VIA MEDICA

PRACA ORYGINALNA

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A retrospective study of hospitalized pneumonia in two Polish counties (2006–2008)

Retrospektywne badanie leczonego szpitalnie zapalenia płuc w dwóch powiatach Polski (2006–2008)

This study was sponsored by Wyeth, which was acquired by Pfizer Inc in October 2009.
A partial summary of this study was provided as an oral presentation at the Polish Vaccinology Conference, Kraków, Poland; November 24–26, 2011.

Abstract

Background: In Poland, multi-cause pneumonia is not well characterized, and there is limited pneumococcal vaccination in the youngest and oldest age groups. The goal of this study was to assess hospitalized pneumonia across all age groups in two Polish counties.

Material and methods: Using electronic administrative databases, cases were identified as county residents hospitalized at Chrzanów and Inowrocław County Hospitals from 2006–2008, assigned a diagnosis of pneumonia. Calculations by admission year, sex, and age category were: hospitalization rates per 1000 persons; in-hospital mortality rates per 100 persons; and median length of stay (LOS).

Results: There were 1444 and 2956 hospitalizations for new episodes of pneumonia with rates of 3.76 (95% confidence interval [CI] 3.57–3.96) and 5.99 (95% CI 5.77–6.21) per 1000 persons in Chrzanów and Inowrocław counties, respectively. In combined data, the highest hospitalization rate was among patients aged 0–4 years (30.77; 95% CI 29.06–32.55) followed by those aged ≥ 75 years (25.39; 95% CI 24.01–26.83). In-hospital mortality rates increased with age at both sites. The median LOS was 8 days.

Conclusions: Pneumonia hospitalizations were substantial, especially for the youngest and oldest age groups. Future public health interventions aimed at these age groups might improve disease outlook.

Key words: community-acquired pneumonia, hospitalization rate, mortality rate, pneumococcal infection, retrospective study

Pneumonol. Alergol. Pol. 2013; 81: 429–438

Streszczenie

Wstęp: Dane dotyczące etiologii zapaleń płuc w Polsce są skąpe, a wyszczepialność szczepionką pneumokokową wśród osób w najmłodszej i najstarszej grupie wiekowej — nieznaczna. Celem prezentowanego badania była ocena leczonego szpitalnie zapalenia płuc we wszystkich grupach wiekowych w dwóch powiatach Polski.

Materiał i metody: W badaniu wykorzystano dane zawarte w elektronicznych szpitalnych bazach danych, dotyczące mieszkańców powiatów, hospitalizowanych w Szpitalach Powiatowych w Chrzanowie i Inowrocławiu w latach 2006–2008, z rozpoznaniem

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Praca wpłynęła do Redakcji: 27.12.2012 r.

ISSN 0867–7077

zapalenia płuc. Uzyskane wyniki: częstość hospitalizacji na 1000 osób, współczynnik śmiertelności w trakcie pobytu w szpitalu na 100 osób, mediana długości hospialization, zgrupowano według roku przyjęcia, płci i wieku.
Wyniki: W Szpitalu Powiatowym w Chrzanowie stwierdzono 1444, a w Inowrocławiu 2956 przypadków hospitalizacji z niezależnymi epizodami zapalenia płuc. Częstość hospitalizacji wyniosła 3,76 (95% przedział ufności [CI]: 3,57;3,96) i 5,99 (95% CI: 5,77; 6,21) na 1000, odpowiednio dla powiatów chrzanowskiego i inowrocławskiego. W całej badanej grupie najwyższą częstość hospitalizacji obserwowano w grupie 0–4 lat (30,77 [95% CI: 29,06; 32,55]) oraz ≥ 75 lat (25,39 [95% CI: 24,01; 26,83]). Współczynnik śmiertelności w szpitalu w obu badanych ośrodkach wzrastał wraz z wiekiem. Mediana długości pobytu w szpitalu wyniosła 8 dni.
Wnioski: Liczba hospitalizacji z powodu zapalenia płuc była znacząca, szczególnie w najmłodszej i najstarszej grupie wiekowej. Przyszłe działania opieki zdrowotnej skierowane do tych grup wiekowych mogą wpłynąć na zapadalność na zapalenie płuc oraz poprawić wyniki leczenia.

Słowa kluczowe: pozaszpitalne zapalenie płuc, częstość hospitalizacji, współczynnik śmiertelności, zakażenie pneumokokowe, badanie retrospektywne

Pneumonol. Alergol. Pol. 2013; 81: 429–438

Introduction

Community-acquired pneumonia (CAP) is a major cause of morbidity and mortality. The highest incidence of CAP occurs among young children and older adults [1, 2], whereas mortality is highest among older adults [3].

