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Children Admitted with Pertussis Over a One-Year Period

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Abstract

Aims

This study examines cases of *Bordetella pertussis* admitted to a tertiary hospital in Dublin, Ireland over a one-year period. Described are the demographics, clinical features, severity, morbidity, clinical course and vaccination status of patients.

Methods

This retrospective cohort study included all children admitted with pertussis from January 2024 to December 2024 inclusive. Data were collected from patient records and analysed with descriptive statistics.

Results

Of the 26 children admitted, 20 (76.9%) were <6 months of age. Median length of stay was 7 days and 3 (11.5%) required readmission. Oxygen supplementation was required in 10 (38.4%) cases and intravenous hydration for >48 hours in 11 (42.3%). The pertussis severity score (PSS) was >5 (severe) in 18 (69.2%). Vaccine eligible children comprised 16 of 26 cases (61.5%). Vaccination status was documented in 24 children; 13 (54.1%) were unvaccinated

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against pertussis, with 10 (76.9%) ineligible due to age. Vaccination was completed in 4 (16.7%), and 7 (29.1%) were partially vaccinated. Maternal vaccination status was documented in 15 cases, 3 (20.0%) received antenatal vaccination.

Conclusion
Pertussis is associated with significant morbidity particularly in infants. Many children are admitted before full vaccination highlighting the importance of maternal antenatal pertussis vaccination.

Introduction

Pertussis is a vaccine preventable major global disease, which affects infants, children and adults[1]. The Health Protection Surveillance Centre (HPSC) in Ireland reported a significant increase in pertussis cases in 2024, with 524 notifications by October 2024 compared to an average of 10 cases per year for the previous 3 years[2]. Pertussis infection tends to occur in 5 year cycles. Nationally, the last period of high case numbers was noted in 2016 (213 cases) and 2017 (263 cases)[3].

In 2024, the European Centre for Disease Prevention and Control (ECDC) reported an increase in pertussis, with 32,037 cases from 1st January to 31st March, 2024. During the COVID-19 pandemic, only 1,578 and 2,623 cases of pertussis were reported in 2021 and 2022 respectively[4].

The risk for severe pertussis is increased in unvaccinated children, or those only partially vaccinated under 6 months of age. Antenatal vaccination is offered to women at 16-36 weeks' gestation, and administered to infants as part of the national immunization program at 2, 4, 6 and at 13 months[5].

The European peak of pertussis activity during 2024 was reflected in our laboratory with 233 positive PCR tests for *Bordetella pertussis* in 2024 compared to 5 in 2023. This includes samples from external hospitals and general practice.

The objective of this study was to describe the clinical features, severity, morbidity, and vaccination status for patients admitted with pertussis over a one-year period to a tertiary paediatric centre in 2024. Our aim is to raise awareness of the cyclical epidemiologic trend in pertussis cases and highlight the importance of prevention where possible with maternal and childhood immunisation[2].

Methods

The study was carried out at Children's Health Ireland (CHI) at Crumlin, Republic of Ireland, a tertiary paediatric hospital which has a capacity of over 220 beds and has greater than 10,000 admissions per year of which over 4,000 are to general paediatrics. This hospital also serves as one of three secondary care facilities for the regional paediatric population[6]. Ethical approval was granted for this study by the Children's Health Ireland research ethics office (REC-502-24).

The study period was January to December 2024. PCR positive cases for *B. pertussis* were identified from laboratory records, only inpatients were included. *B. parapertussis* PCRs were not included. All cases were detected on *B.pertussis/B.parapertussis* specific PCR tests. Positive pertussis cases were identified by testing of clinical specimens using real-time PCR specific for the IS*481* mobile genetic element and the toxin promoter region. Specimens were also cultured onto charcoal agar and incubated at 37° C in a humid environment for 5 days. Any specimens where IS*481* and the toxin promoter were detected were reported as positive for *B. pertussis*. Any isolates grown on charcoal agar were confirmed as *B. pertussis* by MALDI-TOF (bioMériuex, Marcy-l'Étoile, France).

There were 70 positive *B. pertussis* PCRs from 66 patients attending CHI at Crumlin in 2024. Cases not requiring admission were excluded by auditing each case on iPMS (Integrated Patient Management System). These were cases managed in the emergency department and outpatients that were not admitted.

