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Diagnosis and testing practices for adolescent pertussis among a national sample of primary care physicians

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ABSTRACT

Objective. Adolescents are a primary reservoir for propagating pertussis infection. This study aimed to describe diagnosis and testing practices for adolescent pertussis among a national sample of primary care physicians.

Methods. From January to March, 2007 we administered a written survey to a United States sample of American Medical Association physicians that included 725 family practitioners (FPs) and 725 general pediatricians (PDs).

Results. Response rate was 60% ($n = 702$). Overall, 16% of respondents indicated that they did not test adolescents for pertussis as part of their clinical practice. A similar proportion did not recognize the clinical manifestations of pertussis in a standardized adolescent case patient. FPs were less likely than PDs to test for pertussis in general and to diagnose the case patient with pertussis. Barriers to testing adolescents for pertussis included delay in obtaining test results (52%), inconvenience of sample collection (29%), lack of testing supplies (29%), lack of familiarity with testing protocols (28%) and cost (22%).

Conclusion. Our results suggest that a substantial number of primary care physicians do not utilize pertussis testing and may not be able to recognize the clinical symptoms of this infection in adolescents. Interventions to improve physician knowledge about this important public health issue may be warranted.

Introduction

Pertussis, commonly known as whooping cough, is a highly communicable disease, with attack rates of 80–90% among non-immune contacts (Centers for Disease Control and Prevention, 1991; Edwards and Decker, 2004; Gordon and Hood, 1951). Classic symptoms include episodes of paroxysmal coughing followed by an inspiratory "whoop." Though most cases are self-limited, coughing can last up to 12 weeks, and sequelae such as pneumonia, encephalopathy, sepsis, seizures and even death can occur, particularly among infants and young children. Pertussis also causes substantial morbidity in adolescents and adults. Up to 2% of adolescents with this infection experience complications and 49% have a cough lasting greater than 9 weeks (Broder et al., 2006).

The burden of reported pertussis has increased in recent years in all age groups (Centers for Disease Control and Prevention, 2008; Tanaka et al., 2003). Of the 25,827 cases reported at the peak of incidence in 2004, 8897 (34%) occurred among 11–18 year olds. Waning immunity following childhood vaccination contributes to the increased susceptibility among adolescents (Broder et al., 2006) leading to outbreaks, particularly in schools. The first vaccines to prevent pertussis in adolescents (tetanus–diphtheria–acellular pertussis vaccine, Tdap) were licensed and recommended in the United States in 2005 (Broder et al., 2006). Primary prevention of pertussis through vaccination has now become the preferred method for controlling pertussis among this high risk group.

Early diagnosis is critical for pertussis treatment and control measures to be effective. Early treatment of pertussis infection may mitigate the severity of symptoms and reduce a patient's infectiousness (Centers for Disease Control and Prevention, 2002). Moreover, an identified case can trigger public health measures, such as enhancing disease surveillance and implementing control procedures, potentially further minimizing outbreak spread. However, pertussis can be a challenging diagnosis. The disease clinically resembles other respiratory illnesses, particularly early during the catarrhal phase before the cough illness starts, when the patient is already highly contagious and infectious. Laboratory diagnosis is similarly complicated, and each of the available diagnostic modalities in the United States has shortcomings that limit their usefulness.

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An 18-year-old male presents to your clinic with 2 weeks of cough and an intermittently runny nose. He describes the cough as occurring in fits throughout the day, often worse at night, and he occasionally vomits after coughing. He denies fever, sort throat, headaches, and difficulty breathing between coughing spasms. He received the full series of DTaP/Td vaccine as a child and his last Td booster was administered 6 years ago. He has no travel history or drug allergies. A close friend at school has had a cough lasting over one month. On physical exam, his vital signs and lung exam are normal.

Fig. 1. Description of standardized adolescent "case patient" with pertussis.

Given that adolescents are one of the main reservoirs of pertussis within the community, it is imperative that physicians are able to recognize and diagnosis pertussis among this population in a timely and accurate manner. Family physicians and pediatricians are the medical specialties that interface most with adolescent patients (Szilagyi et al., 2008), yet little is known about their clinical approach and diagnostic practices for adolescent pertussis. Understanding these practices may help improve educational outreach programs and may be of use as improved pertussis diagnostic tests become available. The aim of this study therefore was to describe the diagnostic, testing and case management approaches for adolescent pertussis among a national sample of family physicians and pediatricians.