CAP has frequently been found to be pneumococcal in nature. One review of the burden of CAP in Europe, covering 41 prospective studies in a variety of age groups and populations, found that *Streptococcus pneumoniae* played a role in 20–25% of cases, and was the most commonly identified causative agent [4]. Of note, in this review 40–50% of patients in studies had unspecified CAP [4], whereas a similar study in England found even higher proportions [5]. However, because diagnostic specificity may not change treatment, and culture methods have limited sensitivity, the proportion of CAP linked to pneumococcal infection has been difficult to assess [5].

Two vaccine types for pneumococcal disease have been available in Poland: pneumococcal conjugate vaccine (PCV), which initially was indicated only for infants and young children and latter approved for older adults, and 23-valent pneumococcal polysaccharide vaccine (PPSV23), which was recommended for older adults, children above 2 years of age, and adults with conditions that put them at high risk for pneumococcal disease [6–8]. Unlike many other European countries, Poland has not had universal pneumococcal vaccination for children < 2 years as part of its NIP [9]. In 2008, 7-valent PCV (PCV7) became available free-of-charge for all high-risk children throughout Poland [6]. Since 2006, Kielce has been the only city in Poland to provide universal PCV vaccination without charge to resident children [10, 11]. PPSV23 vaccination coverage in adults 65 years of age and older in Poland has been minimal (about 1%) [12].

Poland has little published information on the burden of CAP [1]. Prior investigation of the burden of pneumococcal disease in Poland has focused on children [13, 14] or has largely addressed patients with meningitis [15] due to more widespread use of microbiology culture for this condition [13–16]. Studies conducted in Kielce utilized National Health Fund data among hospitalized and non-hospitalized patients to estimate the incidence of pneumonia before and after the introduction of universal PCV7 vaccination in 2006 [10, 11]. Prior to the introduction of widespread PCV7 vaccination (2004–2005) the investigators found an incidence of pneumonia of 4.94 per 1000 persons in all ages in Kielce [10]. Compared to post-vaccine years (2007–2010), significant declines in pneumonia incidence occurred in children 0–2 years, as well as older age groups [11]. Replication of these results in other parts of Poland is lacking.

Because the burden of pneumococcal disease is not well characterized in Poland and given the absence of widespread pneumococcal vaccination in all age groups, the main goal of this epidemiological study was to characterize the burden of pneumonia in two Polish county populations between 2006 and 2008. Hospital visits characterized by International Classification of Diseases and Related Health Problems 10th Revision (ICD-10) codes were used to measure the burden of pneumonia, an approach similar to several prior studies [2, 5, 17–20].

Material and methods

Study design

A retrospective study was conducted using data from electronic administrative databases at

two Polish county hospitals, Chrzanów County Hospital and Inowrocław County Hospital. As the only hospitals within their counties, primary care physicians refer their patients to these hospitals and residents are likely to seek treatment at these hospitals for emergency care. As health insurance is mandatory in Poland, virtually all residents have access to health care.

The main study objective was to quantify the hospitalization rate of pneumonia in the two study populations utilizing ICD-10 codes. Secondary objectives included describing the mortality rate and quantifying other available data related to the burden of this disease, i.e., diagnostic data and length of hospital stay.

Study subjects

Cases included patients hospitalized at Chrzanów County Hospital and Inowrocław County Hospital from 2006–2008, who were residents of Chrzanów and Inowrocław counties at the time of hospitalization and assigned a diagnosis of pneumonia in accordance with the ICD-10 code list provided in Table 1.

Methods

For each case with an admission date from 2006–2008, information was collected on demographics (age and sex), mortality, and length of hospital stay (LOS). Duplicate and non-incident observations were excluded from the hospitalization rate analysis (n = 198). Hospitalizations were considered duplicates if the same patient had identical information for multiple visits. Visits were considered non-incident if the same patient had < 30 days between two or more given visits. Non-incident visits were included in calculations for the LOS and mortality.

Data were aggregated by year of admission, sex, and age category for each site. Yearly population information by county was obtained from the Polish Central Statistical Office website (http://www.stat.gov.pl). Additional information on chest X-ray results and cultures was available at Inowrocław County Hospital, but not at Chrzanów County Hospital, in the form of electronic discharge cards. This sub-analysis was used to provide further evidence on disease burden. The primary reader abstracted information on a random sample of 250 cases. After data cleaning, 215 cases were included for subsequent calculations. In addition, the secondary reader performed independent validation on 50 cases.

