The clinical characteristics and treatment of pertussis patients in a tertiary center over a four-year period

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We performed a retrospective study of pertussis patients seen during the period July 2007-December 2011. All patients were microbiologically confirmed through polymerase chain reaction (PCR) or culture. Thirty-one patients with positive Bordetella spp. culture or PCR were identified, with a median age of two months. Seventeen patients had received no pertussis vaccination. The most frequent symptoms were paroxysmal cough (100%) and cyanosis (87.1%). The mean duration of the symptoms prior to admission was 12.8±8.0 days. Leukocytosis and thrombocytosis were detected in 64.3% and 67.9% of the 28 hospitalized patients, respectively. Erythromycin had been given to eight patients and clarithromycin to 23 patients. The mean hospital stay was 9.5±5.5 days (range: 3 to 28 days). No patients were readmitted or died. We believe that patients with characteristic paroxysmal cough with cyanosis but no fever should alert clinicians to the possibility of pertussis, and they should be treated without delay. PCR assay provided additional benefit in the diagnoses of the study patients.

Key words: pertussis, infant, leukocytosis, thrombocytosis.

Pertussis, or whooping cough, named after its characteristic inspiratory whoop following a series of continuous paroxysms, is a highly communicable respiratory disease caused by Bordetella pertussis or B. parapertussis. High levels of vaccine coverage have been achieved in infants and toddlers in Europe, and infant morbidity and mortality have significantly reduced. The absolute incidence of pertussis has substantially decreased due to the effective protection of infants and toddlers. In the pre-vaccine era, pertussis was regarded as a childhood disease affecting primarily young children, but pertussis epidemiology in the post-vaccine era is different. Adults and adolescents who become infected because of waning immunity probably act as reservoirs for infection and transmit the infection to unvaccinated or partially vaccinated infants. In Turkey, a steady decline in the incidence rates after the introduction of vaccination was similarly observed. No change in the age distribution of cases has been observed between 1991 and 1995. The highest number of cases occurred in infants aged less than one year (1). The clinical diagnosis must be confirmed by specific laboratory tests, culture, serology, and polymerase chain reaction (PCR). The serology method had poor sensitivity and specificity, which can be affected by multiple factors. For these reasons, the Centers for Disease Control and Prevention (CDC) guidelines for laboratory confirmation of pertussis cases do not include serologic testing (1,2). Culture is very specific, but its sensitivity depends on the culture conditions, including sampling method, age and immunity status of the patient, and stage of illness. As a result, culture sensitivity is low even under optimal technical conditions. PCR is faster than culture: 2.5 hours (h) up to 1-2 days versus 3- 7 days. It remains positive longer than culture, and it provides positive

results for vaccinated patients, for patients with antibiotic pretreatment, and in the late stage of the disease[3-6]. Recent studies suggest that PCR-based assays and real-time PCR-based assays are more sensitive than culture for detection of B. pertussis in nasopharyngeal specimens (NPS). It is also possible to distinguish between B. pertussis and B. parapertussis by using LightCycler PCR method[7]. In our country, the surveillance system was renewed, and a laboratory-based surveillance system for pertussis was established in 2005, but the diagnostic laboratory capacity is still limited. Patients in some regions of Turkey are sometimes diagnosed according to the characteristic history and physical examination. The aim of this study was to identify the demographic, clinical and laboratory characteristics, treatment regimens, and outcomes in children with pertussis.

