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Assessing the Impact of the 2020 Council of State and Territorial Epidemiologists Case Definition for Pertussis on Reported Pertussis Cases

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Abstract

BACKGROUND: In 2020, the Council of State and Territorial Epidemiologists (CSTE) pertussis case definition was modified; the main change was classifying PCR-positive cases as confirmed, regardless of cough duration. Pertussis data reported through Enhanced Pertussis Surveillance (EPS) in seven sites and the National Notifiable Diseases Surveillance System (NNDSS) were used to evaluate the impact of the new case definition.

METHODS: We compared the number of EPS cases with cough onset in 2020 to the number that would have been reported based on the prior (2014) CSTE case definition. To assess the impact of the change nationally, the proportion of EPS cases newly reportable under the 2020 CSTE case

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definition was applied to 2020 NNDSS data to estimate how many additional cases were captured nationally.

RESULTS: Among 442 confirmed and probable cases reported to EPS states in 2020, 42 (9.5%) were newly reportable according to the 2020 case definition. Applying this proportion to the 6,124 confirmed and probable cases reported nationally in 2020, we estimated that the new definition added 582 cases. Had the case definition not changed, reported cases in 2020 would have decreased by 70% from 2019; the observed decrease was 67%.

CONCLUSIONS: Despite a substantial decrease in reported pertussis cases in the setting of COVID-19, our data show that the 2020 pertussis case definition change resulted in additional case reporting compared with the previous case definition, providing greater opportunities for public health interventions such as prophylaxis of close contacts.

Summary:

The 2020 CSTE case definition change for pertussis resulted in additional case reporting compared with the previous case definition despite a substantial decrease in reported pertussis cases in the setting of COVID-19.

Introduction

Pertussis is a highly contagious respiratory disease caused by the Gram-negative bacterium *Bordetella pertussis*. It can cause severe and even debilitating cough illness in persons of all ages, with the highest morbidity and mortality in infants less than one year of age. Pertussis is one of the most poorly controlled vaccine-preventable diseases in the United States, even though vaccine coverage remains above 90% in children and adolescents [1,2]. In the United States, reported cases have increased slowly but steadily since the early 1990s through the start of the COVID-19 pandemic in 2020, with some large peaks in reported disease [1,3].

Pertussis is a nationally notifiable condition in the United States. Reported pertussis cases are classified as confirmed or probable based on a combination of laboratory, clinical, and epidemiologic linkage criteria [4]. While consistency in case definitions over time is important to ensure accurate capturing of disease burden and trends, modifications to the Council of State and Territorial Epidemiologists (CSTE) pertussis case definition have been made in response not only to evolving epidemiology but also to changes in the landscape of pertussis diagnostic testing. The transition from conventional to real-time polymerase chain reaction (PCR) resulted in higher sensitivity and, with the ability to simultaneously target multiple *Bordetella* species, greatly improved specificity [5–7]. This transition has resulted in increased confidence in the accuracy of PCR testing for confirming a case of pertussis, and it is now the primary diagnostic tool for pertussis [8].

Prior to the modifications made in 2020, the CSTE case definition had last been changed in 2014. However, there were notable challenges with the 2014 definition. These included age-specific criteria that made the definition complicated for public health personnel to implement and including laboratory requirements in both confirmed and probable classifications added to the complexity. Additionally, the definitional criterion of at least 14 days of cough for most cases required an unrealistic degree of public health follow-up,

which was especially problematic in the setting of a pertussis resurgence. The CSTE case definition was modified in 2020 not only to address these challenges but also to reflect more accurately predominant pertussis testing practices and the improved reliability of PCR for the detection of *B. pertussis* [5]. Specifically, three changes were made to the 2020 CSTE case definition. First, all age-specific criteria were removed to achieve consistency across age groups. Second, the confirmed classification was limited to cases confirmed by laboratory testing (PCR or culture). And lastly, to reflect the increased confidence in PCR and reduce the burden of follow-up to ascertain cough duration, all PCR-positive cases with acute cough were classified as confirmed, regardless of cough duration or presence of other pertussis symptoms [4]. Overall, changes made in 2020 were expected to increase the sensitivity of the CSTE pertussis case definition.