Table 1. ICD-10 codes used to define pneumonia cases

ICD-10 code	Name
J12: Viral pneumonia, not elsewhere classified	
J12.0	Adenoviral pneumonia
J12.1	Respiratory syncytial virus pneumonia
J12.2	Parainfluenza virus pneumonia
J12.8	Other viral pneumonia
J12.9	Viral pneumonia, unspecified
J13: Pneumonia due to Streptococcus pneumoniae	
J14: Pneumonia due to Haemophilus influenzae	
J15: Bacterial pneumonia not elsewhere classified	
J15.0	Pneumonia due to Klebsiella pneumoniae
J15.1	Pneumonia due to Pseudomonas
J15.2	Pneumonia due to Staphylococcus
J15.3	Pneumonia due to Streptococcus, group B
J15.4	Pneumonia due to other Streptococci
J15.5	Pneumonia due to Escherichia coli
J15.6	Pneumonia due to other aerobic Gram-negative bacteria
J15.7	Pneumonia due to Mycoplasma pneumoniae
J15.8	Other bacterial pneumonia
J15.9	Bacterial pneumonia, unspecified
J16: Pneumonia due to other infectious organisms, not elsewhere classified	
J16.0	Chlamydial pneumonia
J16.8	Pneumonia due to other specified infectious organisms
J17: Pneumonia in diseases classified elsewhere	
J17.0	Pneumonia in bacterial diseases classified elsewhere
J17.1	Pneumonia in viral diseases classified elsewhere
J17.2	Pneumonia in mycoses
J17.3	Pneumonia in parasitic diseases
J17.8	Pneumonia in other diseases classified elsewhere
J18: Pneumonia, organism unspecified	
J18.0	Bronchopneumonia, unspecified
J18.1	Lobar pneumonia, unspecified
J18.2	Hypostatic pneumonia, unspecified
J18.8	Other pneumonia, organism unspecified
J18.9	Pneumonia, unspecified

This study was categorized as exempt from review by the ethics committee by the Regional Chamber of Physicians in Bydgoszcz, and approved by the ethics committee Regional Chamber of Physicians in Kraków.

Analysis

Hospitalization incidence rates per 1000 persons were calculated as case number divided by corresponding at-risk population number and multiplied by 1000. Assuming a Poisson distribution, 95% confidence intervals (CIs) were calculated for all hospitalization rate estimates [21].

In-hospital mortality rates (in percentages) were calculated by dividing the total number of deaths by the hospitalized cases of that disease and multiplied by 100. Deaths could occur during incident hospitalization or during a non-incident hospitalization among patients who had re-hospitalizations for the same condition within 30 days. So both incident and non-incident cases were included in in-hospital mortality rate calculation. Continuity-adjusted 95% CIs using the Wilson method [22] were provided for all in-hospital mortality rates.

For LOS, medians, as well as the 25^{th} and 75^{th} percentile values, were calculated by strata. The Kruskal-Wallis and Mann-Whitney tests were utilized to statistically test differences between two or more relevant groups on the distribution for this dimension. A two-sided threshold of 0.05 was utilized to determine statistical significance.

From X-ray and culture data abstracted in Inowrocław, the proportions of pneumonia in patients with an abnormal chest X-ray with or without lobar consolidation, and/or pleural effusion among those with a chest X-ray performed, were also calculated. The percentage of cultures positive for S. pneumoniae was calculated as the total number of readings that were positive for S. pneumoniae divided by the number of inpatients reviewed with a culture performed on any sterile specimen (e.g. blood, cerebrospinal fluid, pleural fluid).

Two analysts independently analyzed the data, one using SAS version 9.1.3 (SAS Institute Inc., Cary, NC, USA) and one using STATA version 11 (Statcorp, College Station, TX, USA). During validation, the two sets of results were compared with subsequent resolution of discrepancies.

Results

The total county populations over the 3-year study period were 383 644 and 493 727 for Chrzanów County Hospital and Inowrocław County Hospital, respectively. In this period, a total of 1444 and 2956 incident pneumonia cases were identified from Chrzanów County Hospital and Inowrocław County Hospital, respectively. For ICD-10 code J13 (pneumonia due to S. pneumoniae), there were three cases in Chrzanów and zero cases in Inowrocław. In both study sites combined, there were 417 deaths.

