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Pertussis in Germany: regional differences in management and vaccination status of hospitalized cases

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SUMMARY

The incidence of pertussis requiring hospitalization in children younger than 16 years was estimated by the use of an active surveillance-system. Of special interest were differences between West and East Germany following different vaccination strategies before reunification. In 1997 and 1998, 754 pertussis cases required a total of 11151 hospital inpatient days. The incidence of hospitalized pertussis was 2·68/100000 person years and this was significantly higher in East than in West Germany. In East Germany an unusually high percentage of hospitalized cases was found in children aged 6–15 years (45% versus 13% in West Germany). The difference between the regions may be due either to a different perception of the disease or to an increased immunity induced by prior disease or vaccination. In East Germany, pertussis was rare until reunification but it has increased significantly since then. Older children may thus represent a population at risk of pertussis having not had previous exposure to pertussis antigens.

INTRODUCTION

Pertussis is a highly contagious disease causing severe complications especially in early infancy. About 20–40 million cases each year are estimated to occur worldwide [1]. Vaccination is the most effective means of pertussis control. Before reunification in 1990 different vaccination policies were followed in West Germany (former FRG) and in East Germany (former GDR). In the GDR, pertussis vaccination was compulsory [2] but owing to concerns about possible neurological sequelae, pertussis vaccination in West Germany was only recommended between 1975 and 1991 for certain risk groups [3] and vaccine coverage dropped to less than 10% [4]. Since 1991, pertussis vaccination has been generally recommended for all infants in the German vaccination guidelines [4]. Data from a school entrance survey in 1996–8, covering the birth cohorts of 1990–2, showed a higher vaccine coverage in East Germany (80%) than in West Germany (40%) [5, 6]. After the licensing of acellular pertussis vaccines for primary vaccination in Germany in 1995 [7], the acceptance of pertussis vaccination increased in both parts of the country. German vaccine guidelines for infants recommend an immunization schedule at 3, 4, and 5 months with a booster dose between 12 and 15 months [8, 9] but recently another booster vaccination has been recommended for children between 11 and 18 years [10].

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Pertussis is not a notifiable disease in Germany, and thus little is known about its epidemiological development in East and West Germany in recent years. To obtain this information, we surveyed all hospitalized cases of pertussis in Germany. The incidence of pertussis cases requiring hospitalization and the incidence of pertussis related complications (pneumonia, apnoea, encephalopathy, seizures, death) in children younger than 16 years was estimated using a nation-wide hospital-based active surveillance system, the 'Surveillance Unit for Rare Paediatric Diseases' (ESPED) [11]. Differences between East and West Germany in the year of reporting, age, gender and nationality were recorded and the vaccination status of hospitalized children was investigated. Finally, various laboratory methods for pertussis diagnosis were compared.

METHODS

Reporting system

Monthly report cards listing 12 diseases were sent by ESPED to all paediatric departments in Germany. The number of hospitalized children younger than 16 years with pertussis in the study month was reported. Cards had to be returned even if there were no new patients with pertussis. A questionnaire was sent to the paediatric department for each reported case requesting information about the child such as sex, date of birth, nationality, place of residence, reasons for admission, clinical symptoms, complications and the results of laboratory tests. Another questionnaire, filled out by the child's parents, gave additional information about vaccination status, medical history and pertussis exposure before hospitalization. Questionnaires with incomplete information were followed up by a telephone interview.

Case definition

The following case definition was used, based on the information from the questionnaire. A case was considered to be probable if at least two of the three criteria 'typical clinical symptoms', 'positive serology' and 'typical white blood cell count' were met. Clinical symptoms or a positive serology alone made the case definition as tentative. 'Positive serology' was not considered sufficient to define a case as confirmed, because each hospital used its own laboratory to perform serologic tests, and methods as well as criteria for a positive test result differed markedly. A positive culture, PCR or positive direct immunofluorescence test confirmed the case. All cases that did not meet these definitions were excluded from further analysis. The criteria were applied after the receipt of the questionnaire, and two members of our work group decided whether the case definition was valid.

Typical clinical symptoms were defined as a cough lasting for at least 14 days or a paroxysmal cough with whoops lasting for at least 4 days. When exposed to a confirmed case, a cough of at least 7 days or a paroxysmal cough with whoops of any duration was accepted as typical. In children younger than 6 months, apnoea was also regarded as a typical clinical symptom. In infants younger than 6 months, leucocytosis of more than 20000/mm^3 was regarded as typical for pertussis. For the age groups 6–12 months, 1–6 years and 6–15 years the counts were 17500, 14500 and 10000/mm^3, respectively. A lymphocytosis of at least 75% in infants and of at least 60% in older children was accepted as a typical sign.