This analysis included two main objectives: 1) to understand the burden of newly reportable cases in CDC's Emerging Infections Program Network's Enhanced Pertussis Surveillance (EPS) system catchment area under the 2020 CSTE case definition; and 2) to estimate the impact of the 2020 definition change on cases reported nationally through the National Notifiable Diseases Surveillance System (NNDSS).

Methods

In the United States, jurisdictions report confirmed and probable pertussis cases to the Centers for Disease Control and Prevention (CDC) through NNDSS. EPS is conducted in 7 sites (Colorado: 5-county Denver area; Connecticut; Georgia: 20-county Atlanta area; Minnesota; New Mexico; New York: 15-county Rochester/Albany area; and Oregon: 3-county Portland area) to collect additional epidemiologic and clinical data on confirmed and probable pertussis cases reported in the catchment area. Pertussis cases with cough onset from 1 January 2020–31 December 2020 were included in the analysis.

Surveillance personnel complete standardized case report forms that include information on demographics, clinical presentation, vaccination history, and epidemiologic information not captured through NNDSS. Although the new 2020 CSTE case definition no longer required a cough duration of at least 14 days for PCR-positive and epidemiologically linked cases, surveillance personnel at EPS sites continued collecting cough duration of at least 14 days for all reported pertussis cases in their EPS catchment areas.

For this analysis, the 2014 and 2020 CSTE case definitions were applied to all cases with cough onset in 2020 in the EPS catchment area to understand which case classification they would have had according to each definition. Under the 2014 CSTE case definition, confirmed cases were defined as those with acute cough illness of any duration with isolation of *B. pertussis* from a clinical specimen, or PCR-positive or epidemiologically linked cases with cough illness of at least 14 days and at least one pertussis-specific symptom (paroxysmal cough, whoop, posttussive vomiting, or apnea in infants <1 year of age). Probable cases were defined as those, in the absence of a more likely diagnosis, with cough illness of at least 14 days and at least one pertussis-specific symptom; or, in infants <1 year of age, cough illness of any duration, along with a pertussis-specific symptom, and either a positive PCR test result or contact with a laboratory-confirmed case of pertussis

[9]. Under the 2020 CSTE case definition, confirmed cases were defined as those with acute cough illness of any duration with isolation of *B. pertussis* from a clinical specimen or a positive PCR test result for *B. pertussis*. Probable cases were defined as those, in the absence of a more likely diagnosis, with cough illness of at least 14 days duration and at least one pertussis-specific symptom (paroxysmal cough, whoop, posttussive vomiting, or apnea); or epidemiologically linked cases with cough illness of any duration with at least one pertussis-specific symptom [4].

The 2014 and 2020 CSTE case definitions were applied to all cases reported in EPS and the case classifications under each definition were compared to determine which cases were newly reportable under the 2020 CSTE case definition (objective 1). To assess the impact of the 2020 CSTE case definition change nationally (objective 2), the proportion of cases in EPS reportable under the 2020 CSTE case definition but not reportable under the 2014 CSTE case definition was applied to 2020 NNDSS data to estimate how many additional cases were captured nationally. Data were analyzed using SAS version 9.4. Proportions were calculated among those with known responses. Differences in proportions were tested using Pearson's $\chi 2$ or Fisher's exact test. P values of <.05 were considered statistically significant.

This activity was reviewed by CDC and was conducted consistent with applicable federal law and CDC policy.[§]

Results

A total of 442 confirmed and probable pertussis cases were reported in the EPS catchment area with cough onset in 2020. The majority of these cases (n=364, 82.4%) had the same case classification under both the 2014 and 2020 CSTE case definitions, with 257 confirmed cases and 107 probable cases (Figure 1). Thirty-six (8.2%) cases were considered reportable under both CSTE case definitions but were classified differently under the 2014 definition compared to 2020. This included 33 epidemiologically-linked cases that would have been classified as confirmed under the 2014 CSTE case definition but were classified as probable cases under the 2020 CSTE case definition, and three PCR-positive infant cases with cough <14 days that would have been probable cases according to the 2014 CSTE but were considered confirmed cases under the 2020 definition.