Hospitalizations rates

Overall, the hospitalization rate in Chrzanów County (3.76; 95% CI 3.57–3.96) was lower than in Inowrocław County (5.99; 95% CI 5.77–6.21). The hospitalization rate for the two sites combined was 5.01 per 1000 persons (95% CI 4.87–5.17). Males had consistently higher pneumonia hospitalization rates across sites and years (Table 2). Age patterns demonstrated the highest hospitalization rate among inpatients aged 0–4 years (30.77; 95% CI 29.06–32.55) followed by those aged ≥ 75 years (25.39; 95% CI 24.01–26.83) (Table 2). This finding was consistent for all study years (Fig. 1) and by years across sites (data not shown).

In-hospital mortality rates

In-hospital mortality rates were 10.53 (95% CI 9.05–12.22) in Chrzanów County and 8.96 (95% CI 7.99–10.05) in Inowrocław County. The overall in-hospital mortality rate was 9.48 per 100 persons (95% CI 8.65–10.38). There were similar in-hospital mortality rates for males and females at both sites for all study years (Table 3). The in-hospital mortality rates increased by age group with the highest in those aged ≥ 75 years for all study years (Fig. 2). These patterns held irrespective of study site.

Length of stay (LOS)

Median LOS was slightly longer in Chrzanów County Hospital compared with Inowrocław County Hospital for incident pneumonia cases (9 days compared with 8 days; $p < 0.001$). Cases at both sites had a combined median LOS of 8 days (Table 4). Males had significantly higher LOS in Inowrocław, but not in Chrzanów ($p = 0.04$; Table 4). Comparing the distribution of LOS by age, there was significant variation ($p = 0.0001$). In general, those aged <15 years had a significantly lower LOS than those aged >15 years ($p < 0.001$).

Clinical data

In Inowrocław County Hospital, chest X-rays were commonly performed (205 of the 215 patients, 95.35%), and nearly all X-rays were described as abnormal (200 of 205, 97.56%). Lobar consolidation or pleural effusion was rarely identified as the finding for abnormal chest X-rays (1 of 205, 0.49%). In Poland, other infiltrates consistent

Table 2. Pneumonia hospitalization rates by admission year, county, sex, and age group in Chrzanów County Hospital and Inowrocław County Hospital, Poland, January 1, 2006 through December 31, 2008

		Chrzanów County Hospital			Inowrocław County Hospital		
		No. of cases	Population at risk	Hospitalization rate per 1000 persons (95% CI)	No. of cases	Population at risk	Hospitalization rate per 1000 persons (95% CI)
Year	2006	532	128 093	4.15 (3.81, 4.52)	832	164 943	5.04 (4.71, 5.40)
	2007	501	127 859	3.92 (3.58, 4.28)	1213	164 571	7.37 (6.96, 7.80)
	2008	411	127 692	3.22 (2.91, 3.55)	911	164 213	5.55 (5.19, 5.92)
County[a]	Total	1444	383 644	3.76 (3.57, 3.96)	2956	493 727	5.99 (5.77, 6.21)
Sex[a]	Male	785	185 875	4.22 (3.93, 4.53)	1627	239 007	6.81 (6.48, 7.15)
	Female	659	197 769	3.33 (3.08, 3.60)	1329	254 720	5.22 (4.94, 5.51)
Age, years[a]	0–4	365	16 541	22.07 (19.86, 24.45)	845	22 789	37.08 (34.62, 39.67)
	5–14	98	37 648	2.60 (2.11, 3.17)	171	53 728	3.18 (2.72, 3.70)
	15–49	135	196 680	0.69 (0.58, 0.81)	212	257 798	0.82 (0.72, 0.94)
	50–64	195	77 240	2.52 (2.18, 2.90)	415	99 139	4.19 (3.79, 4.61)
	65–74	237	32 025	7.40 (6.49, 8.41)	465	34 084	13.64 (12.43, 14.94)
	≥75	414	23 510	17.61 (15.95, 19.39)	848	26 189	32.38 (30.24, 34.63)