Methods

Sample

A random sample of 725 general pediatricians (PDs) and 725 family physicians (FPs) was drawn from the American Medical Association (AMA) Physician Masterfile through a contracted vendor (Medical Marketing Services). This national sampling frame included allopathic and osteopathic physicians providing direct, office-based patient care. Excluded were physicians aged 70 years or older, resident physicians, physicians with subspecialty board certification, and physicians providing patient care at federal facilities (e.g., Veterans Administration). The institutional review board of the University of Michigan approved all study activities.

Survey instrument and administration

The study team developed a 4-page, 23-question survey (available upon request) that assessed physician practices for and barriers to diagnosing and treating adolescent pertussis, practices for adolescent Tdap vaccine utilization and demographic/practice characteristics. This manuscript focuses on data from questions related to adolescent pertussis diagnosis and treatment. Results related to Tdap vaccine utilization are available in a separate manuscript (Dempsey et al., in press).

The survey was pilot tested by a convenience sample of 10 family physicians and 10 pediatricians drawn from the AMA Physician Masterfile. Survey refinements were made based on pilot-test feedback. The initial survey mailing occurred in January 2007 and included a $5 monetary incentive. Two subsequent mailings for non-respondents were performed at 4-week intervals for a total of three mailings.

Survey measures

The proportion of physicians testing adolescents for pertussis was a primary outcome assessed in this study. This outcome was measured using the question *"When you order a test for pertussis in adolescents, where is the sample collected?"* "Testers" were defined as those participants indicating *"the sample is collected in my office"* or *"patients are referred to an outside facility for collection of the sample."* "Non-testers" were defined as those indicating *"Not applicable — I do not order tests for pertussis."*

Management practices of adolescent pertussis were evaluated using fixed-response questions about adolescent pertussis in general, and about management of a standardized adolescent case patient with pertussis (Fig. 1). Barriers to and diagnostic modalities for pertussis testing were also assessed with fixed-response questions. All participants were queried about management of pertussis patients and perceived barriers to pertussis testing, but only those who were "testers" were asked about testing modalities.

Statistical analysis

Univariate frequency distributions were generated for each variable. Bivariate associations were analyzed using the likelihood ratio Chi-square test. A two-tailed alpha level of .05 was considered the threshold for statistical significance. All analyses were conducted using SAS version 8.2 (SAS, Inc., Cary, NC).

Table 1
Reported characteristics (%) of survey respondents[a] by medical specialty

Characteristic	All respondents ($n=702$)	Family practice ($n=302$)	Pediatrics ($n=400$)
Age			
<35 years of age	8	9	7
35 to 50 years of age	56	53	58
>50 years of age	36	38	35
Years since graduation			
<10 years ago	18	20	17
10–25 years ago	54	56	52
>25 years ago	28	24	31
Number of outpatients per week			
≤40 patients	6	7	5
41–99 patients	35	33	36
≥100 patients	59	60	59
Number of physicians in practice[b]			
1 physician	17	23	12
2–4 physicians	38	41	36
5–9 physicians	29	21	35
≥10 physicians	16	15	17
Ownership/type of practice			
Private	68	61	73
Hospital/Medical Center/University Health System	19	25	14
Practice Network/HMO	5	5	6
Other	8	9	7
Proportion of adolescent patients (11–18 years)[†][c]			
<10%	16	27	8
10–25%	70	70	69
>25%	14	3	23
Previous experience diagnosing adolescent pertussis[c]			
Never	33	46	23
1–5 times	45	41	48
≥6 times	22	13	29

Study performed on a United States sample of physicians of the American Medical Association.
[a] Proportion of total respondents for each medical specialty category.
[b] Includes respondent.
[c] Significant differences between medical specialties, $p<.0001$.