The remaining 42 (9.5%) were cases that were newly reportable based on the 2020 CSTE case definition and would not have been reportable based on the 2014 definition; of these, 37 (88.1%) were confirmed cases with a positive PCR result that would not have met requirements for cough duration (n=31) or presence of other pertussis symptoms (n=6) under the 2014 CSTE case definition. The remaining 5 were probable cases. Four (9.5%) were epidemiologically linked cases that would not have met the 14-day cough duration requirement of the 2014 case definition. Finally, one (2.4%) case was in an adult with apnea that would not have been reportable due to age-specific criteria in the 2014 CSTE case definition. When comparing the newly reportable pertussis cases to all other pertussis cases with cough onset in 2020 that were reported in EPS sites, we found no significant

§ See e.g., 45 C.F.R. part 46.102(l)(2), 21 C.F.R. part 56; 42 U.S.C. §241(d); 5 U.S.C. §552a; 44 U.S.C. §3501 et seq.

differences in age, race, or ethnicity (Table 1). However, the proportion of newly reportable cases was significantly different by EPS site (p=.0014).

To understand the impact of the case definition change on the total number of cases reported nationally through NNDSS, the proportion of newly reportable cases obtained from EPS (9.5%) was applied to the number of cases reported to NNDSS for 2020. A total of 6,124 cases were reported to NNDSS in 2020 [10], resulting in an estimated 582 pertussis cases reported nationally in 2020 that would not have met the 2014 CSTE case definition. In 2019, a total of 18,617 pertussis cases were reported nationally [11]. Between 2019 and 2020, the observed decrease in reported NNDSS pertussis cases was 67%. If the case definition had not changed in 2020, the projected decrease would have been 70%.

Discussion

Because the 2020 case definition change eliminated the requirement for 14 days of cough for PCR-positive cases, the modification was expected to result in an increase in reportable pertussis cases; however, in the setting of the COVID-19 pandemic, there was a substantial overall decrease in nationally reported pertussis cases, similar to what was observed for other reportable communicable diseases [12]. Although the overall number of reported pertussis cases decreased nationally, EPS data show that the 2020 case definition change resulted in a 9.5% increase in reportable cases compared to the 2014 case definition. These newly reportable pertussis cases did not differ significantly from other EPS cases in terms of age, race, and ethnicity. However, the proportion of cases that were newly reportable differed significantly by EPS site (Table 1), which could be driven by site differences in testing practices, age distribution of cases, or clinical presentation.

Overall, nationally reported pertussis cases decreased 67% from 2019 to 2020 despite the case definition change. Many factors likely contributed to this decrease including COVID-19-associated non-pharmaceutical interventions, such as masking and school closures, which would be expected to reduce spread of respiratory diseases including pertussis [13,14]. Additionally, people may have been less likely to seek care and be tested for mild pertussis illness during the COVID-19 pandemic, and clinical labs may have had reduced capacity to test for pertussis during this time. Given these factors, it will be important to evaluate the impact of the case definition change in future years when pertussis transmission and testing have stabilized post-COVID-19 pandemic.

It is important for case definitions for reportable conditions to adapt over time to account for changes in disease epidemiology, testing practices, and other factors that would impact the accuracy of the definition in order to provide data that can be relied upon by clinicians and public-health professionals in their decision making. The majority of the newly reportable cases (n=37, 88%) were PCR-positive cases that did not meet cough duration or other symptom requirements in the 2014 CSTE case definition. The clinical presentation of pertussis has evolved in the setting of waning immunity following acellular pertussis vaccination, and more cases now present with mild illness [15–19]. The update to the pertussis case definition in 2020 to make PCR and culture equivalent for confirming a pertussis case ensures that the case definition is more sensitive and captures these pertussis

cases with mild illness that are capable of transmitting infection, but previously may not have met cough duration or other symptom requirements. Identifying these cases allows public health officials to take steps to prevent illness in their contacts, particularly among susceptible infants. At the same time, the changes reduce the burden of public health follow-up to ascertain cough duration, which has no preventive benefit.

