.2 days, respectively. The total costs related to all 195,372 CAP episodes during these 4 years were €711 million, with the majority (76%) occurring among those aged 50 years and older. Median (and mean) costs were dependent on age and type of care with costs ranging from €344 (€482) per episode for 0–9 year olds treated in the outpatient hospital setting up to €10,284 (€16,374) per episode for 50–64 year olds admitted to the ICU.

Conclusion: There is a large variation in terms of incidence, disease burden and costs across different age groups and the treatment setting. Effective interventions, targeted at older adults, to prevent pneumonia could reduce the (financial) burden due to pneumonia.

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1. Introduction

Community-acquired pneumonia (CAP) is one of the most common acute infections necessitating hospitalization resulting in a considerable clinical and economic burden [1,2]. In the USA, for example, the estimated annual number of CAP episodes in adults is

approximately 5.2 million, with the highest incidence among those aged 65 years and older (4200 per 100,000 population) [3]. For most countries, recent data on the (financial) burden of pneumonia are lacking. Although a few large database studies have been published recently focusing on the clinical burden of CAP in (older) adults [4–7], only one study focused on both the clinical and economical burden of CAP [8]. The latter study focused specifically on patients aged 50 years and older. To our knowledge, there are no published studies focusing on the incidence, the duration of hospitalization and the direct cost of hospitalized CAP simultaneously using a national dataset which covers an entire population. These

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data are, however, important in order to accurately estimate the total burden of disease due to CAP. Furthermore, it was previously shown that both the incidence and CAP related costs are important drivers of the cost-effectiveness of pneumococcal vaccination programs targeting adults [9,10]. Therefore, accurate estimates of these parameters are crucial to estimate the cost-effectiveness of such programs especially now that the results of the CAPiTA trial have shown that the 13-valent polysaccharide conjugate vaccine (PCV13) appeared effective in preventing vaccine-type pneumococcal, bacteremic, and nonbacteremic community-acquired pneumonia and vaccine-type invasive pneumococcal disease in adults aged 65 years and older [11].

To address this gap in the literature, the present study evaluated the incidence rate, the duration of hospitalizations and the direct hospitalization cost of CAP stratified by age and setting of care using a nationwide database covering the entire population of the Netherlands.

2. Methods

2.1. Background

2.1.1. Current pneumococcal vaccination programs in the Netherlands

In the Netherlands, an infant pneumococcal vaccination program was introduced for all infants born after March 31, 2006. Infant received 3 doses of PCV7 at ages 2–4, and an additional booster dose at 11 months (i.e. 3+1). As of 2011, PCV10 replaced PCV7 in the infant pneumococcal vaccination schedule.

For older individuals a 23-valent pneumococcal polysaccharide vaccine (PPV23) is available. However, PPV23 is not recommended for universal use among the elderly [13,14] as there is no convincing evidence that it prevents non-invasive pneumococcal pneumonia, where the vast majority of disease burden lies [15,16]. Consequently, the uptake of PPV23 is very low (i.e. less than 1% of those aged ≥ 65) [9] compared to, for example, the influenza vaccination uptake of approximately 75% [17].

2.1.2. Database

In the Netherlands, hospitals are reimbursed based on a combination of diagnosis and treatment: a DBC (Dutch: Diagnose Behandeling Combinatie). This DBC system is accompanied by an extensive registration, which is gathered in a national database: the DIS (DBC Information System). This DIS database includes all data relevant to the hospitals' reimbursement of their bed occupancy and activities. It contains all diagnoses and activities performed by all hospitals in the Netherlands ($n = 104$) covering a population of 16.7 million inhabitants. Furthermore, it contains some basic information on patient characteristics (e.g. unique identifiers, gender and year of birth) and information on the derived care product which was reimbursed by the insurance company, like site of care (Intensive Care Unit [ICU] or ward) and length of stay (see also below). The database does not contain survival information and "discharge" includes death. For the current study, data from the DIS database were used which were extracted and aggregated by the Dutch case-mix office DBC-Onderhoud, Utrecht, The Netherlands. Further, analyses were performed by the authors.

