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ORIGINAL PAPER

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Population-based burden of pneumonia before school entry in Schleswig-Holstein, Germany

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Abstract Community-acquired pneumonia (CAP) is of predominant interest in analysing the burden of airway diseases. No population-based incidence data for children in Germany exist. In retrospective cohort studies from 1999 to 2001, parents of an entire age-class (28,000–30,000) of 5- to 7-year-old children at school entry medical examination (S1) in a complete federal state (Schleswig-Holstein, population 2.77 million) were interviewed by the Children and Adolescent Service of the Public Health Service. CAP was defined as pneumonia diagnosed by a physician at the time it occurred. The proportion of children investigated (participation rate) was 82.0–86.1%. The CAP-positive rate was 6.7–7.4%, 6.9–8.2% of whom had recurrent CAP. The mean age at first CAP was 36.4–39.4 months (median 42 months). This resulted in a population-based incidence for the age groups 0–1 year and 0–5 years (under 5) of 1,664–1,932 and 1,369–1,690 per 100,000, respectively; 93.7–95.9% received antibiotics. For each percent of CAP, 458 days (1999), 312 days (2000) and 319 days (2001) of at least one parent's work were lost, respectively. *Conclusions*: Despite a relatively weak case definition, the population-based incidence of CAP before school entry was the same as recently reported form California and about 30–50% of that reported 20 to 40 years ago in the USA and Finland.

Keywords Cohort · Pneumonia · School entry · Incidence · Public health service

Abbreviations *ARI* acute respiratory tract infection · *CAP* community-acquired pneumonia · *CAS* children and adolescent service · *LRI* lower respiratory tract infections · *PHO* public health office (Gesundheitsamt)

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Introduction

Acute respiratory tract infections (ARIs) contribute a high burden of disease, especially in children. Therefore, ARIs are of high priority for (epidemiological) research and prevention. Some vaccines against ARI pathogens such as the measles virus, *Bordetella pertussis* and *Haemophilus influenzae type b* are already established in the German immunisation plan. The most recent "anti-ARI vaccine", the 7-valent pneumococcal-conjugate vaccine (Prevenar, Wyeth-Lederle) was licensed in March 2001 in Germany and is available. However, it is currently recommended by the German vaccination committee (STIKO) only for children with underlying risk factors because of a lack of data on the burden of community-acquired pneumonia (CAP) in comparison with the available data on pneumococcal meningitis and invasive disease [23]. CAP is of predominant interest since it is a disease category caused frequently by *Streptococcus pneumoniae* and a major reason for antibiotic use in the community.

Subjects and methods

In three retrospective cohort studies from 1999 to 2001, parents of children aged 5–7 years were interviewed by the Children and