Material and Methods

A retrospective study of 31 confirmed pertussis patients was performed in the Department of Pediatric Infectious Diseases, Dr. Sami Ulus Maternity and Children's Health and Diseases Training and Research Center, from July 1, 2007 to December 31, 2011. A confirmed case was described as a case that is confirmed culture-positive and in which an acute cough illness of any duration is present; or a case that meets the clinical case definition and is confirmed by positive PCR; or a case that meets the clinical case definition (cough illness lasting at least 2 weeks with one of the following: paroxysms of coughing, inspiratory "whoop", or posttussive vomiting, without other apparent cause) and is epidemiologically linked directly to a case confirmed by either culture or PCR according to the CDC and Turkish Ministry of Health confirmed case definition[8,9]. The diagnosis of *B. pertussis* had been confirmed by culture or PCR in a NPS specimen. The cases that met the clinical case definition and were linked epidemiologically directly to a confirmed case were also included in the study. Medical records of the patients were reviewed with respect to age, gender, pertussis vaccination status, paroxysmal cough, duration of the cough, cough with inspiratory whoop and/or cyanosis, cough ending in apnea or vomiting, findings on physical examination, results of laboratory tests, chest X-ray findings, treatment choices, the duration of hospital stay (if hospitalized), complications, and clinical outcome. To evaluate the household contacts of the index cases, family medical history of each patient was reviewed. Household contacts of the index cases had been considered as persons who were living in the same residence and had acute cough illness during the month preceding the pertussis diagnosis of the infant[10]. Those with positive culture results were included in the study. Pneumonia was defined as the presence of tachypnea, retractions, crepitant rales, and fever on physical examination and/or chest radiography findings, plus pulmonary infiltrate on chest X-ray[11]. To evaluate the acute phase reactants, the patient's laboratory data [complete blood count (CBC) with differential, erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP)] were collected upon admission to the hospital. We used values of $15x10^3/\mu L$, $5x10^3/\mu L$ and $450x10^3/\mu L$ as the cut-off points for leukocytosis, lymphocytosis and thrombocytosis, respectively. Median leukocyte, lymphocyte and thrombocyte counts were compared between patients with early versus late start of antibiotic treatment (cough <14 days' duration versus cough ≥14 days' duration). The relationship between the presence of leukocytosis, lymphocytosis and thrombocytosis and the length of hospitalization and cyanosis was studied. NPS of the patients had been obtained by Dacron swab (MW173C, Medical Wire, UK®) and transported in Amies medium with charcoal to the Pertussis National Reference Laboratory of Refik Saydam National Hygiene Center in order to confirm the clinical diagnosis. All swabs had been plated onto Bordet-Gengou agar medium supplemented with cephalexin, which was incubated at 37°C for 7 days. Swabs were then immersed in 200 microliters of phosphate buffered saline. The wire from the NPS was cut, and then, after brief vortexing to remove cellular material into the fluid, the swab was removed. If necessary, samples were stored at

-80°C. Suspected colonies were characterized using classical bacteriological techniques, including growth on culture, Gram morphology, oxidase and urease tests, and the slide agglutination with specific B. pertussis antiserum (Difco, USA®). Those samples submitted after January 2011 were also examined by PCR. For PCR, genomic DNA extraction of bacterial suspensions was done with the High Pure PCR

Template Preparation Kit (Roche, Germany®), according to the manufacturer's instructions[12]. In-house PCR method using primer pairs of PTp1/PTp2 specific for pertussis toxin S1 subunit (ptxA)-Pr gene and PIp1/PIp2 specific for IS481 gene was performed, as described previously[13]. Real-time LightCycler PCR method was performed using the LightCycler 480 II instrument (Roche, Germany®), the LightCycler Fast Start DNA Master Hybridization Probes (Roche, Germany®) and the LightMix Kit for *B. pertussis* and *B. parapertussis* according to the manufacturer's instructions (14,15). Oligonucleotides from IS481 and IS1001 for *B. pertussis* and *B. parapertussis*, respectively, were used. Detection of *B. pertussis* was achieved by the amplification of a 130 base pair (bp) fragment from the IS481 region using hybridization probes with an LC640 label, while B. parapertussis was detected using a 97 bp fragment from the IS1001 region using probes with an LC690 label.

According to our Pediatric Infectious Disease Department protocol for management of pertussis, patients ≤6 months of age with suspected pertussis were hospitalized and all patients were managed with supplemental oxygen. All patients who had been suspected as having pertussis clinically were started on macrolides treatment without waiting for PCR and culture results. Until the last months of 2009, patients were treated with per oral erythromycin (40–50 mg/kg per day in 4 divided doses, for 14 days). Thereafter, patients were treated with intravenous/per oral clarithromycin (15 mg/kg per day in 2 divided doses for 7 days). Patients were followed for the most common side effects (epigastric distress, abdominal cramps, nausea, vomiting, and diarrhea). If the patients had a diagnosis of pneumonia as a complication, they were treated with an additional beta-lactam antibiotic. Patients were discharged when their paroxysms improved and cyanosis disappeared. Patients who had received erythromycin versus clarithromycin were compared with respect to median elapsed time until improvement in cyanosis, duration of hospital stay and age. Median duration of hospitalization and elapsed time until improvement in cyanosis were compared between patients with early versus late start of antibiotic treatment (cough <14 days' duration versus cough ≥14 days' duration).