A retrospective review of medical charts was carried out for inpatient cases (12 paper and 14 electronic records). Data were gathered on the presentation, clinical course, interventions and severity of disease. We assessed severity using the Pertussis Severity Score[7] (PSS), which is internationally recognised[8]. This scoring system is measured from 0 to 15, where a score of less than 5 is deemed not severe and over 5 is deemed severe. Factors considered are duration and level of hospitalisation, hydration requirement, respiratory support and complications. Descriptive statistics were calculated using Microsoft Excel (Version 16.101.2).

Results

The clinical features of patients admitted with *B. pertussis* infection in 2024 are summarised in Table 2. Inpatient admission was required in 26 cases in 2024, compared to 2 cases in 2023. Children under 6 months of age amounted to 20 (76.9%). Stratified according to gestational age; 3 (11.5%) were preterm (<37 weeks gestation), 22 (84.6%) were term (37-40 weeks gestation), 1 (3.8%) was postterm (>40 weeks).

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Almost all patients (25 cases) had a paroxysmal cough (96.1%) with post-tussive vomiting in 20 (76.9%), 16 (61.5%) had apnoea (Table 2). The majority of patients (18 (69.2%) were apyrexial. Intravenous antibiotics were administered to 11 (42.3%) patients, in addition to oral azithromycin.

Oxygen support was required in 10 (38.4%) cases and 1 (3.8%) patient was intubated and ventilated. This patient was the only patient requiring admission to paediatric intensive care unit (PICU) and was 1 of 2 cases to experience seizures. Intravenous hydration was required for over 48 hours in 11 (42.3%) cases. Abnormal chest x-ray findings were noted in 16 (65.3%) cases. Severe cases amounted to 18 (69.2%) (PSS of greater than 5). The median PSS was 7 (Table 3). Coinfection with rhino/enterovirus was noted in 14 of 26 cases (53.8%) and SARS-COV-2 in 3 cases (11.5%).

Complex medical histories were noted in 4 (15.3%) cases. This included an ex-31 week infant who required two weeks of CPAP (continuous positive airway pressure) at birth, an ex-33 week infant with DiGeorge syndrome and congenital heart disease, an ex-41 week infant who required a 1 week admission to a special care baby unit (SCBU) after birth for hypoglycaemia management, and an ex-35 week infant who required intubation for seizures at 3 weeks of life. This patient also experienced seizures and bradycardia during their admission with pertussis at 11 weeks old. The median length of stay for these 4 patients was 12.5 days, none required PICU admission. Readmission was required in 2 of these cases.

Vaccination status was documented in 24 cases and is summarised graphically in Figure 1. Notably, 4 children were fully vaccinated. There were 3 patients who were eligible but not vaccinated (Figure 1). The maternal vaccination status was documented in 15 cases (57.7%), of these 3 (20.0%) were vaccinated in pregnancy.

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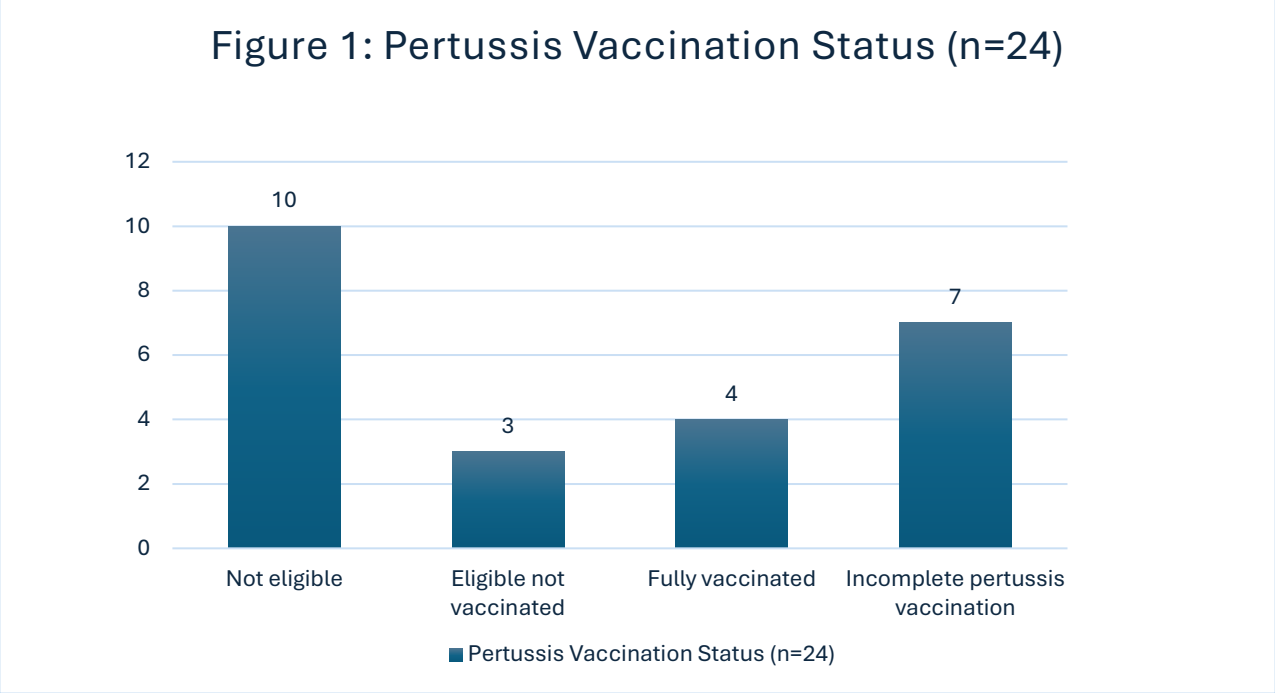