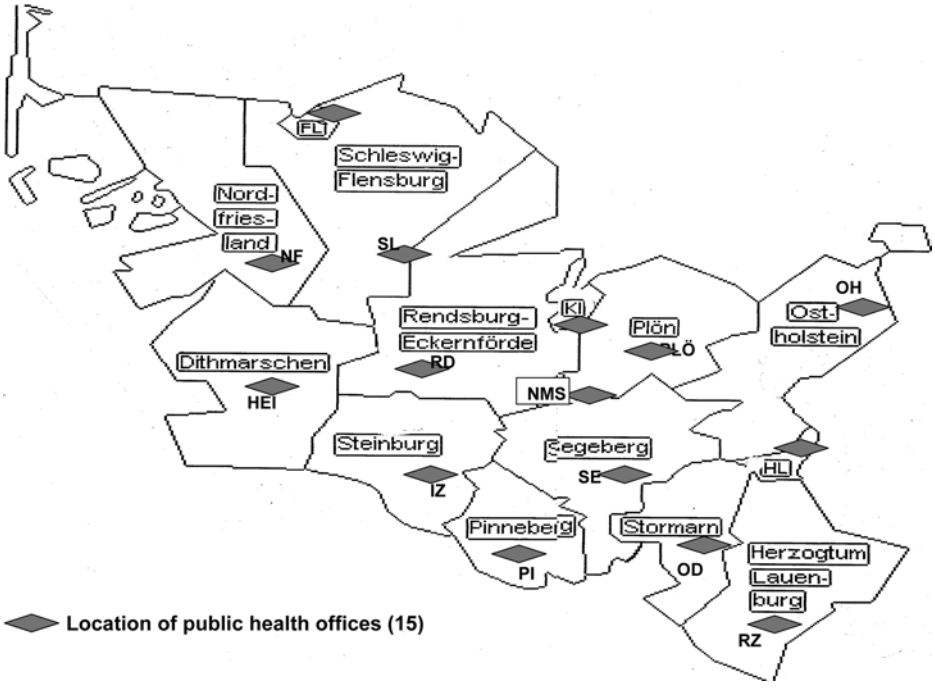

Fig. 1 Counties and municipalities in Schleswig-Holstein (Germany)

Adolescent Service (CAS) of the Public Health Service, Schleswig-Holstein, at the school entry health check (S1). Examinations were carried out in the months before school entry in the years 1999, 2000 and 2001. Schleswig-Holstein is the most northern federal state of Germany, just south of Denmark. A particular asset for this study was the dense network of the Public Health Service in Schleswig-Holstein. All Public Health Offices (PHO, $n = 15$) of the four independent municipalities (Kiel, Lübeck, Flensburg, Neumünster), as well as the 11 counties, were involved (Fig. 1). The CAS conducts several health checks at school age (S1 to S3) during which it samples data on a whole range of items—basic parameters, certain diseases, social factors and vaccination data. Four data entry sites on the questionnaire used for the S1 health check were reserved for our study. A case was defined as pneumonia when reported as having been diagnosed by a physician at the time of occurrence.

1. Item 1 "age at first pneumonia in life". From this item, the age distribution and age group specific population-based incidence can be calculated
2. Item 2 "number of pneumonia episodes up to now". The burden of CAP for the average CAP-positive child could be calculated and a correction factor for the population-based incidence could then be established for the referring age class and the proportion of recurrent pneumonia estimated
3. Item 3 "antibiotic use in case the child had a CAP". Primary costs, medical practice and pressure for antibiotic resistance can be estimated
4. Item 4 "weeks out of work of at least one parent". The number of weeks taking into account all the child's episodes of CAP was required. Secondary costs to society can be calculated

Denominator

To calculate the denominator and the case ascertainment rate, population data from the Office for Statistics (Statistisches Landesamt) of Schleswig-Holstein were used. In 1999, Schleswig-Holstein had a population of 2,777,275. The population of children aged 5 to 6 years in 1999, 2000 and 2001 (age classes 1993, 1994 and 1995) were 30,306, 28,982 and 28,605, respectively (data from 1999). Data for all 15 PHOs were available for stratified analysis.

Incidence calculation and statistical analysis

Only the proportion of the cohort available for interview was included in the calculation of the cumulative population-based incidence per 100,000. Assuming incidences in the non-reporting population to be the same as in the study population, no correction for ascertainment rates had to be made. Since one child with a positive history of CAP could have had CAP on more than one occasion, the ratio of CAP episodes per CAP-positive child had to be determined and the population-based incidence multiplied by this factor (correction factor for multiple CAP). Since no data were gathered at the age when this multiple CAP occurred, the factor was used for all age groups homogeneously. This resulted in the following formula for incidence calculation:

100,000 divided by number of children interviewed per age class ascertained times the number of CAP-positive children observed multiplied by the correction factor (for multiple CAP). All rates refer to patients at risk only, i.e. the correlating age group. The 1-year cumulative incidence for the age group 0–5 years is approximated by the cumulative numbers of the cohort divided by 5. In reality, five different age classes would contribute to the incidence in the 0–5-year age group.

To estimate the total time away from work, the figures were corrected by the case ascertainment rate. For cross-validation of the age distribution, data from a second source were compared. The sentinel system of office paediatricians in Schleswig-Holstein (EVI-D) served as this second source. In this network, data on CAP are sampled prospectively on a monthly basis in 42 of the 120 private offices of paediatricians since 1997.

The data were entered into a MS Excel 1997 database. SPSS version 10 served as statistical package. For continuous parameters, the mean, median and range are given; for proportions the Pearson chi-square test was applied.