Data were entered into a database, and statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS) (version 11.0, SPSS, Inc, Chicago, IL). The significance of difference between groups was evaluated using χ^2 test and Mann-Whitney U test.

Results

A total of 28 confirmed pertussis patients were included in the study. Three patients were diagnosed as pertussis during the household contact screening. Sixteen (57.1%) of the patients were boys and 12 (42.9%) were girls. The mean age of the patients was 61.6±34.5 days (median: 50 days, range: 13 days-150 days). All of our patients were under 6 months of age. Fifteen (53.6%) were <2 months of age, and 13 (46.4%) were aged 2-6 months. Sixteen (51.6%) of the patients had a history of contact with a household member with respiratory symptoms. Three patients who were diagnosed during the household screening were aged 8 months, 17 months and 10.5 years old, and were siblings of the index cases. The number of the pertussis cases in each year of the study period (2007-2011) by months is demonstrated in Figure 1. Twenty-five (80%) of the pertussis cases in the total study period occurred between the months of May to August. Fifteen patients (53.6%) had no pertussis vaccination due to being <2 months in age and an additional 4 patients were 60, 61, 69, and 71 days old and had not yet been vaccinated. Two patients (2/28, 7.1%) were 4.5 and 5 months old and had not been vaccinated for social reasons. The remaining 7 patients (25%) had received appropriate doses according to age. Three patients who were diagnosed during the household screening had

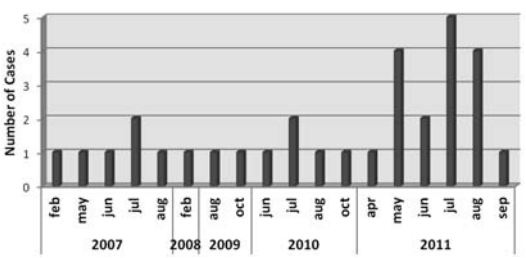

Figure 1. Distribution of pertussis cases according to months over the total study period of 2007-2011.

Table I. Summary of Patients' Symptoms

Symptoms	No.	%
Cough	28	100
Paroxysmal cough	28	100
Cough with cyanosis	27	96.4
Cough <7 days	3	10.7
Cough 7-14 days	13	46.4
Cough >14 days	12	42.9
Whooping	11	39.3
Posttussive vomiting	7	25
Apnea	2	7.1
Fever	1	3.6

received appropriate doses according to age. No patient had an underlying disease, and none was premature.

The mean duration of the symptoms prior to admission was 11.6±7.0 days (median: 10 days, range: 2-30 days). Overall, at initial presentation, all of the patients had paroxysmal cough, which was accompanied by cyanosis in 96.4%. Apnea was observed in 2 patients aged 13 and 45 days old. Two other patients presented with the severe respiratory symptoms; both were aged 30 days and presented with paroxysmal cough, cyanosis and tachypnea. Nasopharyngeal multiplex viral PCR was performed in one of them and the result was negative. Their blood cultures were negative. Chest radiographs of these patients revealed bronchopneumonic infiltration. Results of their echocardiographic investigation were normal. Carbon dioxide retention developed on their clinical follow-up and nasal continuous positive airway pressure (CPAP) was applied. They responded to noninvasive mechanical ventilation well and recovered fully. Clinical symptoms of the 28 patients are summarized in Table I. Three patients who were diagnosed during the household screening had paroxysmal cough for 12-30 days.

Leukocytosis and lymphocytosis were detected in 18 (64.3%) and 27 (96.4%) of the 28 hospitalized patients, respectively. Nineteen (67.9%) of the patients had thrombocytosis. The 2 patients with severe respiratory findings had severely increased leukocyte, lymphocyte and thrombocyte counts. These values of the first patient were 42,000/μL, 21,840/μL and 551,000/μL, and of the second patient were 69,000/μL, 44,850/μL and 740,000/μL, respectively. Median leukocyte, lymphocyte and thrombocyte counts were not significantly different between patients with early versus late start of antibiotic treatment (p=0.384, p=0.184, p=0.778). The length of hospitalization and cyanosis were found not to be related to the presence of leukocytosis, lymphocytosis and thrombocytosis (p=0.368, p=0.493, p=0.862 and p=0.502, p=0.401, p=0.612, respectively). Mean values and range of the CBC, CRP

Table II. Mean Values and Range of the Laboratory Tests Results of the Hospitalized Patients with Pertussis