Table 1

***Bordetella pertussis* PCR testing CHI at Crumlin 2023 compared to 2024 (inc. duplicate testing)**			
	PCR tests processed	**PCR positive tests**	**Percentage positivity**
2023	73	4	5.5%
2024	322	70	21.7%

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Table 2

Characteristics	**Total Number n=26 n (%)**
Demographics/ Clinical features	
Sex	
Male	9 (34.6)
Female	17 (65.3)
Age	
Median age at admission in weeks	12.5 weeks
Less than 1 month	5 (19.2)
1-4 months	13 (50.0)
5-11 months	3 (11.5)
Greater than 12 months	5 (19.2)
Risk factors	
At least one viral coinfection	17 (65.4)
Complex medical history	4 (15.4)
Clinical features	
Paroxysmal Cough	25 (96.1)
Post tussive vomiting	20 (76.9)
Respiratory distress	19 (73.1)
Cyanosis	17 (65.4)
Apnoea	16 (61.5)
Dehydration	12 (46.1)
Coryza	14 (53.8)
Fever >37.5°C	7 (26.9)
Wheeze	4 (15.4)
Bradycardia	1 (3.8)
Seizures	2 (7.7)
Encephalopathy	0 (0)
Cardiomyopathy	0 (0)
Mortality	0 (0)

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Table 3

Hospital Course	**Number of cases n=26 - n (%)**
Duration/ Disposition	
Length of stay in days, median (interquartile range)	7 (10)
PICU admission	1 (3.8)
Readmission with pertussis	3 (11.5)
Fluid replacement	
Intravenous hydration >48 hrs	11 (42.3)
Intravenous hydration <48 hrs	4 (15.3)
Nasogastric rehydration alone	6 (23.1)
No nasogastric or intravenous hydration	5 (19.2)
Antibiotic treatment	
Azithromycin for 3 or more days	26 (100)
Additional broad spectrum antibiotic	11 (42.3)
Respiratory support (highest level)	
Nasal Prongs	3 (11.5)
High flow nasal cannula	6 (23.1)
CPAP	0 (0)
Intubation and ventilation	1 (3.8)
Total patients requiring oxygen support	10 (38.5)
Investigations	
Bloodwork performed	19 (73.1)
CRP, mg/L median	<4
CRP, mg/L Interquartile range	19
Lymphocyte 10^9 cells/L median	10.3
Lymphocyte 10^9 cells/L (interquartile range)	8.95
Chest X-ray performed	24 (92.3)
Chest X-ray	**(n=24)**
Abnormal findings	17 (70.8)
Interstitial	15 (62.5)
Lobar	2 (8.3)
Severity	

Pertussis Severity Score median (interquartile range)	7 (3)
PSS >5	18 (69.2)

Discussion

There were 322 *B. pertussis* PCR tests processed in 2024 for patients attending CHI at Crumlin (including duplicate testing), of which 70 (21.7%) were positive. This is a notable increase in the 2023 numbers when 73 PCRs were processed and 4 (5.5%) samples were positive. Additionally, there were 26 patients hospitalised with pertussis infection in 2024, compared to 2 in 2023.

Our study highlights the significant burden of disease for children admitted with pertussis infection in 2024. Of the 26 cases, the median pertussis severity score was 7 (IQR 3) and 18 (69.2%) cases had PSS >5, which is considered severe. This is compared to 45.3% of cases with a PSS>5 noted in an Italian cohort of 75 hospitalised children by Poeta et al 2024[8]. Mean length of stay was 9.76 days compared to 6.5 days in the Italian cohort, and 3 (11.5%) of our cases required readmission.