Results

Ascertainment

The participation rate for the S1 examination and interview was 83.9%, 82.0% and 86.1% for 1999, 2000 and

Table 1 Participation rate of children at school entry in Schleswig-Holstein, Germany from 1999 to 2001. *CAP* community-acquired pneumonia

Year	Denominator (age class)	Registered eligible children (% of denominator)	Enrolled (ascertainment %; range)	CAP-positive (%)
1999	30,306	27,245(89.9)	25,416(83.9; 74.9–100.0)	1,704(6.7)
2000	28,982	26,812(92.5)	23,771(82.0; 77.8–100.0)	1,596(6.7)
2001	28,605	25,650(89.7)	24,640(86.1; 77.5–100.0)	1,830(7.4)
Average	29,298	26,569(90.7)	24,609(84.0; 76.4–100.0)	1,710(6.9)

Table 2 Age groups of children reported with CAP at school entry in Schleswig-Holstein, Germany from 1999 to 2001

Year	0–1 year	Fraction (%) in sample (range[a])	0–5 years[b]	Fraction (%) in sample (range)[a]	All (0–7 years) CAP-positive, % (% range[a])
1999	318	1.25 (0.67–2.09)	1,308	5.15 (3.08–7.15)	1,704, 6.7 (3.9–9.6)
2000	331	1.39 (0.55–3.22)	1,310	5.51 (2.61–8.35)	1,596, 6.7 (3.3–9.4)
2001	345	1.40 (0.29–3.07)	1,509	6.12 (2.29–9.35)	1,830, 7.4 (2.7–11.6)
Average	331	1.35 (0.50–2.79)	1,376	5.59 (2.66–8.28)	1,710. 6.9 (3.3–10.2)

[a]Range between PHOs
[b]Under 5

2001, respectively (Table 1). One PHO did not participate in the study and one (Pinneberg) delivered data only on items 1 and 2. Between offices, the case (child at time of school entry) ascertainment rate varied from 74.9 to 100% in 1999, from 77.8 to 100% in 2000 (outlier Pinneberg 25.4%) and from 77.5 to 100.0% in 2001.

The registration of eligible children by the PHOs was 89.9%, 92.5% and 89.7% per year, respectively. Following the referring birth cohorts, a mean increase of 4.8% in the number of children to the time of school entry was noted. However, the slight increase in the population due to immigration into Germany may have overestimated the absolute burden, at least in early childhood, i.e. less than 1 year of age.

Positive rate and age grouping

The percentage of children with a positive history of CAP was 6.7–7.4% (Table 1). The range between offices for all age groups was 3.9–9.6% for 1999, 3.3–9.4% for 2000 and 2.7–11.6% for 2001 (Table 2).

Age distribution (item 1)

The mean of reported age at first CAP was 39.4 months (median 42 months) in 1999, 36.4 months (median 42 months) in 2000 and 36.0 months (median 30 months) in 2001. The age distribution of the pooled data is shown in Fig. 2. After the 1st year of life, a slight trough occurred at 2 to 4 years of age. The figures for years 6 and 7 not only reflect the incidence of CAP, but also the age of school entry. Children enter school in general at age 6 years. Very few enter school, however, with a delay of 1 year. From the second source (EVI-D), the mean age at first CAP was 35.2 months and the median 35.0 months, i.e. very close to the data generated by the CAS. The trough of the incidence after the 1st year of life was also seen in EVI-D between 30 and 40 months. The first 6 months were proportionally spared in this office sentinel system. The CAS system did not allow this differentiation, since the age scale (1 year) was too broad for this purpose.

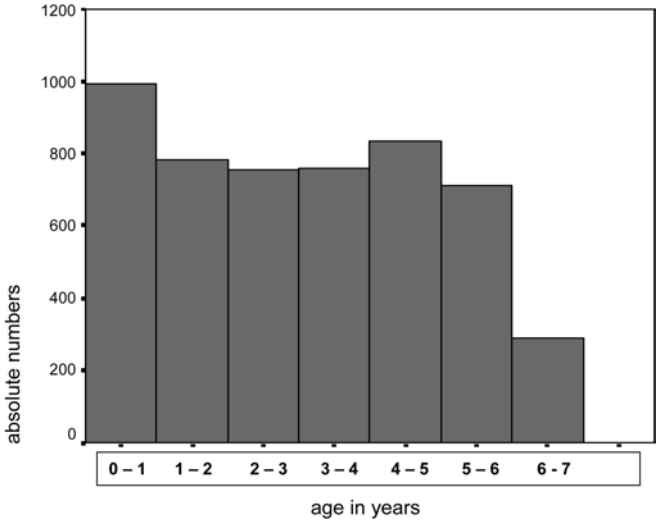

Fig. 2 Age distribution of the first reported CAP in children entering school in Schleswig-Holstein, Germany