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Results

Sample characteristics

From the initial 1450 physicians in the mailing sample, 139 were excluded because of undeliverable mailing addresses, and an additional 148 were excluded because they did not meet eligibility criteria (e.g., retired or no outpatient adolescent care). Of the remaining 1163 potential participants, usable surveys were returned by 702 subjects, for a response rate of 60% (53% FPs, 68% PDs). There were no significant differences between non-respondents and respondents with respect to gender, age, medical degree, years since graduation, or geographic area of practice. However, non-respondents were significantly less likely to be board certified than respondents (44% vs. 56%, $p=.0007$).

Characteristics of the respondents are described in Table 1. Overall, the majority of subjects practiced in multi-physician private practices seeing more than 100 patients per week, of which at least 10% were adolescents. Most respondent characteristics were similar between FPs and PDs, although PDs were significantly more likely that FPs to have higher adolescent patient volumes and to have previous experience in diagnosing pertussis in adolescent patients (Table 1).

Reported diagnostic practices for adolescent pertussis

Overall, 84% ($n=585$) of respondents reported that they tested adolescents for pertussis as part of their clinical practice (i.e. "testers"), either by collecting the sample in the office or by sending the patient to another facility for sample collection (Table 2). A substantial minority of physicians (16%, $n=111$), indicated that they did not perform pertussis testing on adolescent patients (i.e. "non-testers"). PDs were significantly more likely to be testers than FPs (Table 2).

Non-testers differed from testers in other ways (Table 3). Non-testers were significantly more likely to report lack of familiarity with testing protocols and a belief that clinical judgment was sufficient for diagnosing adolescent pertussis than testers as major barriers to testing. However, approximately 8% ($n=9$) of the non-testers indicated that there were "no major barriers" to testing adolescents for pertussis. Non-testers also had significantly less previous experience diagnosing adolescent pertussis (Table 3), and differed in their management of the adolescent "case patient" with pertussis (described below).

When asked to choose the type of pertussis testing modalities typically ordered for their adolescent patients, polymerase chain reaction (PCR, 36%) and culture (33%) were the most common, followed by direct fluorescent antibody (DFA, 24%) and serology (12%). One third of the respondents indicated that they used more than one testing modality. Notably, 13% of respondents were unsure of the type of pertussis tests they typically ordered.

Table 3
Statistically significant differences* between physicians who do, and do not, test for pertussis in adolescents (%)

Physician characteristic	Proportion of "Testers" with characteristic)[a] ($n=585$)	Proportion of "Non-testers" with characteristic)[a] ($n=111$)
Barriers to testing		
Cite lack of familiarity with testing protocols as a barrier	24	54
Believe that clinical judgment is sufficient for diagnosis	8	14
Previous experience diagnosing adolescent pertussis		
Never diagnosed pertussis in adolescents previously	28	60
Previously diagnosed 1–5 cases of adolescent pertussis	48	28
Previously diagnosed ≥6 cases of adolescent pertussis	24	12

Study performed on a United States sample of physicians of the American Medical Association.
* $p<.0001$.
[a] 6 respondents from original sample could not be classified due to missing data.

Delay in obtaining test results was the most frequently cited major barrier to pertussis testing in adolescents (52%) followed by inconvenience of having to send the patient to an outside facility for collecting the sample (29%), lack of available testing supplies (29%), lack of familiarity with testing protocols (28%) and cost (22%). Quality of test results (14%) and a belief that clinical judgment was sufficient for diagnosing pertussis in adolescents (9%) were the least commonly cited major barriers to testing. Fourteen percent of the respondents indicated that there were "no major barriers." FPs were more likely than PDs to cite cost (26% vs. 20%, $p=.042$) and lack of familiarity with testing protocols (42% vs. 18%, $p<.0001$) as major barriers to adolescent pertussis testing. In contrast, PDs were more likely than FPs to cite delay in obtaining results as a major barrier (58% vs. 44%, $p<.0002$).