[a]Aggregates 2006–2008

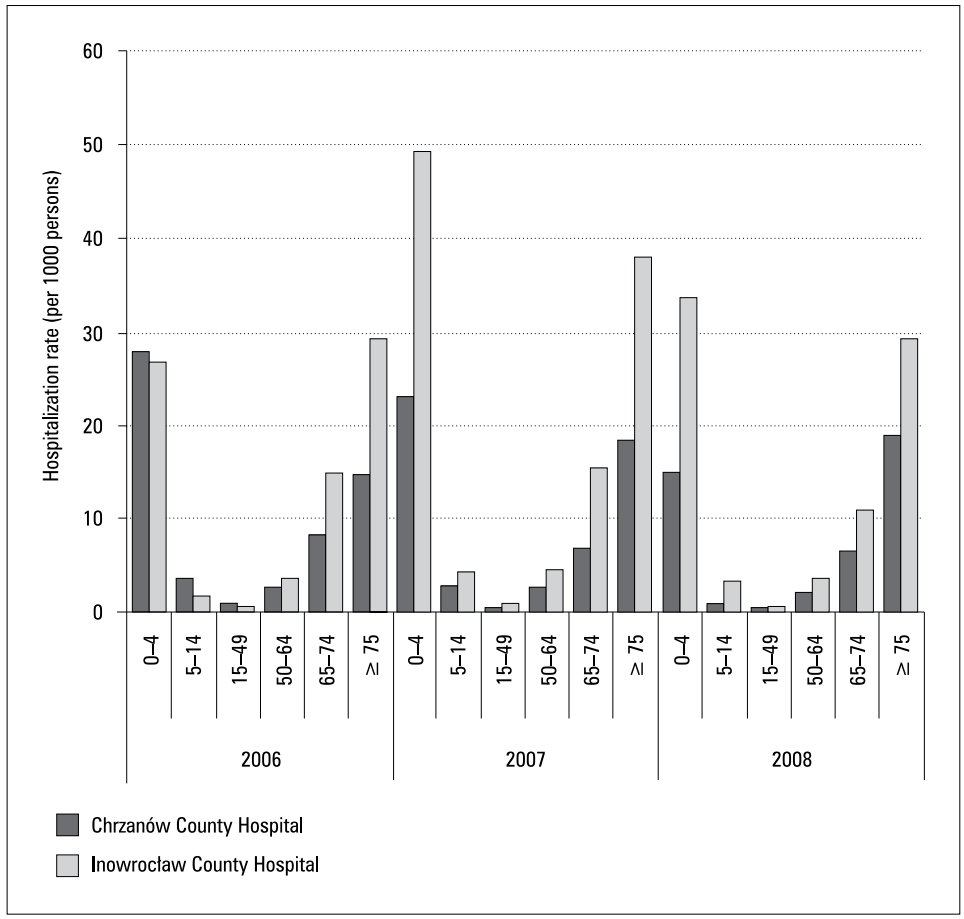

Figure 1. Hospitalization rates of pneumonia cases by admission year and age group in Chrzanów and Inowrocław County Hospitals, Poland, January 1, 2006 through December 31, 2008

Table 3. In-hospital mortality rate (IHMR) per 100 patients hospitalized with pneumonia by admission year, county, sex, and age group in Chrzanów County Hospital and Inowrocław County Hospital, Poland, January 1, 2006 through December 31, 2008

		Chrzanów County Hospital			Inowrocław County Hospital		
		No. of deaths	No. of cases	IHMR per 100 patients (95% CI)	No. of deaths	No. of cases	IHMR per 100 patients (95% CI)
Year	2006	48	532	9.02 (6.87, 11.76)	73	832	8.77 (7.04, 10.89)
	2007	39	501	7.78 (5.75, 10.46)	94	1213	7.75 (6.37, 9.39)
	2008	65	411	15.82 (12.61, 19.66)	98	911	10.76 (8. 91, 12.94)
County[a]	Total	152	1444	10.53 (9.05, 12.22)	265	2956	8.96 (7.99, 10.05)
Sex[a]	Male	86	785	10.96 (8.96, 13.33)	161	1627	9.90 (8.54, 11.44)
	Female	66	659	10.02 (7.95, 12.54)	104	1329	7.83 (6.50, 9.39)
Age, years[a]	0–4	0	365	0 (0, 1.04)	0	845	0 (0, 0.45)
	5–14	0	98	0 (0, 3.77)	0	171	0 (0, 2.20)
	15–49	9	135	6.67 (3.55, 12.18)	15	212	7.08 (4.33, 11.34)
	50–64	12	195	6.15 (3.55, 10.45)	53	415	12.77 (9.90, 16.33)
	65–74	33	237	13.92 (10.09, 18.91)	59	465	12.69 (9.97, 16.02)
	≥ 75	98	414	23.67 (19.83, 28.00)	138	848	16.27 (13.94, 18.91)