Number of CAP per CAP-positive child (item 2)

In 1999, 2,266 episodes of CAP were registered in 1,704 children (1.33 per CAP-positive child), in 2000, 2,101 episodes in 1,596 children (1.32 per CAP-positive child) and in 2001, 2,526 episodes of CAP in 1,830 children (1.38 per CAP-positive child). In 92%, one or two CAPs per CAP-positive child were registered. 7.7% (6.9% to 8.2%) had recurrent CAP, i.e. three to eight episodes as defined by Wald (Table 3) [24].

Table 3 Number of reported CAP episodes per child at school entry in Schleswig-Holstein, Germany from 1999 to 2001 (CAPs per CAP-positive child)

Year	CAP positive episodes	CAP positive children	Number of CAPs per CAP positive child	Percent of children with one or more CAPsreported					
				1 CAP	2 CAP	3 CAP	4 CAP	5 CAP	> 5 CAP
1999	2,266	1,704	1.33	81.2	11.5	4.3	1.1	0.8	0.9
2000	2,101	1,596	1.32	81.1	12.0	3.8	1.6	0.9	0.6
2001	2,526	1,830	1.38	79.7	11.4	4.4	1.9	1.2	1.4
Mean	2,298	1,710	1.34	80.7	11.6	4.2	1.5	1.0	1.0

Table 4 Population-based incidence of CAP in children in Schleswig-Holstein, Germany from 1999 to 2001

Year	CAP incidence per 100,000 (range[a]) at 0–1 year	CAP incidence per 100,000 (range[a]) at 0–5 years[b]
1999	1,664(842–2,786)	1,369(820–1,902)
2000	1,838(731–2,591)[c]	1,455(689–2204)
2001	1,932(750–2,908)[d]	1,690(663–2581)
Average	1,811(658–2,762)	1,505(714–2229)

[a]Range between PHOs
[b]Under 5
[c]Upper outlier (4,247)
[d]Lower and upper outlier (401, 4,242)

Population-based incidence of CAP (item 1 and 2)

From the data of items 1 and 2, the population-based incidence was calculated (Table 4). The age grouping was chosen in order to make comparisons with studies in the literature and it must be remembered that the correction factor for multiple CAP was applied equally for all age groups. The population-based incidence was highest in the 1st year of life. As evidenced by the EVI-D system, CAP occurred in a relatively higher proportion in the second 6 months of the 1st year of life.

Antibiotic use (item 3)

Antibiotic use was quite constant over time. In 1999 it was 93.7% (range 76.6–98.3%), in 2000, 95.9% (range 83.2–99.4%) and in 2001, 95.7% (range 88.6–98.6). Taking 1999 as reference, antibiotics were used more often in the cohorts in 2000 ($X^2 = 5.2$; $P = 0.022$) and the cohort in 2001 ($X^2 = 7.2$; $P = 0.007$).

Weeks away from work of at least one parent (item 4)

In 16.5% (14.9% to 18.8%) of families with children with CAP, CAP in an offspring led to sick leave being taken by one parent. Comparing the different cohorts using 1999 as reference, time out of work decreased significantly in 2000 ($X^2 = 8.6$; $P = 0.003$) and in 2001 ($X^2 = 6.2$; $P = 0.013$). Converting the weeks approximately into days and correcting the absolute number of days per year per cohort by the participation rate, an estimate of the total number of days' work lost by at least one parent can be given (Table 5). The absolute number of days away from work decreased from 3,069 days in 1999 to 2,089 days in 2000, and 2,363 days in 2001. For each percent of CAP in the cohort, 458 days, 312 days, and 319 days' work of at least one parent were lost, respectively. Assuming the cost of one working day to be roughly 100.00 Euros, the total financial loss for time away from work would have been 306,900 Euros in 1999, 208,900 Euros in 2000 and 236,300 Euros in 2001 in a total population of 2.77 million.