2.1.3. Case selection

Patients with at least one medical claim with a final discharge diagnosis of pneumonia between January 2008 and December 2011 were retrospectively selected. Pneumonia was identified using specific diagnostic codes which were mapped to International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) codes (480, 481, 482.xx–483.xx, 484.xx, 485, and 486). Diagnostic codes in the database are classified according to

the medical specialization. The following diagnosis codes were included to select CAP cases in the analysis: (i) 0313. Internal medicine: 401. Pneumonia, unspecified and 402. Interstitial pneumonia; (iii) 0316. Pediatrics: 3028. Lower respiratory infections; (iv) 0322. Pulmonology: 1401. Pneumonia; (v) 0335. Geriatrics: 273. Pneumonia. Only patients with a final diagnosis code were selected. To exclude potential hospital acquired pneumonia (HAP) episodes, patients were excluded if they had been treated clinically for any other final diagnosis than those mentioned above, in a parallel DBC in the same hospital.

We differentiated between the following type of care: ICU (hospitalized CAP admitted for at least one night to the ICU), general ward (hospitalized CAP only admitted to the general ward) and outpatient hospital setting (ED and outpatient hospital visits without an overnight stay and therefore not counted as a hospitalization day). Please note that outpatient CAP in the current study only include patients treated in the hospital and that cases only treated by the general practitioner are not collected in the database.

2.1.4. Data and outcome measures

The following data from the DIS database were collected per case: date of presentation (month, year), age at presentation, type of care (see above), length of hospital stay separated into those spent in general ward, ICU, hospital costs, and the specialists' fees which are claimed separately.

The outcome measures considered in this study are the incidence rate, duration of hospitalization, and the direct costs of hospitalized CAP stratified by age and care-setting. In order to calculate incidence rates, Dutch population data from Statistics Netherlands were extracted from the electronic databank Statline [12].

2.2. Analyses

All above mentioned study variables were analyzed using Microsoft Excel (Microsoft, Redmond, WA, USA). Descriptive statistics (mean, standard deviation (SD), median, and inter quartile range (IQR)) were calculated. Depending on the outcome measure (i.e. sample size) the study population was either divided into (i): age bands of 5 years with the exception of those aged less than 5 years which were divided into 1 year age bands and those aged 85 years and over who were aggregated into a single group, (ii) or into the following age groups 0–9, 10–17, 18–49, 50–64, 65–74, 75–84 and 85 years and older if the sample size (< 50 cases per age class) was not sufficient to provide finer age grouping.

3. Results

3.1. Incidence

A total of 195,372 CAP episodes were included in the analysis between January 2008 and December 2011. The overall number of CAP episodes were stable throughout the first 3 years (47,119; 48,522; 46,994 for 2008, 2009, 2010 respectively) while a small increase was observed in 2011 ($n = 52,737$). The mean annual number of CAP episodes throughout the entire study period was 48,843 resulting in an average incidence of 295 per 100,000 inhabitants per year. Across treatment settings, the highest incidence rate was found for treatment episodes in the general ward (176 per 100,000 inhabitants per year), followed by those treated in the outpatient setting (109 per 100,000 inhabitants per year) and in the ICU (11 per 100,000 inhabitants per year). Approximately 45% and 64% of all CAP episodes occurred in individuals aged 65 years (incidence of 881 per 100,000 inhabitants per year) and 50 years and older (incidence of 535 per 100,000 inhabitants per year), respectively. Within the more severe episodes (i.e. excluding outpatient cases)