All serology results from ELISA or indirect immunofluorescence assays (IFA) were accepted as reported by the hospitals.

Analytical and statistical methods

Crude point and interval estimates (95% confidence intervals (CI)) of incidence rates were calculated assuming Poisson distribution. A direct standardization for age and gender with the German population at 31 December 1997 as a reference was used to compare incidences. To adjust for confounding and effect modification multivariate Poisson regression models were fitted to the data. For contingency tables a χ^2-test or Fisher's two-sided exact test was performed to test for homogeneity hypotheses. As the variables age and length of hospitalization could not be assumed to be normally distributed, the two-sided nonparametric Wilcoxon rank-sum test was used to compare subgroups. A p-value of less than 0·05 was considered as statistically significant. Statistical analyses were performed with SAS (Release 6.12).

RESULTS

From January 1997 to December 1998, 895 cases of pertussis requiring hospitalization were reported to ESPED. The following cases were not included in the study, 58 where another pathogen was found (e.g. *Bordetella parapertussis*), 35 where no questionnaire

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Table 1. *Confirmation of diagnosis of pertussis*

Classification of diagnosis		Criteria	Number	Proportion (%)
Confirmed		Culture or direct immunofluorescence test or PCR positive	206	27·3
Probable		Clinical symptoms *and* typical white blood cell count	174	23·1
	or	Clinical symptoms *and* positive serology	87	11·5
	or	Positive serology *and* typical white blood cell count	28	3·7
	or	Clin. symptoms *and* pos. serology *and* typ. White blood cell count	161	21·4
Tentative		*only* clinical symptoms	75	10·0
	or	*only* positive serology	23	3·1
Total			754	100

Table 2. *Incidence of pertussis requiring hospitalization* (*univariate analysis*)

Variable		Person years at risk	Incidence/ 100000 py*	95% CI†	Standardized‡ Incidence/100000 py*	95% CI†
Global analysis		28.134.937	2·68	[2·49; 2·88]	2·70	[2·51; 2·89]
Year						
1997		14.109.070	3·18	[2·89; 3·49]	3·23	[2·93; 3·53]
1998		14.025.867	2·17	[1·94; 2·43]	2·17	[1·93; 2·42]
Region						
West Germany		23.243.093	2·47	[2·28; 2·68]	2·36	[2·17; 2·55]
East Germany		4.891.844	3·66	[3·14; 4·24]	4·50	[3·82; 5·19]
Nationality						
German		24.884.856	2·37	[2·18; 2·57]	2·42	[2·22; 2·61]
Other		3.250.081	4·74	[4·02; 5·55]	4·28	[3·61; 4·96]
Age/gender						
0	Male	825.553	31·86	[28·12; 35·95]		
1–5	Male	4.132.873	0·85	[0·59; 1·18]		
6–9	Male	3.859.984	1·17	[0·85; 1·56]		
10–15	Male	5.622.499	0·55	[0·37; 0·78]		
0	Female	781.993	33·50	[29·57; 37·82]		
1–5	Female	3.921.321	0·89	[0·62; 1·24]		
6–9	Female	3.660.694	1·28	[0·94; 1·71]		
10–15	Female	5.330.020	0·68	[0·47; 0·94]		

* Person years; † Confidence interval; ‡ Standardized for age and gender; reference population: Germany 1998.

was available, and 48 that did not meet the case definition. Thus, 754 cases (84·2%) remained for further analysis. In 27·3% of these patients pertussis was considered to be a confirmed diagnosis, in 59·7% a probable and in 13% a tentative diagnosis (Table 1).

Incidence of pertussis

The crude incidence of hospitalized pertussis cases in children younger than 16 was estimated at 2·68/100000 person years (py) for the whole period of observation. In East Germany it was significantly higher than in West Germany (4·5 versus 2·36/100000 py, standardized for age and gender) (Table 2). From 1997 to 1998 the standardized incidence of pertussis cases requiring hospitalization significantly decreased from 3·18/100000 py to 2·17/100000 py (Table 2). During this period, no seasonal pattern was observed.