Discussion

Pathogen-specific surveillance of CAP is hampered by the lack of routine and timely diagnostic tool for the microbiological identification of (especially bacterial) pathogens in CAP in children [13]. Despite this drawback, three options for obtaining data are possible:

1. Invasive techniques such as lung tap or blood samples for circulating immune complexes and/or paired sera [8, 9, 12]
2. Placebo-controlled vaccine trials, which can estimate the burden of CAP of a specific pathogen using differences in the incidence of CAP between the verum and the placebo group [2, 14, 22]
3. Data from syndromic surveillance or surveys [11], which by their nature are not pathogen-specific, but if mass vaccination for a given pathogen causing CAP in a significant (measurable) proportion is administered, its effectiveness can be approximated

To investigate the situation outside the hospital setting, the form of the retrospective cohort study was

Table 5 Total time (weeks) away from work of at least one parent due to their child suffering one or more CAP episode before entering school

Year	CAP positive	0	< 1	1–2	3–4	> 4	Estimated days lost
1999	1,704	81.2	7.9	9.7	0.9	0.3	3,069
2000	1,596	85.1	8.4	5.6	0.3	0.5	2,089
2001	1,830	84.3	8.5	6.4	0.7	0.3	2,363
Average	1,710	83.5	8.3	7.2	0.6	0.4	2,507

chosen. Cohort studies are supposed to be of the highest, i.e. fair or level II, quality according to the Canadian Task Force on the Periodic Health Examination for showing evidence in this type of epidemiological research [10]. The CAS seems particularly suitable for this type of study. To render the approach feasible, the excess workload for the CAS of the PHOs had to be as limited as possible. Studies in the community require considerable manpower and confidence of the population. Therefore, only four items on the questionnaire form were included in this study. Since establishing data on the population-based incidence was the predominant objective, items 1 and 2 were of highest priority. Related problems of CAP, i.e. antibiotic use and the problems and secondary costs to society involved, were secondary objectives, since they are major arguments for the introduction of new anti-ARI vaccines such as the pneumococcal-conjugate vaccines. By limiting the workload for the CAS, we hoped to maintain the compliance of the CAS at a high level over the complete time period of the study. A positive asset for our study was that PHOs in Schleswig-Holstein are still present in all legislative units, i.e. counties and independent municipalities, forming a comprehensive and dense network in contrast to other federal states in Germany.

The fact that one PHO did not participate in the study and one (Pinneberg) only partially reduced the sample size, should not have introduced any bias. Whether the figures for the sampled items were different in the 17–18% of non-enrolled children is most unlikely, but cannot be ruled out. They belonged mainly to anthroposophist schools (Waldorfschulen) and schools of the Danish minority. Since the enrolled number of children formed the number entered for incidence calculation, variation in ascertainment did not matter. The variations were very small between PHOs (74–100%), generally over 83%. The case ascertainment rate was included in the calculation only in order to estimate the absolute costs. Since we were mainly seeking a reasonably precise estimate, this also should not have weakened the output for the goal we set.

There was some variation in age and incidence between local PHOs, but the numbers of real outliers was very limited (three outliers, see footnote of Table 4). The impact of this can only be estimated by using a second source of information. This could partially be achieved by the sentinel office network (EVI-D), at least for age and incidence.

The mean and median ages in the CAS system were very close to the mean and median observed in the EVI-D. The proportion of children under 1 year of age was lower in the EVI-D than in the CAS system. This is most likely due to infants with CAP being readily admitted to hospital. Young age is the predominant variable determining the chance for admission to hospital [10, 26] and therefore does not appear in the practice sentinel system.

The lower incidence of first CAP in the 2nd to 4th year of age was also seen in the EVI-D. If it is incorrect, recall bias might be an explanation. If the finding is correct, the explanation would be that the life span after the 1st year of life, i.e. the 2nd to 4th year, carries a lower risk than the other years (below 6 years). Nevertheless, this is the period when children in general do not yet attend kindergarten and other day care facilities, which are a major underlying risk for the spread of infections and therefore raise the population-based incidence [17].