[a]Aggregates 2006–2008

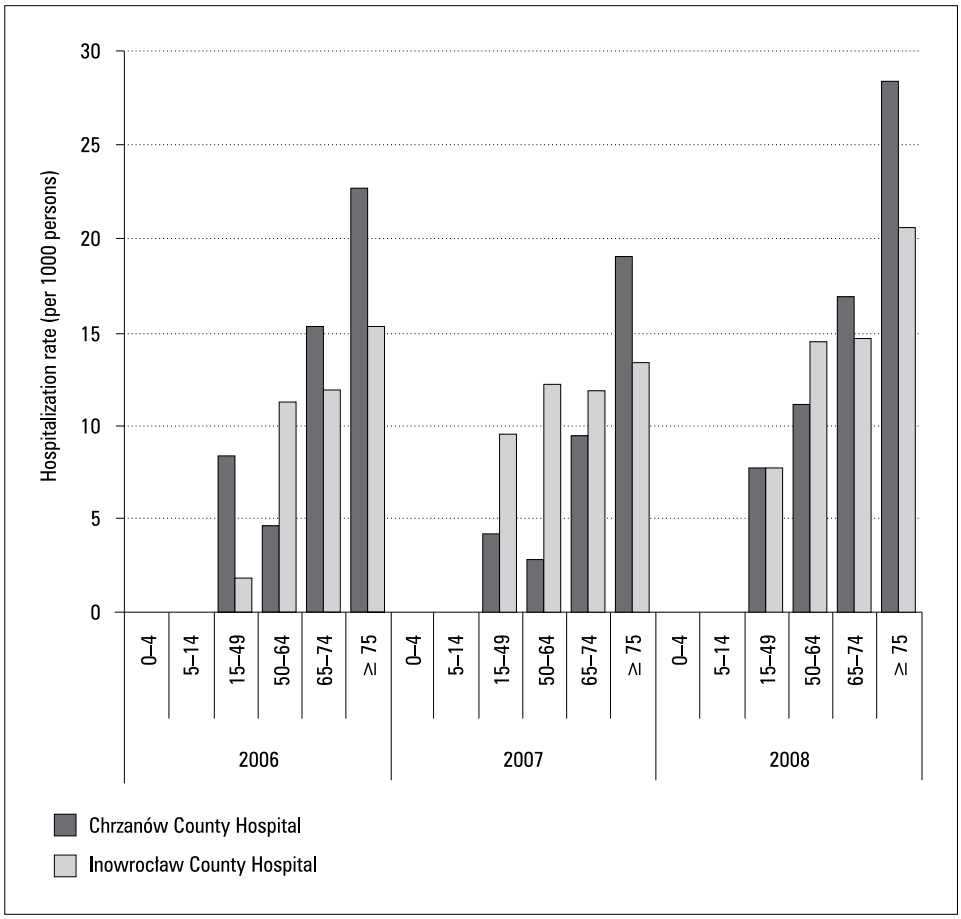

Figure 2. In-hospital mortality rates for pneumonia cases by admission year and age group in Chrzanów and Inowrocław County Hospitals, Poland, January 1, 2006 through December 31, 2008

Table 4. Median length of stay for hospitalized pneumonia cases by admission year, county, sex, and age group in Chrzanów County Hospital and Inowrocław County Hospital, Poland, January 1, 2006 through December 31, 2008

		Chrzanów County Hospital			Inowrocław County Hospital		
		No. of cases	Median length of stay, days	25th, 75th percentile	No. of cases	Median length of stay, days	25th, 75th percentile
Year	2006	532	9	8, 12	832	8	7, 9
	2007	501	9	8, 12	1213	8	6, 9
	2008	411	10	8, 15	911	8	5, 9
County[a]	Total	1444	9	8, 13	2956	8	6, 9
Sex[a]	Male	785	9	8, 13	1627	8	6, 9
	Female	659	9	8, 13	1329	8	6, 9
Age, years[a]	0–4	365	8	8, 10	845	7	5, 8
	5–14	98	8	8, 10	171	6	4, 8
	15–49	135	9	8, 12	212	8	6, 10
	50–64	195	10	8, 14	415	8	8, 12
	65–74	237	10	8, 15	465	8	8, 10
	≥75	414	10	8, 15	848	8	7, 10

[a]Aggregates 2006–2008

with pneumonia are commonly noted, although we did not collect these data. In terms of the culture results, very few cultures were reported as performed (7 of 215, 3.26%) and none was recorded as positive for *S. pneumoniae* (0 of 7).