	Mean ±SD (n)	Minimum-maximum
Hemoglobin (g/dl)	11.4±1.7	7.9-15.6
Mean corpuscular volume (MCV)	88.2±9.9	59-105
WBC count /μL±SD	20.435±12.828	5.500-69.000
Lymphocyte ±SD (%)	63.6%±11.8	25%-79%
Absolute lymphocyte count (ALC)/ μL±SD	12.956±7.894	3.740-44.850
Platelet count	546.785±182.876	116.000-912.000
Erythrocyte sedimentation rate (ESR) mm/h	13.3±9.5	2-44
C-reactive protein (CRP) mg/L	2.5±4.3	1-23

Table III. Culture and PCR Findings in 18 Patients Tested by Both Tests

Culture/PCR results	Total no of cases (100%)	
Culture-positive/PCR-positive	9 (52.9)	38.9
Culture-negative/PCR-positive	7 (41.2)	44.4

and ESR results of the hospitalized pertussis patients are presented in Table II.

Pertussis culture of the NPS was performed in all and PCR in 17 of the patients. *B. pertussis* was cultured from 23 of the patients. In-house and LightCycler PCR for *B. pertussis* were found as positive in 16 of the patients. One patient had negative results for both tests. However, she met the clinical case definition and had household contact with a confirmed case. Comparative culture and PCR results of 16 patients who were tested by both tests are presented in Table III. *B. parapertussis* was not detected in any case. Nasopharyngeal multiplex viral PCR was performed in 8 patients (28.5%), and parainfluenza virus was detected in 1 of them. The concomitant parainfluenza virus/B. pertussis infection occurred in a 4-month-old girl who presented with a history of rhinitis for one day, cough with paroxysms for seven days and diarrhea for two days. Physical examination findings and chest radiography of this patient were normal.

All of the patients were hospitalized except for 3 patients who were diagnosed during the household screening. They were followed as outpatients and treated with per oral clarithromycin. Erythromycin had been given to 8 patients (25.8%). Five patients had received clarithromycin per orally and 15 patients intravenously. The mean duration of hospitalization was 9.6 days. The elapsed time until improvement in cyanosis and duration of hospitalization were similar between patients who had received erythromycin versus clarithromycin ($p=0.728$, $p=0.219$). Age, length of hospitalization and elapsed time until improvement in cyanosis according to the treatment groups are demonstrated in Table IV. The median duration of hospitalization was not significantly different between patients with early versus late start of antibiotic treatment ($p=0.704$). No drug-related adverse effect was observed in any patient. None of the patients required admission to the pediatric intensive care unit (PICU). Outcome was favorable in all cases, and no patients died or were readmitted.

Discussion

Routine immunization against pertussis began in Turkey in 1968 with whole cell diphtheria-tetanus-pertussis (DTwP) vaccine for the primary (at 2, 3, 4 months of age) and booster doses (at 16-24 months of age), and the coverage rates regularly increased, reaching 90% by 2005. After 2008, acellular DBT (DTaP) vaccine replaced DTwP in the national immunization schedule[16]. Despite this widespread vaccination practice in our country, infants <2 months of age are still unprotected from pertussis. According to a retrospective survey of the records of the Turkish Ministry of Health, reported pertussis cases between 2000 and 2005 were mostly under one year of age[17]. For this reason, most of the patients in this study were young infants who had not yet been vaccinated. Family members with undiagnosed and unrecognized pertussis are the major source of pertussis in infants. Studies have shown that parents, especially mothers,

Table IV. Median Age, Duration of Hospitalization, Elapsed Time Until Improvement in Patients Treated with Clarithromycin versus Erythromycin

	Clarithromycin group (n= 20)	Erythromycin group (n=8)
Age (median)	62 days	49 days
Length of hospitalization (median)	8.5 days	7 days
Elapsed time until improvement (median)	4 days	3 days

are the source of disease transmission[18]. In our study, more than half of our patients had a history of contact with a family member who was coughing. Three cases were siblings of our index patients. In a study from Turkey that investigated immunoglobulin (Ig) G antibodies to B. pertussis in 550 subjects aged 4–24 years, the lower titers were found in the age group of 4–6 years[19]. A DTaP dose was added to the vaccine schedule in the first year of primary school in Turkey in 2010. A retrospective survey of the records of the Turkish Ministry of Health indicated that the incidence of pertussis among adolescents and adults had increased over the past years[17]. It has been known that, despite the widespread vaccine practice in developed countries, the pertussis epidemiological cyclic pattern has not changed. Although the overall incidence of pertussis has been reduced dramatically, epidemics continue every two to five years[20]. While most cases reported previously were infants, after 2001, the annual pertussis incidence among persons aged 10-19 years steadily increased in the United States. After studies related to the pertussis epidemiology, the Advisory Committee on Immunization Practices recommended a single DTaP dose for persons aged 11 through 18 years who have completed the recommended childhood DTP/DTaP vaccination series and for adults aged 19 through 64 years[21].