If one accepts the definition of recurrent pneumonia as being three or more episodes in any given time interval [24], our percentage of 7.7% is close to the 8% reported by Owayed et al. [18]. The proportion of children with an underlying condition in our setting cannot be accurately stated, since only aggregated data on the four pneumonia items were accessible. From the population statistics, however, it can be estimated to be 3–4% in the general paediatric population up to 6 years of age in Germany.

The population-based incidence is the best parameter and scale for longitudinal and international comparisons (Table 6). Comparison is, however, only warranted with countries of similar social and health care level and geographical latitude. The incidences found in our study are about 30–50% lower than those reported 20–40 years ago in Finland and the USA [5, 6, 7, 11, 15, 16, 29], but similar to those recently reported in the Kaiser Permanente study in California (HR Shinefield, personal communication). Jokinen et al. found the highest variability in CAP incidence between counties in children in contrast to older age groups [11]. Local outbreaks most likely due to respiratory viruses and

Table 6 International comparison of the population-based incidence of CAP in children

Area (country) [reference]	Years (time study done)	CAP case definition	Cohort size	Incidence in 0–1 year-olds per 100,000	Incidence in 0–5 year olds per 100,000
Schleswig-Holstein (Germany) present study	3(1999–2001)	History of physician diagnosis	30,000	1,800	1,500
California (CA, USA)[a]	3(1999–2002)	Physician diagnosis	39,354	–	1,500
Seattle (WS, USA) [6, 7]	8(1963–1971)	Physician diagnosis	13,434	4,990	4,200
Chapel Hill (NC, USA) [5, 16]	11(1964–1975)	Physician diagnosis	6,500	3,000	4,000
Monroe (NY, USA) [15]	4(1971–1975)	Physician diagnosis	1,965	1,680	–
Tucson (AZ, USA) [29]	4(1980–1984)	Physician diagnosis	1,179	4,765	–
Kuopio (Finland) [11]	1(1981–1982)	Chest X-ray or autopsy	2,917	–	3,600

[a]HR Shinefield, personal communication

Mycoplasma pneumoniae were thought to be responsible for this [6, 7, 11, 16]. Since outbreaks were also observed in several areas in Schleswig-Holstein during the study period, they could explain some of the variations of incidence between different PHOs. The 30–50% drop in incidence is most likely explained to a large extent by the formerly limited availability or coverage with vaccines against pathogens causing ARI (e.g. *H. influenzae*, measles and *B. pertussis*) [10, 14] compared with the present day. The vaccine coverage in the local population under 5 years of age in the year 2000 was 89.2% for *H. influenzae type b*, 89.7% for pertussis and 84.8% for measles [1]. Social factors also influence the incidence of CAP. The incidence in the study population was as reported for an upper class population in Monroe county in the USA [15]. Furthermore, other factors such as a secular trend with a decreasing population-based incidence of CAP also play a role [28]. Comparing the incidence of RSV-positive CAP hospitalisation (0.8%) [25] with the 1.6–1.9% overall incidence of CAP in the 1st year of life means that at least 50% of CAP episodes in the 1st year are related to RSV, as they already form 50% on the basis of RSV-positive CAP hospitalisations.

The higher incidence in the 1st year of life, especially in the second 6 months, was a common finding of other authors [5, 6, 7, 16, 29] and is most likely explained by a placental transfer of protective antibodies to the offspring. On the other hand, this means that a considerable proportion of CAP even in the 1st year of life would be accessible by the current immunisation plan, if one adheres to the established immunisation schedule with three basic shots of a given ''anti-CAP-vaccine'' within the first 6 months of life.

Antibiotic use was of interest for estimating primary costs and the pressure for resistance of bacteria as well as for validating the relatively unspecific case definition of CAP. Since diagnosis of CAP in our country generally leads to the prescription of an antibiotic [20], hints given by this information should raise the specificity of the case definition or at least point to a more severe lower respiratory tract infection (LRI) in a given situation. This would mean that there could have been an overestimation of the burden of CAP of 4.1–6.3% if the non antibiotic-treated cases were incorrectly reported by the parents as being CAP. Despite antibiotics being widely used to treat CAP, the overall antibiotic use in Germany is low compared with other countries within the European Union [4]. Macrolide-resistance of *Streptococcus pneumoniae*, however, rose to nearly 15.7%, in contrast to the very low resistance rates towards penicillin [19].