Discussion

For Chrzanów and Inowrocław counties, the overall hospitalization rates of pneumonia were 3.76 and 5.99 per 1000 persons, respectively. These rates were within the range of CAP rates found in other European studies [23–25] though there were differences in case definitions. The higher hospitalization rates in Inowrocław relative to Chrzanów County may be associated with the lower socioeconomic status of residents of Inowrocław County compared with Chrzanów County, given prior evidence of a relationship between low socioeconomic status and higher pneumonia incidence [26]. In addition, variable patterns in hospitalization could contribute to county differences. If there was a higher threshold for inpatient treatment of pneumonia in Chrzanów, due to greater willingness or capacity to manage patients in the community, then that could lead to its lower hospitalization rate.

Men consistently had higher hospitalization rates relative to women in Poland likely due to an increased number of risk factors including smoking, alcohol, and toxic occupational exposures [27, 28]. Consistent with results seen in other countries [1, 20, 29] the youngest and oldest age groups had the highest hospitalization rates for pneumonia. In adults aged ≥ 65 years, the pneumonia rate of 18.41 per 1000 persons in Kielce before widespread PCV vaccination [10] was between the rate (for this age group) of 11.72 in Chrzanów and 21.78 per 1000 persons in Inowrocław. According to a co-author, the data in Kielce [10] included both hospital and primary care visits.

The in-hospital mortality rate for adults aged ≥ 18 years with pneumonia in this study, 14.16 per 100 persons, was higher than that seen in other studies [30, 31]. Nevertheless, this slightly higher in-hospital mortality rate could be a measurement artifact related to the inability of this study to exclude nosocomial pneumonia infections, which often have higher mortality rates [32]. The highest in-hospital mortality rate was seen in 2008 despite lower hospitalizations for disease during this period. One potential explanation for variations in in-hospital mortality rates by year could be linked to the proportion of those aged ≥ 75 years among cases, which was highest (31.85%) in 2008, and lower in 2006 and 2007 (26.39% and 28.06%, respectively). Between genders, mortality rates were similar despite differences in hospitalization rates observed between males and females. The highest pneumonia mortality rates were in those

aged ≥ 75 years, similar to patterns described in other developed countries such as Germany [18], England [1], and Spain [3]. The in-hospital mortality rate was lower in Inowrocław especially in the oldest age groups, although this could be linked to higher hospitalization rates in Inowrocław among less severely ill patients, thereby lowering the mortality rates. Given the lack of clinical data for pneumonia patients in this study, there is no way to systematically evaluate patterns of hospitalization.

As each day of hospital admission requires considerable human and administrative resources as well as accrued direct costs, LOS provides a proxy for the burden of specified diseases on the healthcare system. Comparing the median LOS for pneumonia patients seen in this study to other countries, it was greater than the median LOS of 6 days found in a Canadian hospital-based study from 1991–2001 among patients aged ≥ 15 years [17], and less than the average LOS of 10.8 days in a study in German hospitals among adults aged ≥ 18 years with CAP [30]. There was no difference in LOS between males and females overall, similar to research in Canada which demonstrated no difference in LOS for CAP patients based on sex [17]. There was variability in LOS by age with patients aged < 15 years being more likely to have a shorter LOS.

According to co-investigators at study hospitals, adult patients hospitalized with pneumonia in almost all cases have chest X-rays performed and receive diagnoses of pneumonia only when confirmed by chest X-ray. In contrast, in children diagnoses may be based on clinical symptoms only. Laboratory data using electronic hospital discharge cards were examined in Inowrocław County Hospital only. Consistent with investigator statements, chest X-rays were frequently performed and almost always had abnormal findings, although these were rarely recorded as lobar consolidation or pleural effusion. Of note, the information recorded in the hospital discharge cards was not recorded in a systematic or comprehensive manner. The low rates of cultures for pneumonia patients observed in this study in Inowrocław County Hospital were consistent with the limited performance of cultures for pneumonia patients (approximately 10% according to the study investigators), although there could also be incomplete reporting by the doctors completing this information. It is worth noting that difficulties in identifying the etiologic agent in pneumonia cases in Poland have been documented in previous studies and are believed to be due to economic, logistical, and technical issues [5, 10]. Therefore, the low rates of culture are not unusual for the setting, and diagnoses of pneumonia may be pneumococcal in nature although not identified or recorded as such with ICD-10 codes.