Nationality

A total of 590 children (78·2%) were German, 154 children (20·4%) had other nationalities. For 10 children (1·3%) nationality was unknown. All children were German residents. The median age was lower in non-German children (median, 3 months; mean, $18{\cdot}1 \pm 37{\cdot}1$ months) than in German children (median, 4 months; mean, $33{\cdot}7 \pm 51{\cdot}4$ months) [$P < 0{\cdot}001$]. The standardized incidence of pertussis requiring hospitalization was significantly lower in

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Table 3. *Age-stratified distribution of hospitalized pertussis cases – comparison of East and West Germany*

Age group	East Germany Number (%)	West Germany Number (%)	Germany Number (%)
<6 months	60 (33·5)	388 (67·5)	448 (59·4)
6–11 months	20 (11·2)	57 (9·9)	77 (10·2)
1–5 years	18 (10·1)	52 (9·0)	70 (9·3)
6–9 years	36 (20·1)	56 (9·7)	92 (12·2)
10–15 years	45 (25·1)	22 (3·8)	67 (8·9)
Total	179 (100)	543 (100)	754 (100)

German children than in children of other nationalities (2·42 versus 4·28/100000 py, standardized for age and gender) (Table 2). For West Germany the incidence rate was 2·01 for German children versus 4·21/100000 py for other nationalities. In East Germany, only a small percentage of children (2%) were non-German, and thus only six cases in non-Germans were reported. Due to the low numbers, the difference between German and non-German children observed in East Germany (4·38 versus 7·15/100000 py) was statistically not significant.

Age distribution

Table 3 shows the classified age distribution of hospitalized children with pertussis in East and West Germany and for the whole country. Approximately 70% of all hospitalized pertussis cases were infants and 60% of all hospitalized pertussis cases were younger than 6 months. The distribution of the age groups showed significant differences between East and West Germany [$P < 0{\cdot}001$]. In East Germany the median age was much higher (mean, $62{\cdot}7 \pm 63{\cdot}5$ months; median, 32 months) than in West Germany (mean, $20{\cdot}4 \pm 38{\cdot}4$ months; median, 3 months) [$P < 0{\cdot}001$]. Only 34% of cases reported by paediatricians in East Germany were younger than 6 months compared to 68% in the West. In the East 25% of patients were older than 9 years (4% in West Germany). Although the number of hospitalized infants was smaller in East Germany, the age-specific incidence (43·22/100000 py) was also higher in this age group compared with West Germany (31·28/100000 py) [$P < 0{\cdot}001$].

Multivariate analysis

To adjust for confounding variables and effect modification a multivariate Poisson regression model with the independent variables 'year of report' (1997, 1998), 'region' (West Germany, East Germany), 'age' (classified into four age groups), 'nationality' (German, other), and 'gender' was fitted into the data. An interaction term between 'region' and 'age less than 1 year' was also included in the model. The goodness-of-fit was 98% compared to the saturated model including all interactions between two and three variables. All variables other than 'gender' showed a significant influence on the incidence of pertussis requiring hospitalization, thus confirming the results of the univariate analyses (Table 4).

Length of hospitalization

During the observation period, 11151 inpatient days due to pertussis were reported. The mean length of hospitalization was 14·9 days (median, 13 days), and was significantly longer in East Germany (mean, $17{\cdot}4 \pm 11{\cdot}3$ days; median, 16 days) than in West Germany (mean, $14{\cdot}2 \pm 10{\cdot}0$ days; median, 12 days) [$P < 0{\cdot}001$]. The difference was statistically significant in all age groups (mean, 0–11 months: 22·1 versus 15·7 days [$P < 0{\cdot}001$]; 1–5 years: 16·5 versus 9·4 days [$P < 0{\cdot}001$]; 6–9 years: 14·3 versus 8·4 days [$P < 0{\cdot}001$]; 10–15 years: 12·1 versus 8·0 days [$P = 0{\cdot}025$]). This difference was also found for both children with complications (mean, 20·7 versus 17·5 days [$P = 0{\cdot}01$]) and those without complications (mean, 14·8 versus 11·6 days [$P < 0{\cdot}001$]). From 1997 to 1998 the duration of hospitalization decreased by approximately one day in both parts of Germany without achieving statistical significance.