Reported management of an adolescent "case patient" with pertussis

When presented with a description of an 18-year-old male with symptoms of pertussis (Fig. 1), 83% of respondents overall had at least moderate suspicion that the patient had pertussis and 51% indicated that they would test the patient for this disease (Table 4). There was a strong association between suspecting pertussis and testing for pertussis in the case patient, with testing proposed by 75% of those who suspected pertussis compared to 0% among those who did not suspect pertussis ($p<.0001$). FPs were significantly less likely than

Table 2
Physician practices in testing adolescents for pertussis[a] (%)

Testing practice	All respondents[b] ($n=696$)	Family practitioners ($n=300$)	Pediatricians ($n=396$)	*p*-value
"The sample is collected in my office"	46	39	51	<.0001
"Patients are referred to an outside facility for collection of the sample"	38	36	39	
"Not applicable — I do not order tests for pertussis"	16	25	10	

Study performed on a United States sample of physicians of the American Medical Association.
[a] Response to question "When you order a test for pertussis in adolescents, where is the sample collected?"
[b] 6 respondents with missing data.

Table 4
Physician practices (%) in the diagnosis and treatment of an adolescent "case patient"[a] with pertussis

Diagnosis or treatment practice	All respondents ($n=702$)	Family practitioners ($n=302$)	Pediatricians ($n=400$)	*p*-value
Suspect patient has pertussis				
No/low suspicion	17	28	9	<.0001
Mod/high suspicion	83	72	91	
Initiate pertussis testing				
Yes	51	36	59	<.0001
No	49	64	41	
Prescribe Antibiotic				
Yes	79	77	79	.51
No	21	23	21	

Study performed at the University of Michigan, Jan 2007.
[a] Case patient described in Fig. 1.

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PDs to suspect the patient had pertussis and to initiate pertussis testing. Despite this, a similarly high percentage of FPs and PDs (79% and 77%, respectively) indicated that they would prescribe antibiotics for the patient (Table 4). Macrolides were the treatment antibiotic of choice for 95% of respondents.

In bivariate analyses, management of the case patient reflected general patterns of pertussis testing. Testers were significantly more likely than non-testers to suspect the case patient had this infection (87% vs. 61%, $p<.0001$) and to test for disease (58% vs. 4%, $p<.0001$). Similarly, physicians who reported having never diagnosed adolescent pertussis in the past were significantly less likely than those who had diagnosed adolescent pertussis frequently (≥6 times) to suspect the case patient had pertussis (41% vs. 97%, $p<.0001$) and test the case patient for this infection (31% vs. 65%, $p<.0001$).

Public health reporting of pertussis

Overall, 57% of the sample indicated that they had contacted the health department (HD) in the past to report a case of pertussis, with the vast majority (96%) first waiting for lab confirmation of this infection. PDs were more likely to have reported pertussis to the HD than FPs (71% vs. 30%, $p<.0001$), as were older physicians (61% vs. 48% for >50 year olds and <35 year olds, respectively; $p=.0128$) and those with greater previous experience diagnosing adolescent pertussis (77% vs. 34% for those diagnosing adolescent pertussis ≥6 times and those never diagnosing adolescent pertussis, respectively; $p<.0001$).

Discussion

Pertussis is an endemic disease that appears to be increasing in incidence. Because adolescents are considered one of the main reservoirs for propagating pertussis infection in the population, there is a critical need for primary prevention of pertussis through vaccination and for understanding how well physicians recognize and manage this illness among this age group. Results of this national survey – the first to explore physician practices for adolescent pertussis management in the U.S – suggest that testing, recognition of clinical symptoms, and case management of pertussis in adolescents among primary care physicians may be suboptimal. We found that nearly one out of six physicians do not test adolescents for pertussis as part of their clinical practice and a similar proportion were not able to recognize the clinical manifestations of pertussis in a standardized adolescent case patient. Furthermore, 86% of providers acknowledged at least one barrier to pertussis testing.

Many of the commonly cited barriers to testing for pertussis in our study, such as delay in obtaining test results, having to send the patient to an outside facility to collect the testing sample, and lack of testing supply availability, are to some extent a function of the limitations of currently available diagnostic modalities. Each of the currently available diagnostic tests for pertussis (culture, PCR, serology and DFA) have shortcomings that limit their usefulness. For example DFA has low sensitivity for detecting pertussis, is not included in the Council of State and Territorial Epidemiologists (CSTE) pertussis case definition and is not a recommended confirmatory test. An added complicating factor is that the interpretation of test results is affected by numerous factors such as stage of disease, antimicrobial administration, previous vaccination, and the quality of the technique used to collect the specimen, among others. Nonetheless, our results also suggest that increased efforts aimed at improving clinician knowledge about the symptoms of and diagnostic procedures for identifying pertussis might be warranted. This conclusion is supported by the fact that a substantial proportion of physicians identified lack of familiarity of testing protocols as a major barrier to pertussis testing, that many did not recognize the clinical symptoms of pertussis in the case patient, and that clinicians more familiar with this disease, as indicated by their level of experience in diagnosing adolescent pertussis in the past, were more likely to manage the case patient appropriately.