A recent study in Kielce, Poland has demonstrated not only a decrease in pneumonia incidence for those vaccinated but also herd effects of the vaccinations in non-vaccinated older age groups after widespread PCV7 vaccination [11], paralleling similar findings in the United States and Australia [2, 33]. In 2011 in Poland, 13-valent PCV (PCV13) replaced PCV7 for use in high-risk children. In addition, in 2013, PCV13 was recommended in place of PPSV23 for adults > 65 years and children (> 2 years) and adults at risk [8]. In children, there is emerging evidence that PCV13 is reducing the number of cases of IPD involving covered serotypes [34, 35]. For example, in the US following the introduction of PCV13, invasive pneumococcal infections decreased 42% in 8 hospitals for children in 2011 compared to years 2007–2009 [34]. For adults, preliminary evidence for the effectiveness of PCV13 was based on immunogenicity studies that compared antibody responses for the new vaccine with PPSV23 [36]. Results from a randomized, placebo-controlled trial of the clinical efficacy of PCV13 against pneumococcal pneumonia in adults 65 years and older in The Netherlands are not yet available [36, 37].

This study had several strengths. Available data were used which curtails the time and expense of conducting prospective surveillance. This study also removed non-incident and duplicate cases from the calculations of hospitalization rates because re-hospitalizations for the same episode of illness have the potential to inflate the hospitalization rate. A threshold of 30 days was used based upon prior work, which defined incident invasive pneumococcal disease cases as occurring ≥4 weeks (approximately 30 days) apart [38]. This was a conservative approach but prevented overestimation due to readmission for the same disease episode.

This study also had limitations common to studies conducted with retrospective administrative data. The application of ICD-10 codes may not be valid or reliable as it is often influenced by reimbursement systems; although evidence of this pattern has been mixed [39, 40]. There were changes in the approach for coding diagnoses in August 2008 but these were not anticipated to substantially affect hospitalizations for

pneumonia. For in-hospital deaths, there was no verification of pneumonia as the cause of death. Furthermore, based on standard of care, there was limited performance of cultures, and resultant utilization of ICD-10 codes was mostly non-specific with respect to etiology (i.e., there were only three cases coded as pneumococcal disease). In addition, because this study only included inpatients it underestimated the true burden of pneumonia in the populations of interest. Also, county differences in hospitalization rates could be influenced by selection factors as cases were only counted when hospitalized, and any differences in capacity to diagnose and treat pneumonia patients outside the hospital could alter this count. The ICD-10 codes also did not allow for the exclusion of nosocomial infections as no codes specific to this diagnostic category exist. Although the two study hospitals are the only acute care hospitals serving their respective counties, there was no evidence that all residents attended the county hospitals for treatment of the diseases of interest. Given this, the current study may underestimate hospitalization rates if county residents sought care outside the county for pneumonia. Furthermore, as this study was only conducted in two counties in Poland the results cannot be generalized to the country as a whole.

Conclusions

In summary, this study measured multiple indicators of the burden of pneumonia in two Polish hospitals serving separate countywide populations, and suggested considerable hospitalization for pneumonia in these counties, especially for those aged 0–4 years and ≥ 75 years. Future public health interventions aimed at these age groups might improve disease outlook.

Acknowledgments

This study was sponsored by Wyeth, which was acquired by Pfizer Inc in October 2009. We acknowledge the MediScience team, Dr. Marcin Ossowski and Eliza Filipiak for their administrative support, assistance in study implementation and data acquisition and site communication (MediScience Network, Warsaw, Poland). We thank the hospital staff who prepared the data, in particular Danuta Oksinska (Data Manager) at Chrzanów County Hospital (Chrzanów, Poland) and Mrs. Grażyna Lukaszewicz (Data Manager) and Dr. Anna Lukowiak-Rychlik (Data Abstractor) at Inowrocław County Hospital (Inowrocław, Poland). We also recognize Mark Todd (former employee of Pharmanet/i3, contracted to Pfizer Inc, Collegeville, PA, USA) for his assistance in coordinating all the research activities. Editorial support in styling the completed manuscript for submission was provided by Rachel Spice, PhD, at ExcerptaMedica and was funded by Pfizer Inc. A partial summary of this study was provided as an oral presentation to the Polish Vaccinology Conference, Kraków, Poland, November 24–26, 2011.

Conflicts of interest

R. Harat received payments from Pfizer as a consultant for his work in preparing and executing the study addressed by this publication. G. Górny received payments from Pfizer as a consultant for his work in preparing and executing the study addressed by this publication. L. Jorgensen is a consultant on the staff of Via Research, LLC and E.M. Gutterman is president of Via Research, LLC; the research conducted by Via Research, LLC described in this publication was funded by Pfizer. J. Pluta is an employee of Pfizer Poland. S. Gray is an employee of Pfizer Inc, PA, USA. N. Dartois is an employee of Pfizer France. Jian Ye, a co-author, is a former employee of On Assignment Inc, who was a paid contractor to Pfizer at the time of this study and during the development of this manuscript.

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