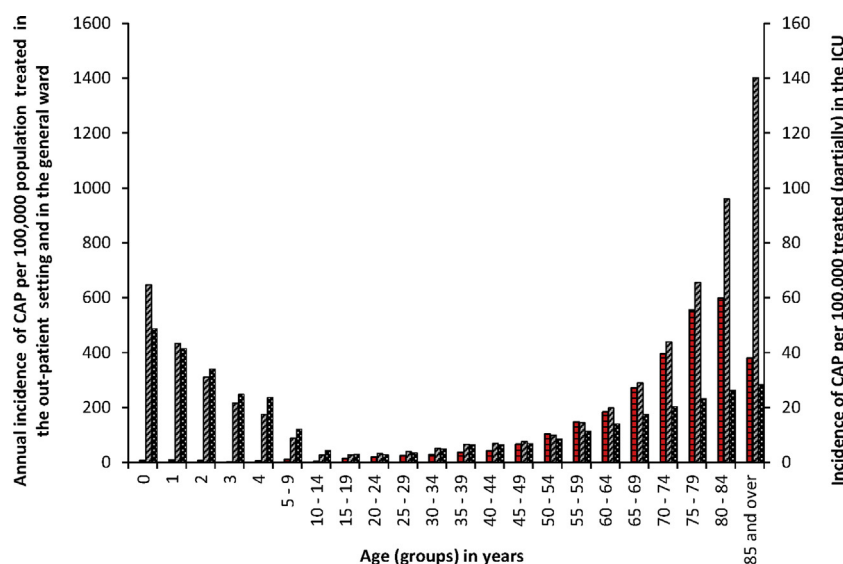


Fig. 1. Incidence rate of CAP by age and type of care. Note that the incidence of CAP treated in the general ward (gray bars with black diagonal lines) and in the outpatient hospital setting (black bars with white dots) are displayed on the left axis while the incidence rate of CAP treated (partially) in the ICU (red bars with vertical black lines) is displayed on the right axis with a different scale.

these percentages increased to 54% and 71% for 65 and 50 years and older individuals, respectively.

Fig. 1 shows the age- and care-setting specific incidence rate of hospitalized CAP. The incidence follows a U-shaped curve with the highest incidence among those aged less than 5 years of age and those aged 60 years and older. In particular, from age 45 to 50 years onwards, the incidence rate of overall CAP starts increases exponentially with approximately 36% per 5-year age group. In addition, with increasing age, the proportion of patients treated in the inpatient setting increased. For example, in 80–84 years old 80% of episodes were treated in the inpatients setting compared to 56% for those aged 50–54 years. Although the overall inpatient proportion increases with age, the proportion and the incidence of patients admitted to the ICU decreased after the age of 85.

3.2. Length of stay in the hospital

In total 123,357 (63%) of all included episodes were hospitalized for 1 or more nights of which 5.9% ($n=7241$) spent at least one night on the ICU. Overall, these 123,673 patients spent 824,985 days in the hospital of which 48,324 were spent on the ICU, resulting in a overall mean length of stay of 6.7 days. The mean length of stay in the hospital of patients treated in the ICU (15.2 days) was substantially longer than those treated in the general ward (6.2 days). ICU patients spent 44% of hospitalized time on the ICU (i.e. 6.7 days).

In general, the mean length of stay of patients treated in the general ward increased with age from around 3.6 days in the youngest children up to 7.7 days in adults ≥ 85 years (Table 1). In contrast to those patients only treated in the general ward, the mean length of stay in the hospital in patients treated in the ICU decreased after the age of 75 years (see Table 1 and Fig. 2).

3.3. Costs of hospitalization

The 195,372 CAP episodes resulted in a total financial burden of €711 million, corresponding to a mean annual cost of €178 million. The general ward cost contributed with 77.5% (€551 M) the most to the overall costs, followed by the ICU costs with 15.4% and the outpatient hospital costs (7.1%). The median costs per CAP episode (partially) treated in the ICU (€6000–€10,000) were 2–3

times higher compared to those episodes treated only in the general ward (€2000–€50,000). The median costs for an outpatient hospital visit was substantially lower, varying from €300 to €800 per episode.