Distribution of complications

A total of 329 (44%) of all 754 cases had at least one typical complication and this proportion was the same in West and East Germany; 60% of complications were observed in infants younger than 6 months. Pneumonia was the most common (212 (28%)), and 7 cases required assisted ventilation. Apnoea was present in 155 cases (21%), with 27 cases requiring

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Table 4. *Multivariate analysis of the incidence of pertussis requiring hospitalization (Poisson regression)*

Variable	Regression coefficient [95% CI]	Relative Risk [95% CI]	*P*
Intercept	−10·64 [−10·99; −10·30]		< 0·001
Year			
1997	0·41 [0·26; 0·56]	1·51 [1·30; 1·75]	< 0·001
1998		1·00	
Region			
West Germany	−1·44 [−1·71; −1·16]	0·24 [0·18; 0·31]	< 0·001
East Germany		1·00	
Age [years]			
< 1	3·40 [3·06; 3·76]	30·08 [21·24; 42·84]	< 0·001
1–5	0·53 [0·19; 0·87]	1·70 [1·20; 2·39]	0·002
6–9	0·73 [0·41; 1·05]	2·07 [1·51; 2·86]	< 0·001
10–15		1·00	
Nationality			
German	−0·72 [−0·90; −0·54]	0·49 [0·41; 0·58]	< 0·001
Other		1·00	
Gender			
Male	−0·08 [−0·23; 0·06]	0·92 [0·80; 1·06]	0·266
Female		1·00	
Interactions Age < 1* region	0·98 [0·62; 1·34]	2·67 [1·86; 3·83]	< 0·001
			Goodness-of-fit: 98·0%

Table 5. *Complications – comparison of East and West Germany*

	East Germany		West Germany		Germany	
	Number	Proportion* %	Number	Proportion* %	Number	Proportion* %
Pneumonia	70	39·1%	142	24·7%	212	28·1%
Apnoea	21	11·7%	134	23·3%	155	20·6%
Seizures	4	2·2%	15	2·6%	19	2·5%
Encephalopathy	1	0·6%	15	2·6%	16	2·1%
Death	—	—	2	0·4%	2	0·3%

* Proportion of hospitalized children.

assisted ventilation. Seizures (19 (2·5%)) and encephalopathy (16 (2·1%)) were less frequent (Table 5). A 2 months old infant died of pertussis and another death was reported in a 4-week-old infant with a neural tube defect, but bacterial meningitis was regarded as the primary cause of death. The estimated incidence of pertussis complications was 1·17/100000 py. The incidence estimates for pneumonia, apnoea, seizures and encephalopathy were 0·75, 0·55, 0·07 and 0·06/100000 py, respectively (Table 6). A significantly higher incidence of pertussis complications was found in East Germany (2·04 versus 1·03/100000 py standardized for age and gender) (Table 6). The age-specific difference was higher in children older than 9 years (0·65 [95%-CI: 0·37–1·06] versus 0·09 [95%-CI: 0·04–0·18]/100000 py). Pertussis-related pneumonia was more frequent in East German children (1·43 [95%-CI: 1·12–1·81]/100000 py) than in West German children (0·61 [95%-CI: 0·51–0·72]/100000 py). For other complications significant differences in incidence were not found. Suspected pneumonia was the reason for hospital admission in 49% of cases in East Germany, and in 37% in West Germany [$P < 0·001$]. This diagnosis was confirmed in 60% in both regions.

Vaccination status

In 691 (91·6%) of the 754 pertussis cases vaccination status was known, in 63 (8·4%) unknown. On admission, 155 (22·4%) of the 691 children with known vaccination status were younger than 2 months and therefore too young to be vaccinated. Of the 536 children eligible for at least one vaccination 79·3%

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Table 6. *Incidence of complications* (*univariate analysis*)

Variable	Incidence/100000 py*	95% CI	Standardized incidence†/ 100000 py*	95% CI
Global analysis				
All complications	1·17	[1·05; 1·30]	1·18	[1·05; 1·31]
Pneumonia	0·75	[0·66; 0·86]	0·76	[0·66; 0·86]
Apnoea	0·55	[0·47; 0·64]	‡	
Seizures	0·07	[0·04; 0·11]	‡	
Encephalopathy	0·06	[0·03; 0·09]	‡	
Year				
1997	1·43	[1·24; 1·64]	1·45	[1·25; 1·66]
1998	0·91	[0·75; 1·08]	0·91	[0·75; 1·06]
Region				
West Germany	1·08	[0·95; 1·22]	1·03	[0·90; 1·16]
East Germany	1·59	[1·26; 1·99]	2·04	[1·58; 2·51]
Nationality				
German	1·04	[0·91; 1·17]	1·06	[0·93; 1·19]
Other	2·09	[1·62; 2·65]	1·89	[1·44; 2·34]
Age				
0	14·68	[12·87; 16·68]	14·68§	[12·81; 16·55]
1–5	0·35	[0·23; 0·50]	0·35§	[0·22; 0·48]
6–9	0·55	[0·39; 0·74]	0·55§	[0·38; 0·71]
10–15	0·22	[0·14; 0·33]	0·22§	[0·13; 0·31]

* Person years; † Standardized for age and gender; ‡ Number too small; § Standardized for gender.