The seasonality of pertussis and age-specific long-term periodicity in the Netherlands were investigated over a 10-year period from the monthly reports. They found the highest incidence for all age groups to be in August, except for the group aged 13–18 years, in which the peak occurred in November[20]. In a Canadian study, the peak incidence of hospitalizations for pertussis occurred between July and September each year during a seven-year period. Overall, 37.9% of cases presented in this three-month period, and 66.4% of cases between July and December[22]. On the other hand, in another study from Germany, cases of pertussis were diagnosed with equal frequency during both the warm season from April to September (47.2%) and the colder season from October to March (52.8%) over the six-year study period[23]. In a study from Turkey, which included 26 patients who were admitted with pertussis-like syndrome and with a mean age of 7 months between February and July 2010, the authors found that most of the patients were admitted in May and June 2010[24]. Although most of our patients were seen between May and August, the current study was a clinical case series, not an epidemiological study.

In a large study that described the features and outcomes of neonatal pertussis and compared the results with non-pertussis acute respiratory illness, the presentation symptoms according to frequencies were reported as cough, cyanotic spell, paroxysmal cough, equally apnea and rhinorrhea/congestion, tachypnea, and fever. The authors also found that neonates with pertussis were more likely to be discharged home with supportive care compared to those with acute respiratory illness[25]. In our study, there were three infants <30 days of age admitted with the symptoms of apnea, paroxysmal cough or paroxysmal cough with cyanosis for 3-12 days. None of them required invasive or noninvasive mechanical ventilation. We thought that they had been given appropriate antibiotics and supportive care early in the illness, and thus their clinical courses were not progressive. In our study, all of the patients were aged <6 months, including three neonates. According to our protocol, all patients ≤6 months of age with suspected pertussis are hospitalized regardless of the disease severity. Three patients who were diagnosed during the household screening were followed as outpatients and all of them were aged >6 months. It has been recommended that infants <3 months be admitted to the hospital almost without exception, as well as many aged 3-6 months if their paroxysms are severe, and further, patients of any age if significant complications occur[26,27]. Most cases of severe pertussis occur in small infants, and mortality in hospitalized infants can be as high as 2%; young infants contribute a substantial pertussis disease burden[28]. Infants <3 months often present with paroxysmal cough, gasping, choking, and apneic episodes, like in our series[27]. A history of immunization with ≥1 dose of pertussis vaccine was found to be associated with reduced severity of disease, mainly due to lower rates of cyanosis, whooping and wheezing inspirations in infants and children[28]. The cause of the higher cyanosis rate in our study may be due to the majority of our patients (75%) being unimmunized or <6 months of age. More than half of the patients in the current study had cough for

less than 14 days; thus, they did not meet the clinical case definition of the CDC[8]. On the other hand, all of the presented patients had paroxysmal cough, and the majority of them had cough with cyanosis. In a study that included 207 children hospitalized with pertussis, the 33 children readmitted with pertussis were compared with the 174 who did not require readmission. The authors found that paroxysmal cough and cyanosis are clinical signs that can be used in children hospitalized with pertussis to help decide when to discharge them from the hospital[29]. In our case series, no patient was readmitted, because these clinical signs were used as the discharge criteria. Fever is not an expected finding of pertussis[27]. One of our patients that presented complicated pertussis with pneumonia had fever. We believe that especially infants who have characteristic paroxysmal cough with cyanosis and no fever, even if they fail to meet the criteria for the case definition of CDC, should alert clinicians to suspected pertussis. These patients should be treated with macrolides without delay.