Fig. 3 shows the total costs of CAP by age group for the entire study period (2008–2011) split by age and care-setting. The majority of the costs are generated in the elderly. In particular 76% of the total CAP costs are attributable to those aged 50 years and older. The median costs per CAP case treated in the general ward was very similar between all adults age groups (with a mean and median around €5000) and between those aged 18 years or less (mean and median of around €2750 and €2300, respectively). The costs of patients treated in the ICU were more similar across all age groups, although here, the mean costs in the youngest and oldest age groups were lower compared to the other age groups (please note that the numbers in the youngest age groups are relatively small, see also Table 1). Finally, the mean outpatient hospitalization costs were the only costs that increased with age, from a mean cost of €482 (median €344) in 0–9 year olds up to around €757 (median €361) in the oldest age groups.

4. Discussion

This is, to our knowledge, the first study using a healthcare claim database covering the entire population to estimate the age and the type of care specific incidence, duration of hospitalization and the direct hospitalization costs CAP. We found that the average annual incidence of hospitalized CAP is 295 per 100,000 inhabitants per year leading to approximately 49,000 hospitalizations and a financial burden of €178 million annually in the Netherlands. This €178 million corresponds to 51% of the annual budget spent in hospitals on the treatment and prevention of infectious diseases [18].

We also found that there is a large variation in terms of incidence, disease burden and costs across different age groups and the treatment setting. In particular, those aged 50 years and older are disproportionately affected by hospitalized CAP with the majority of the CAP episode (64%) and costs (76%) occurring among this group while representing only 35% of the Dutch population. Individuals under the age of 5 years are affected in a similar way (13% episodes, and 6% of the population) although the total treatment costs (5% of the total costs) in this age groups is relatively low as

Table 1
Number of episodes, annual incidence, costs and duration of hospitalization.