Table 7. *Vaccination status of children eligible for at least one vaccination* (*with known vaccination history*)

	West Germany			East Germany			Germany		
Vaccination status	0–5 years	6–15 years	Total	0–5 years	6–15 years	Total	0–5 years	6–15 years	Total
Not vaccinated	257 (77·6%)	59 (96·7%)	316 (80·6%)	54 (77·1%)	55 (74·3%)	109 (75·7%)	311 (77·6%)	114 (84·4%)	425 (79·3%)
Less than recommended	64 (19·3%)	1 (1·6%)	65 (16·6%)	15 (21·4%)	7 (9·5%)	22 (15·3%)	79 (19·7%)	8 (5·9%)	87 (16·2%)
According to guidelines	10 (3·0%)	1 (1·6%)	11 (2·8%)	1 (1·4%)	12 (16·2%)	13 (9·0%)	11 (2·7%)	13 (9·6%)	24 (4·5%)
Total	462	61	523	70	74	144	401	135	536

had not been vaccinated at all and only 4·5% had been vaccinated according to the recommendations (Table 7) [8, 9]. No significant difference was observed between German and non-German children. A total of 441 children would have been eligible for at least 2 and 361 children for at least 3 vaccinations. In this last group 272 children (75·3%) were not vaccinated and only 18 (5%) had a vaccination history complying with the guidelines. The percentage of children appropriately immunized for their age was higher in East than in West Germany. This result was valid for all children old enough to be vaccinated (9% versus 2·8%, [$P = 0{\cdot}005$]) as well as for those eligible for at least three vaccinations (9·9% versus 2·5%, [$P = 0{\cdot}002$]). The difference was evident in children older than 5 years (16·2% versus 1·6%, [$P = 0{\cdot}004$]), whereas in younger children no significant difference was observed (Table 7).

Laboratory methods

In 58·6% of all cases a serological test was performed. Serology was used more frequently in East (88·8%) than in West Germany (49·9%) [$P < 0{\cdot}001$]. Moreover, positive results were significantly more often found in the East (82·4%) than in the West (64·8%)

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[$P < 0{\cdot}001$]. In both regions serology was used preferentially in children older than 1 year [West: $P < 0{\cdot}001$; East: $P = 0{\cdot}004$] but in East Germany more than 80% of children in all age groups received a serological test. The percentage increased with age from 44% in infants to 84% in children older than 9 years in West Germany.

No significant differences in the detection of *Bordetella pertussis* by culture, direct immunofluorescence test and/or PCR were observed in both parts of the country. In East Germany these methods, usually attempted in infants [$P < 0{\cdot}001$], were used in 39·1% of cases compared to 44·6% in West Germany [$P = 0{\cdot}19$]. A positive result was found in 60% of cases independent of the region.

DISCUSSION

Our data provide an insight into the epidemiological situation of pertussis in Germany. During the 2-year observation period 11 151 days of hospitalization due to pertussis were recorded, resulting in an incidence of 2·68/100 000 py. Pertussis is thus a disease of major public health relevance despite increasing vaccine coverage. The data reveal considerable differences between East and West Germany.

The incidence of hospitalized pertussis with or without complications was significantly higher in East than in West Germany. This was observed in all age groups, but the greatest difference was seen in older children. In East Germany an unusually high percentage of hospitalized cases was found in children aged 6–15 years (45%). This age distribution has not been reported from other countries, even in those with high vaccine coverage. In most countries infants younger than 6 months represent 60–70% of hospitalized cases, for example in the United States the age group of 5–19 years represented only about 4% of all hospitalized cases [12, 13] and this is similar to the age distribution found in West Germany. The differences between East and West Germany may be due either to a different perception of the disease or to the rate of immunity induced by prior disease or prior vaccination. In East Germany, pertussis was reported in very low numbers until reunification, and it has significantly increased during recent years [14, 15]. Thus, 6–15-year-old children may represent a population at risk, either because they have had no previous exposure to pertussis antigens or because of waning immunity after primary vaccination. Recent data from the Robert Koch Institute also show a resurgence of pertussis in older East German children [14, 15], who may be a source of infection for younger children. This could partly explain the observed higher incidence of hospitalized pertussis cases in East Germany. The introduction of another booster vaccination into the recommendations is the first step to counter this problem.