Isolation of *B. pertussis* from clinical specimens is the "gold standard" for the diagnosis of pertussis due to its high degree of specificity. The method is still widely used, although the sensitivity has been shown to be variable depending on a number of factors like transport and laboratory methods, disease stage, age, vaccination status, and antimicrobial pretreatment[30]. To overcome the limitations of culture, detection of B. pertussis DNA from NPSs has been described using PCR assays, including those targeting the promoter region of the gene encoding ptxA, the insertion element IS481 and IS1001, the adenylate cyclase gene, and the porin gene. Both in-house PCR and LightCycler PCR were carried out to overcome the limitations of culture in our study[4-6]. We performed in-house PCR (IS481 and pertussis toxin promoter region) and LightCycler PCR (IS481) in addition to culture. PCR methods were found positive in 16 of the patients. Both culture and PCR positivity were detected in nine of the patients. PCR was detected as positive in seven patients whose cultures were negative. These patients were in the paroxysmal stage. It is known that isolation rates are also positively correlated with younger age and with the decreased number of pertussis vaccination doses[30]. However, PCR was detected as positive in more patients than with culture in those who were young and unvaccinated in our study. Using LightCycler PCR method of detection, it is also possible to distinguish between *B. pertussis* and *B. parapertussis*[7,31]. There was no case of *B. parapertussis* in the present study.

The principal complications of pertussis are apnea, secondary infections (such as pneumonia and otitis media), respiratory failure (apnea, pneumonia, or pulmonary hypertension), physical sequelae of forceful coughing (rib fracture, conjunctival bleeding, inguinal hernia), seizures, encephalopathy, and death[23,27,28]. The reported rate of pneumonia varies from 1.7-9.4%[22,23]. On the other hand, pneumonia was reported as 36% among pertussis patients who admitted to the PICU[32]. Pertussis pneumonia is a very serious clinical condition and often requires invasive mechanical ventilation for respiratory support. However, pneumonia developing later in the illness is associated with less severe disease progression and often related to secondary viral infections[32,33]. It was found that pertussis patients presenting with pneumonia had significantly raised white cell count, lower PaO_2 level, and higher mechanical ventilation rate and mortality than the group of patients presenting with apnea[32]. Two of our patients had been diagnosed as pneumonia at admission. These patients had very high leukocyte count, had not had documented viral coinfection, and their blood cultures were negative. Both of them required CPAP and recovered uneventfully. Other than pneumonia and apnea, there were no complications like seizures, cardiopulmonary failure, or death in our study.

Pertussis is a toxin-mediated disease associated with several virulence factors, including pertussis toxin. Pertussis toxin has multiple proven biological activities, and some of them may account for the systemic manifestations of the disease, like leukocytosis and lymphocytosis. Leukocytosis attributable to lymphocytosis is a hallmark of pertussis infection. It has been reported that severe or fatal pertussis is correlated with the degree of lymphocytosis. Severe leukocytosis with pulmonary hypertension is associated with increased risk of mortality[32,33]. The majority of our patients had significant lymphocytosis. Although we did not find a relationship between

leukocytosis and the clinical course, the two more severely ill patients who needed CPAP had the highest lymphocyte count. The majority of our patients also had significant thrombocytosis regardless of the duration of symptoms. Secondary or reactive thrombocytosis, typically occurring in the second or third week of the infection, is a common finding in pediatric ages, occurring in 3-13% of hospitalized children[34]. Although it has been not emphasized previously, we believe thrombocytosis may be a supportive evidence of pertussis in young infants in the absence of other causes.

The recommended antibiotics for the treatment of pertussis in persons aged >1 month are macrolide agents as erythromycin, clarithromycin and azithromycin. In our study, we did not determine any differences in the clinic progress between patients who were treated with clarithromycin versus erythromycin. Although for infants aged <1 month, azithromycin is preferred, intravenous clarithromycin, if available, was used in our hospitalized patients who were <1 month of age. We suggest that intravenous clarithromycin is an effective and safe treatment, especially for patients with apnea, hypoxia or feeding difficulties.

In conclusion, despite the widespread vaccination efforts, pertussis remains a common disease in Turkey. Vaccine-related immunity is not permanent; therefore, there is ongoing transmission from sick adults and adolescents to unimmunized/incompletely immunized young infants. The clinical course of pertussis in unimmunized children tends to be more severe and commonly requires hospitalization. In any country in which adolescents and adults have not been vaccinated for pertussis, the first dose of vaccine before two months of age could be beneficial. Hospitalization of patients ≤6 months of age with suspected pertussis, regardless of the disease severity, and treatment with macrolides and supportive measures without waiting for PCR and culture results could have contributed to the uncomplicated and unprotracted clinical course of our patients. PCR assay provided additional benefit for the diagnoses of the study patients.

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