Age group	Number of episodes	Incidence per 100,000	Total costs during study period (2008–2011)	Mean (SD) cost per episode	Median (IQR) cost per episode	Total length of hospital stay during study period (2008–2011)	Mean (SD) length of hospital stay per episode	Median (IQR) length of hospital stay per episode
<i>Overall CAP (all CAP cases combined)</i>								
0–9	34,606	447	€52,188,440	€1508 (€1389)	€2190 (€321: €2279)	60,729	1.75 (3.27)	0 (0: 2)
10–17	4356	69	€6,886,475	€1581 (€4668)	€692 (€321: €2279)	8093	1.86 (4.74)	0 (0: 2)
18–49	32,039	111	€108,692,358	€3393 (€3932)	€4854 (€777: €5145)	88,828	2.77 (5.13)	1 (0: 4)
50–64	36,131	273	€142,657,253	€3948 (€5693)	€4887 (€790: €5180)	145,690	4.03 (7.15)	1 (0: 6)
65–74	31,671	577	€137,912,703	€4355 (€5847)	€4935 (€914: €5220)	164,784	5.2 (7.94)	2 (0: 8)
75–84	36,535	1084	€170,538,683	€4668 (€5114)	€5034 (€4819: €5251)	226,679	6.2 (7.86)	4 (1: 9)
85 and over	20,034	1724	€91,785,200	€4581 (€2580)	€5034 (€4856: €5251)	130,182	6.5 (7.41)	5 (1: 9)
<i>CAP treated in the general ward</i>								
0–9	16,809	217	€42,835,162	€2548 (€679)	€2279 (€2206: €2528)	60,128	3.58 (3.86)	3 (1: 4)
10–17	1743	27	€5,068,043	€2908 (€1040)	€2279 (€2236: €3275)	7766	4.46 (6.34)	3 (1: 5)
18–49	16,085	56	€82,686,913	€5141 (€625)	€5102 (€4935: €5274)	74,454	4.63 (4.42)	4 (1: 6)
50–64	19,290	146	€99,391,781	€5153 (€594)	€5081 (€4887: €5253)	115,235	5.97 (5.84)	5 (2: 8)
65–74	19,553	356	€100,660,679	€5148 (€567)	€5069 (€4887: €5253)	135,246	6.92 (6.7)	6 (2: 9)
75–84	26,349	782	€135,639,913	€5148 (€570)	€5069 (€4887: €5253)	197,585	7.5 (6.98)	6 (2: 10)
85 and over	16,287	1401	€84,311,610	€5177 (€626)	€5081 (€4935: €5253)	124,745	7.66 (7.27)	6 (2: 11)
<i>CAP treated (partially) in the ICU</i>								
0–9	70	1	€809,681	€11,567 (€11,992)	€6429 (€4444: €14,328)	601	8.59 (9.27)	4 (2: 13)
10–17	33	1	€523,380	€15,860 (€49,851)	€5823 (€3738: €8181)	327	9.91 (12.46)	6 (2: 14)
18–49	1071	4	€15,239,015	€14,229 (€13,771)	€9460 (€7079: €16,168)	14,374	13.42 (14.94)	9 (4: 16)
50–64	1900	14	€31,111,478	€16,374 (€19,042)	€10,284 (€7424: €18,077)	30,455	16.03 (17.75)	11 (5: 20)
65–74	1793	33	€28,696,800	€16,005 (€19,568)	€10,000 (€7390: €16,736)	29,538	16.47 (17.59)	12 (6: 21)
75–84	1932	57	€28,097,645	€14,543 (€17,959)	€9353 (€7047: €14,886)	29,094	15.06 (15.38)	11 (5: 20)
85 and over	442	38	€4,972,460	€11,250 (€10,547)	€8171 (€6653: €11,439)	5437	12.3 (11.85)	9 (4: 17)
<i>CAP treated in the outpatient hospital setting</i>								
0–9	17,727	229	€8,543,598	€482 (€540)	€344 (€224: €463)	N/A	N/A	N/A
10–17	2580	41	€1,295,052	€502 (€520)	€374 (€224: €505)	N/A	N/A	N/A
18–49	14,883	52	€10,766,430	€723 (€590)	€771 (€260: €805)	N/A	N/A	N/A
50–64	14,941	113	€12,153,995	€813 (€704)	€788 (€531: €911)	N/A	N/A	N/A
65–74	10,325	188	€8,555,224	€829 (€777)	€788 (€361: €871)	N/A	N/A	N/A
75–84	8254	245	€6,801,125	€824 (€961)	€767 (€260: €805)	N/A	N/A	N/A
85 and over	3305	284	€2,501,131	€757 (€1116)	€361 (€239: €789)	N/A	N/A	N/A

N/A: not applicable, population size per age group: 0–9 years: 7.7 million, 10–17 years: 6.4 million; 18–49 years: 28.8 million, 50–64 years: 13.2 million, 65–74 years: 5.5 million, 75–84 years: 3.4 million, 85 years and over: 1.2 million.

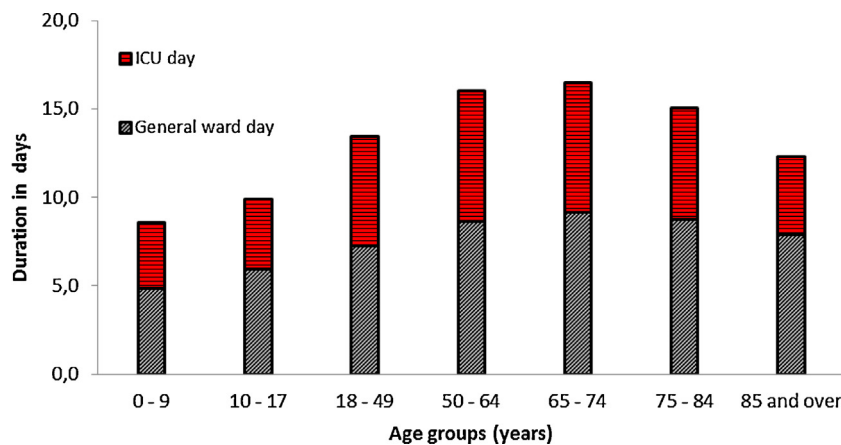


Fig. 2. Mean duration of hospitalized CAP patients (partially) treated in the ICU. The gray bars (with diagonal black) show the mean duration of hospitalization spend in the general ward while the red bars (with vertical black lines) show the mean duration spent in the ICU.

almost half of the episodes are treated in the outpatient (hospital) setting. Finally, the general ward and ICU hospitalizations contributed with 92.9% to the vast majority of the total hospitalization costs.