When case definitions are modified, it is important to understand the impact of the changes in order to accurately interpret trends in disease incidence over time. Changes to the U.S. pertussis case definition in 2020 resulted in almost a 10% increase in reported cases. Capturing these additional cases potentially provides greater opportunities for public health interventions such as the identification and post-exposure prophylaxis of close contacts, including those at high risk of severe pertussis morbidity and mortality.

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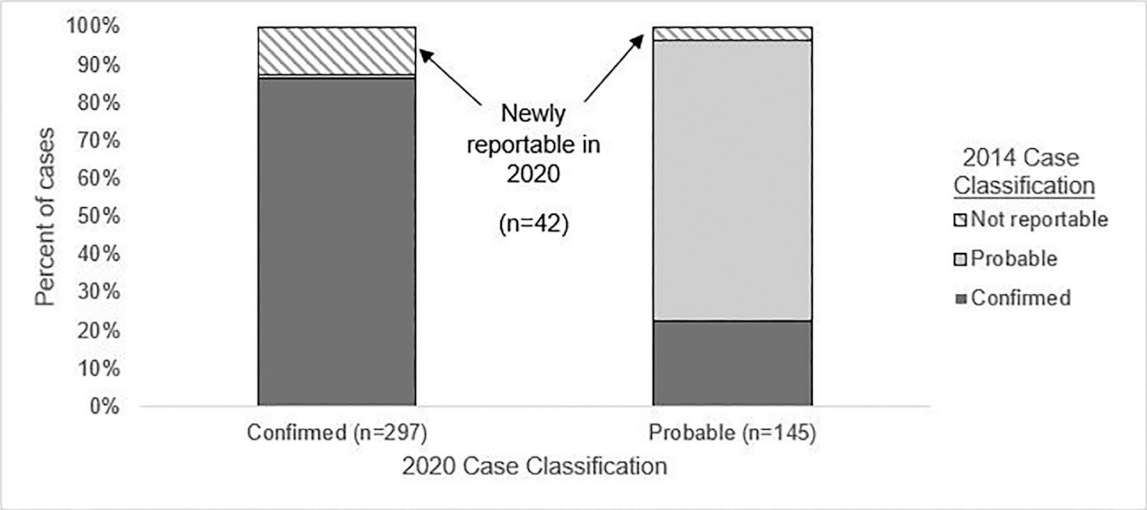

Figure 1.

Reported 2020 pertussis cases classified by the 2014 and 2020 CSTE case definition—Enhanced Pertussis Surveillance. Abbreviation: CSTE, Council of State and Territorial Epidemiologists.

Table 1.

Epidemiologic characteristics of 2020 pertussis patients — Enhanced Pertussis Surveillance

Characteristic	Reportable Cases Under the 2014 Case Definition, n (%)	Newly Reportable Cases Under the 2020 Case Definition, n (%)	p-value
N	400	42	
Site			
CO	46 (11.5)	4 (9.5)	.0014
CT	4 (1.0)	4 (9.5)	
GA	87 (21.8)	3 (7.1)	
MN	106 (26.5)	8 (19.1)	
NM	51 (12.8)	5 (11.9)	
NY	21 (5.3)	6 (14.2)	
OR	85 (21.3)	12 (28.6)	
Age (years)			.5
<1	38 (9.5)	3 (7.1)	
1–10	118 (29.5)	11 (26.2)	
11–19	116 (29.0)	17 (40.5)	
≥20	128 (32.0)	11 (26.2)	
Race *			.7
White	330 (87.1)	31 (86.1)	
Black	23 (6.1)	3 (8.3)	
American Indian or Alaskan Native	6 (1.6)	0	
Asian/Pacific Islander	9 (2.4)	0	
Other	11 (2.9)	2 (5.6)	
Ethnicity±			1.0
Hispanic/Latino	65 (16.8)	6 (16.7)	
Non-Hispanic/Latino	321 (83.2)	30 (83.3)	

* Calculated out of those with known response; n=379 for “Reportable Cases Under the 2014 Case Definition” and n=36 for “Newly Reportable Cases Under the 2020 Case Definition”.

±Calculated out of those with known response; n=386 for “Reportable Cases Under the 2014 Case Definition” and n=36 for “Newly Reportable Cases Under the 2020 Case Definition”.