Nearly 10% of respondents in our study believed that clinical judgment was sufficient for diagnosing pertussis. Clearly, the importance of clinical acumen in combination with a high index of suspicion cannot be overstated. However, pertussis often resembles other respiratory diseases early in the course of illness. The clinical case definition set forth by the CDC for a sporadically identified case of pertussis (i.e., not outbreak-related) requires at least two weeks of cough without other apparent cause in combination with paroxysms, inspiratory "whooping" or post-tussive vomiting (Centers for Disease Control and Prevention, 2002). In contrast to the long time period needed to fulfill these clinical criteria, laboratory confirmation of pertussis by PCR can take as little as 1–2 days. Despite this advantage, PCR testing does have limitations, as evidenced by a recent report describing three separate outbreaks of respiratory illnesses mistakenly attributed to pertussis due to false positive test results, resulting in significant resource utilization erroneously aimed at pertussis outbreak containment (Centers for Disease Control and Prevention, 2007). The CDC is currently undertaking a diagnostic validation study to assess the clinical accuracy of several diagnostic tests, with the goal of ensuring that standardized laboratory tests for pertussis become available for routine testing and public health interventions.

Our study also highlighted important specialty-based differences in pertussis testing practices. We found that FPs were less likely than PDs to have diagnosed an adolescent with pertussis in the past, to utilize pertussis testing of adolescents as part of their current practice, to manage the case patient appropriately, and to report pertussis cases to the HD. These results are consistent with other studies showing specialty-based differences in diagnostic and testing practices (Arnold et al., 2005; Evink et al., 2000). In our study, these specialty-based differences appear to be influenced, at least in part, by differences between these two groups in their familiarity with pertussis testing protocols. Given that other studies have also demonstrated differences between these two medical specialties in the utilization of pertussis-preventing vaccines (Davis et al., 2006; Dempsey et al., in press), these results suggest that future educational interventions aimed at improving clinician knowledge about pertussis diagnosis, treatment, containment, and prevention options should be tailored to reflect the specific needs of each medical community.

Limitations

An important limitation to all studies relying on survey methods is the potential for response bias. Though our response rate and characteristics of participants in our survey are comparable with that of other published studies of physician behavior (Asch et al., 1997; Crane et al., 2008; Cull et al., 2005; Cummings et al., 2001), it is possible that non-respondents differed from respondents in important ways that could have affected interpretation of the data. However, our analysis indicated that there were only small differences with regard to several demographic characteristics between respondents and non-respondents, suggesting that any potential bias was minimized.

Additional limitations are that data are based on self-reported practices and have not been confirmed by observation or chart review — it is possible that physicians answered questions in ways that reflect professional desirability rather than their own practice characteristics, or that the use of fixed-response questions biased the results. Furthermore, our description of the study instrument as a "survey about pertussis" may have influenced respondents' self-reported practices regarding pertussis testing and management of the case patient. Additionally, in our study both physicians who performed pertussis testing in the office and those who referred patients to an outside facility for testing were defined as "testers". There are likely to be barriers to testing that are specific to each of these scenarios, but were not identified in our study. Finally, the case patient was described

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as not having received previous Tdap vaccination. It is possible that physician-reported practices in managing adolescents who had received this vaccine might differ from those found in our study.

Conclusions

Results of this first national study on pertussis management for adolescent patients indicate that a substantial number of primary care physicians do not utilize pertussis testing in this population and may not be able to recognize the clinical symptoms of this infection among this age group. This suggests that interventions to improve physician knowledge about the diagnosis and management of this important public health issue are warranted. Barriers to testing adolescents for pertussis identified by our study include difficulties in obtaining the test sample and results, understanding testing protocols, and reimbursement.

Conflict of interest statement
The authors declare that there are no conflicts of interest.

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