4.1. Comparisons to other database studies

In Germany, a neighboring country, the incidence of hospitalized CAP cases in those aged ≥ 18 years was estimated to be very similar to our study (296 per 100,000 inhabitants in 2006 as compared to 301 in our study) [4]. The incidence was estimated higher in a recent Portuguese study for the same age group, with 361 per 100,000 population [6]. Other recent studies found annual incidences of hospitalized CAPs of 366, 472, 518, 627 and 832 per 100,000 inhabitants for those aged ≥ 50 years in Czech republic, Slovakia, Poland, Spain and Hungary, respectively [5,8]. If we look at the same age-group in our study we observe an incidence of 535 per 100,000 population which is well in between the estimates of these other European countries. Similar to our study, all studies who reported age-specific incidences showed a steep increase in the incidence of hospitalized CAP with age in adults [4,7,8,19,20]. Although our observed incidences are similar to those described earlier one should take into account factors which can impact the

country specific incidence of pneumonia, like immunization programs.

The median duration of hospitalization for different age groups found in our study (3–6 days for those admitted to the general ward) is similar to those found previous in England (3–9 days) [7] while the mean length of stay in the hospital found for Spain was up to 100% longer than we found in our study (13 days vs 7.6 days in our study for those aged 50 years and older) [5]. A possible explanation for the difference between Spain and the UK and the Netherlands might be the availability of continuing care outside the hospital environment.

Comparing costs per episode between different countries is difficult as resource prices and diagnostics and treatment standards may vary. Our mean costs of (\approx €5000) for hospitalized adults on the general ward are very similar to a recent smaller prospective (\approx €4000) and retrospective (\approx €4900) studies performed in the Netherlands [21,22]. Similar to our study, a study performed in the USA also showed that while the mean length of hospital stay increased with age, the costs did not increase proportionally to the length of stay in the hospital [23]. In our study this can be explained by the fact that hospitals are reimbursed based on prices for a combination of diagnosis and treatment which may include a wide range of hospitalized days. Only when the maximum number of days within this range is exceeded, additional costs can be charged.

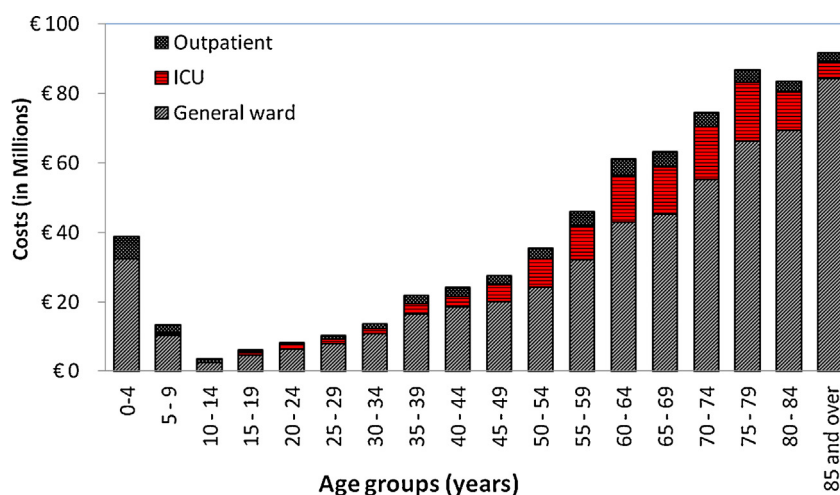


Fig. 3. Total costs of community-acquired pneumonia (CAP) by age groups and type of care during the study period (2008–2011). The gray bars with black diagonal lines represent the CAP costs due to episodes hospitalized in the general ward, the red bars with vertical black lines represent the CAP costs due to episodes treated (partially) in the ICU, and black bars with white dots lines represent CAP costs related to outpatient hospitalizations.