In East Germany the incidence of pertussis requiring hospitalization was almost twice as high as in West Germany (4·5 versus 2·36/100 000 py, standardized for age and gender). However, several biases may have contributed to the observed difference in incidences. The active surveillance system ESPED can only identify hospitalized children with pertussis. Since the hospitalization rate in Germany is not known, an assessment of 'real' pertussis incidence from these data is not possible. Experiences from other countries have shown that there are large differences in hospitalization rates. For example in the USA (a country with high vaccine coverage) it is approximately 40% [12, 13], in the Netherlands (a country with nearly complete immunization) it is 52% [16], while in Great Britain it was less than 10% in the 1970s when there was decreasing acceptance of pertussis vaccination [17, 18]. A previous survey in 1982 estimated the hospitalization rate at 3·1% for West Germany [19]. These discrepancies could lead to the conclusion that pertussis is regarded to be a more severe disease in countries with a high vaccine coverage. Accordingly, children with pertussis might be admitted less frequently to hospitals in countries with low vaccine coverage. Due to the historically higher vaccine coverage in East Germany, children with pertussis may be admitted to hospitals more frequently than in West Germany, thus offering a possible explanation for the higher incidence of hospitalizations due to pertussis found in the East. Moreover, data of the German Federal Bureau of Statistics (Krankenhausstatistik 1997) show a generally higher frequency of hospitalizations in children under 15 years in East than in West Germany. However, as the percentage of hospitalized children with pertussis showing typical complications was identical in both regions, the difference in incidences cannot only be due to a different admission rate.

Children with complicated pertussis are usually hospitalized and thus this study provides a realistic estimation of the incidence of disease. Even using an active surveillance system it is possible to underestimate the true incidence. In similar studies [20, 21] completeness of ascertainment as assessed by capture-

recapture analysis [22] was about 70–80%. It is possible that part of the observed difference in pertussis incidences between East and West is due to a traditionally higher reporting rate in East Germany.

Differences between West and East Germany were also observed in terms of diagnostic strategies. An indication for serological tests is more often seen in the East. Frequent use of serology may have led to a greater detection rate of pertussis cases in East Germany and therefore may partly explain the difference in incidences observed. Overall, it seems necessary to standardize diagnostic procedures and to establish guidelines for the clinical and laboratory diagnosis of the disease [23].

This study also provided some other interesting results. First of all, the average length of hospitalization was higher in East Germany than in West Germany. This is valid for all age groups and for children with and without complications. In contrast to this finding the average length of hospitalization in paediatric units in general shows no difference between East and West Germany (Federal Bureau of Statistics). One possible reason is a different patient management in the two regions. In the light of a growing necessity to reduce costs this is an important finding. However, evaluation is difficult, because clinical parameters such as comorbidity and outcome measures were not investigated.

Second, comparing the distribution in the population, non-German children were over-represented among hospitalized cases in both regions. A previous study also showed a higher percentage of non-German children within pertussis cases detected in outpatient clinics [19]. A possible explanation seems to be a lower vaccine coverage in this group, as observed in previous investigations in Germany [24–26]. There are, however, no recent data about vaccine coverage in Germany in relation to different nationalities. If additional data should show that non-German children have a lower vaccine coverage, this group should be specifically targeted for vaccination.

The observed decline in pertussis incidence from 1997 to 1998 probably reflects the epidemic cycle of pertussis. This is supported by the findings of a pilot study of the decreasing incidence of hospitalized pertussis cases with defined complications from 1993 to 1996 [27]. If only those cases meeting the definition of the pilot study are analysed, 1997 was an epidemic year. Although the observational period is still too short, our findings for Germany are consistent with the reported epidemic cycle length of pertussis of about 3–4 years [28–30]. A final observation is noteworthy. Only 9% (East Germany) and 2·8% (West Germany) of hospitalized children old enough to be immunized were vaccinated according to the guidelines. During the 2-year observation period, 509 children, who were not vaccinated according to the recommendations, spent 7117 days in hospital. Thus, a large percentage of hospital admissions due to pertussis may have been prevented by adequate vaccination. Both East and West Germany are still far from reducing the pertussis incidence below 1/100000 person years set as a goal by the WHO [31].

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