The majority of our patients were less than 6 months old (median 12.5 weeks old) and received no vaccination against *B. pertussis*. These risk factors for severity have been well described previously by the US Centers for Disease Control and Prevention (CDC)[9]. Not surprisingly, paroxysmal cough was noted in 25 (96.1%) patients. There was coinfection with another virus in 17 (65.4%). Apnoea which is often a symptom leading to admission was common. Interestingly only 7 cases (26.9%) developed a fever >37.5°C. Administration of additional broad spectrum antibiotics was required in 11 (42.3%) to cover for the possibility of sepsis awaiting culture results. Chest x-ray findings were evident in 10 of these 11 cases (90.9%). All of these cases had a PSS of >5, although only 3 (27.3%) experienced fever.

Blood tests were performed in 19 (76%) cases. In our cohort, median CRP was less than 4 and lymphocytes were not markedly elevated with a median of 10.3 10^9 cells/L, similar to findings of Marshall et al 2015 in Australia and Poeta et al 2024 in Italy[7,8].

Compliance with recommended antibiotic guidelines was achieved with oral azithromycin administered for at least 3 days in all 26 (100%) cases[10]. Intravenous hydration was required for greater than 48 hours in 11 (42.3%) cases, which was a significant marker of severity, scoring 3 points on the PSS. Oxygen supplementation was required in 10 (38.5%) cases, while 6 (23.1%) required high flow nasal cannula. PICU admission and intubation and ventilation was only required in one case (3.8%). This was much lower than previously documented in other studies with 9% requiring PICU admission in an Italian cohort in 2024, and 25% needing intensive care in a study in a tertiary centre in Canada from 1999 to 2015[11,12].

Seizures are a well described complication of pertussis with the Health Service Executive (HSE) estimating occurance in 1 in 70 cases[13]. Two of our cases had seizures (7.7%), one patient had pre existing seizures and the other developed seizures during the course of illness. The latter required PICU admission for intubation and ventilation.

Of the 24 cases with vaccination status documented, only 4 (16.7%) patients were fully vaccinated highlighting lack of vaccination as a significant risk factor. As 10 (41.7%) of the patients were not eligible for vaccination due to their young age, this emphasises the importance of antenatal vaccine in pregnant women. With maternal vaccination status documented in only 15 (57.6%) of the total 26 cases, the significance of antenatal vaccination may be underappreciated by paediatricians looking after these patients. Of the 11 cases where vaccination status was not documented, 8 (72.7%) were under 5 months of age. In the 15 cases where it was documented only 3 (20%) cases of the mothers had received antenatal vaccination.

The need to promote maternal vaccination in pregnancy has been previously described[13]. Infants most at risk are pre-vaccine, thus maternal vaccination is a key strategy for protection[14]. A scoping review for antenatal vaccination in Ireland published in 2025 found that antenatal pertussis vaccination ranged between 31% to 67%[14]. Increased uptake was associated with maternal age greater than 30 and higher socioeconomic status, and those identifying as being of Irish descent[15]. The lack of maternal antenatal vaccination for pertussis has similarly been noted with respiratory syncytial virus (RSV) in the UK[15].

Our study collected robust data with follow up/outcome data available for all patients. The limitations include the small sample size and the retrospective nature of this study. Additionally, as cases were identified from internal positive PCR results (CHI at Crumlin laboratory), we may not have identified externally transferred PCR confirmed cases. We also had limited data on maternal vaccination due to variability in documentation.

There has been a significant surge of pertussis cases in Ireland since the COVID-19 pandemic with the HPSC identifying 514 cases by October 2024[2]. This has been attributed to low circulating levels of pertussis in Europe during the COVID-19 pandemic due to increased infection control measures[17]. There has been recent research into the upsurge in pertussis cases in the post COVID-19 era in China, which has been observationally associated with pathogen evolution[18]. Macrolide resistance and vaccine escape have been suggested as potential factors in this increase[19]. Characterisation of the local *B. pertussis* strains is an important part of the Irish Reference Laboratory work and may lead to a greater understanding of the post-COVID surge in the Irish population in the future.

This study highlights the significant disease burden of pertussis in our tertiary paediatric centre during this cyclical surge of cases. We also identified a need to raise awareness among

healthcare professionals about the importance of timely maternal and child immunisation against pertussis to prevent severe infection.

Declarations of Conflicts of Interest:
None declared.

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