4.2. Strength and weaknesses of the study

In comparison with previous studies our results might be more generalizable as we cover an entire population rather than specific groups such as elderly, or individuals with commercial medical benefits or medical coverage. Obviously, our study suffers from the limitations of using a healthcare claim database. The ICD codes, which were mapped to diagnostic codes, are similar to those used by previous studies. However, on top of these diagnostics codes we were able to apply additional criteria to exclude HAPs. The approach used to define a HAP can, however, only be considered as a proxy to determine a true HAP since specific data required to identify HAP were not available in the database. A previous Dutch study showed that the overall sensitivity of the ICD9 coding for detecting confirmed hospitalized CAP was 72% for the principal code [24], which is similar to a recent study in the USA (62%) [20,25]. On the other hand, also some cases of CAP might have been missed (due to lack of specificity of the coding system), especially in the case of a CAP episode complicated by respiratory failure, shock or sepsis when the latter was encoded as the primary code of hospitalization (i.e. under-reporting). Unfortunately, mortality data were not collected within the used database. Previous studies have shown huge variety in case-fatality rates of 0 up to 47%, but all showed an increasing mortality with age [4,7,8]. The high mortality rates in the oldest age groups can explain the lower duration of hospitalization of those admitted in the ICU aged ≥ 75 years and older compared to those age between 50 and 75 years.

It is known that certain chronic illnesses such as diabetes (prevalence in the Netherlands 4.8%), chronic heart and lung disease (prevalence of 5.8% and 7.5% respectively) [26] are associated with an increased risk for pneumonia [3,23,27]. Unfortunately, data regarding comorbidities were not available in the database so we were not able to calculate risk group specific incidences. Similarly, the database did also not contain information on the microbial etiology. *Streptococcus pneumoniae* is generally accepted to be the most common cause of CAP [28]. A recent Dutch study among 505 patients hospitalized with community-acquired pneumonia showed that in those cases in which a pathogen could be detected ($n = 295$) *S. pneumoniae* was causative pathogen in 42% of the cases [22]. Furthermore, data from the CAPiTA trial showed that 13% of the first episodes of community-acquired pneumonia were episodes caused by the 13 vaccine serotypes included in PCV13 [11].

We did not observe an increase in CAP incidence during the 2009–2011 flu pandemic. The main reason might be that we did not include influenza in our analysis but solely focused on pneumonia. Furthermore, the increase awareness during the flu pandemic might have limited the number of cases with bacterial superinfection.

4.3. Implications and future research

We show that CAP represents a substantial disease and economic burden, especially in the elderly. In the next decades both the incidence and costs related to CAP are expected to raise, as the baby boomers are approaching senescence and due to a continues increase in the general life expectancy. Although, CAP guidelines from major medical societies already highlight the need for prevention efforts [29,30], the CAP-induced health and economic burden suggests that there is a need for additional preventive measures. However, before a preventive program (e.g. vaccination) would be implemented, among others, the cost-effectiveness needs to be evaluated. The current research, where the costs of hospitalized CAP has been determined, is a first step for such an evaluation. In order to obtain risk group specific costs estimates, to accurately estimate the cost-effectiveness, specific data with regard to etiology, quality-of-life losses, and costs of continuing

care outside the hospital environment due to pneumonia and are required [31]. Such information would not only be useful when determining the overall cost-effectiveness of a vaccination program in elderly, but could help to define specific target groups.

5. Conclusion

There is a large variation in terms of incidence, disease burden and costs across different age groups and the treatment setting. Effective interventions, targeted at specific age-groups, to prevent pneumonia could reduce the disease and financial burden due to pneumonia.

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