As far as secondary costs are concerned, attitudes towards financial aspects of disease and cost-benefit margins are important. However, to obtain an initial insight, the number of working days lost by a parent and an estimate of secondary costs are at least a first step, as no costs data exist, especially data on the secondary costs of CAP in children in Germany. A major variable is the proportion of mothers working or the amount of time spent away from work after delivery and being supported by the social system. (Women receive benefits up to 1 year after delivery and their job is guaranteed for up to 3 years in Germany.) The generous support for women after delivery in Germany was one factor for the low percentage of women away from work, since most mothers were probably not working, at least during their child's 1st year of life when the incidence of CAP was highest. The decrease after 1999 is most likely caused by higher pressure on the workforce to abstain from absenteeism, with unemployment rising and work laws tightening in the late 1990s.

If community-based investigations are chosen to estimate the burden of CAP in children as in our study, longitudinal and soundly analysed data on a certain population in a given geographic area form the baseline. The burden of CAP attributable to a vaccine-preventable pathogen can then be estimated if this vaccine covers a significant proportion of CAP so that it is accessible by a less precise technique. Since no efficacy (phase III) trials for the 7-valent pneumococcal-conjugate vaccine were performed in Germany, only a general use of the vaccine (phase IV) in a particular previously well-investigated area could render data on the effectiveness of this vaccine. Data on the population-based incidence of CAP in children 0–1 year and under 5 years respectively would be most important for this approach.

Since the currently discussed 7-valent pneumococcal-conjugate vaccine would be introduced into the basic immunisation schedule in the 1st and 2nd year of life, a time lag of 3–4 years minimum for the referring cohort would be expected to deliver the effectiveness data, if the effects were measured by the CAS system as described here. Effects in the population per se, however, could be expected earlier because of herd immunity and reduction of household exposure [3, 27]. Since the minimum prerequisites of phase II trials to establish data for immunogenicity in parallel with established combination-vaccines in Germany have already been generated [21], this approach could be launched right now.

The retrospective nature of our study implies several limitations:

1. Recall bias: parents, mainly the interviewed mothers, may have recalled the time of the first CAP episode in their child incorrectly. For the 1st year of life this seems less likely than for the years after, since CAP in the 1st year of life mainly involves hospitalisation [10, 26].
2. Interviewer bias: interviewers, i.e. doctors at the CAS, may have phrased the questions set to the mothers in a different way, thus causing different responses. Also the vague definition of a CAP episode in general may have added to this; particularly regarding the proportion of more than two CAP episodes per CAP-positive child. Other LRI, i.e. non-CAP LRIs, might have been confused with CAP, but the diagnosis of CAP, even in a prospective outpatient setting without using a chest X-ray, is not certain.

3. Compliance of the CAS: compliance did not decline over the 3 years and explained little of the observed variance. Differences between different CAS and PHOs were present, but did not increase considerably over the 3-year period.

Conclusions

Data generated by the Public Health Service by retrospective cohort studies in the way described here, allow access to the hidden parts of the ARI iceberg, or in this instance, the CAP iceberg. They are sufficiently accurate, precise and consistent over time. The age distribution and population-based incidence for children under 1 year and under 5 years, respectively, in Schleswig-Holstein were considerably lower than that those reported by other authors 20 to 40 years ago, but the incidence today is the same as that recently described in California. Antibiotic use was as high as expected, but the secondary financial costs of time away from work were lower than expected.

More disaggregated data from the PHOs should allow the analysis of other variables and risk factors such as social factors. Together with the data from the practice sentinel (EVI-D) and the local hospital network, a concise and comprehensive picture of CAP in Schleswig-Holstein can be deduced. These data have now opened the way in Schleswig-Holstein to conducting effectiveness studies for interventions such as the pneumococcal-conjugate vaccines.

The study has proven the CAS (PHOs) to be able to generate reliable data on the incidence and prevalence of infectious diseases with high cost-effectiveness. The existing system of PHOs in Germany can deliver answers to actual questions provided it is used in a flexible manner and the questions are posed in the right way. Further prospective studies and long-term surveillance are warranted to elucidate the epidemiology of CAP further.

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