REASSESSMENT OF THE EPIDEMIOLOGY OF PERTUSSIS IN LOS ANGELES COUNTY DUE TO AN ATYPICAL SEASONAL INCREASE IN CASES

ABSTRACT

Because of an unusual increase in the number of reported cases of pertussis in the winter of 2001, the epidemiology of pertussis in Los Angeles County (LAC) over the last ten years was reexamined—specifically looking for trends in certain age groups and seasons. Key findings showed that all age groups are not of equal importance in the current epidemiology of LAC pertussis incidence. Specifically, the 5–14 age group appears to be emerging as an age group disproportionately affected by pertussis morbidity. In addition because of specific seasonal peaks in cases, this age group may also be contributing to the pertussis incidence among the most severely affected age groups as well as the 3–4 year cyclical rise in cases evidenced in LAC since 1997.

BACKGROUND

Since the early 1980s, the natural history of pertussis in LAC, much like the rest of the nation, became characterized by non-uniform temporal and age-specific patterns different from other infections transmitted by the respiratory route [1,2].

According to the findings from the 2001 National Immunization Survey, 80.2% (95% CI: 75.4%, 85%) of children 19–35 months of age in LAC (born February 1998 through May 2000) had been vaccinated with the recommended 4 or more doses of pertussis-containing vaccine. However, protection with vaccine decreases over time, with little or no protection 5–10 years following administration of the last dose (recommended at 4–6 years of age). With a secondary attack rate of 80%, adolescents and adults have become the primary reservoir of continued transmission of the infection and challenge the current concept of pertussis herd immunity [3]. During 1997–2000, a total of 29,134 pertussis cases were reported nationwide, with 29% of the persons with pertussis aged <1 year and 49% aged 10 and older [4].

LAC has historically evidenced a yearly seasonal summer peak in cases among infants less than 1 year of age. However, in the winter of 2001, an unusual increase in the number of reported cases spurred a reexamination of the epidemiology of pertussis in LAC compared to the entire state of California during the past 12 years—with a special focus on the seasonal morbidity differentials among age groups across time.

METHODS

Suspect pertussis reports received by the LAC Department of Health Services are classified as confirmed or probable cases if they meet the state of California's case definition. Reported pertussis cases from 1991–2003 that met the case definition were analyzed by age group and season of disease onset by the following categories:

- Age group: <1; 1–4; 5–14; 15–24; 25+
- Seasonal group: October-January (winter season); February-May (spring season); June-September (summer season)

Using data collected during case investigations, a temporal association was measured utilizing the following case factors with chi-square as the test of independence:

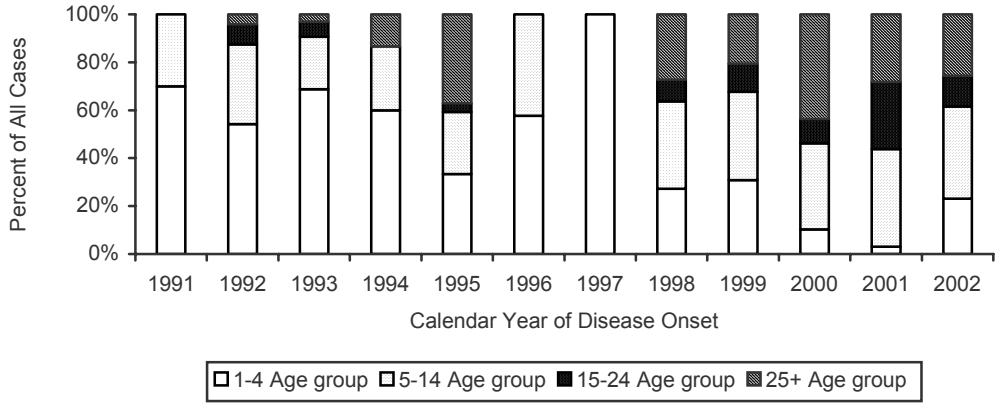
- Ethnicity (Hispanic vs. non-Hispanic)
- Gender
- Immunization history (<4 DTP doses versus ≥4 DTP doses)
- Case severity (developed complications or was hospitalized due to illness)

- Epidemiological linked status (contact to person with cough or a diagnosed pertussis case)
- Case status (probable versus confirmed)

RESULTS

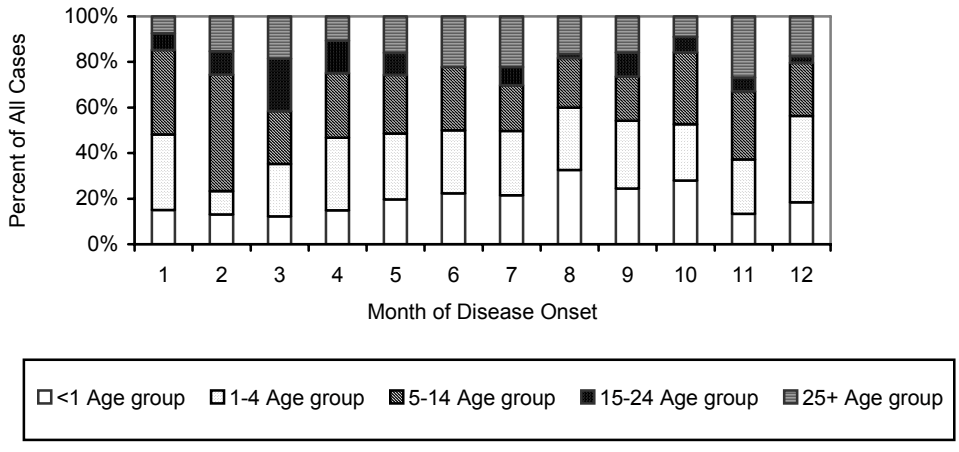
The first analysis in the reassessment evaluated the reported cases of pertussis each calendar year by age group during 1991–2002 (Figure 1). The majority of the cases (75%) were <1 year of age, and in comparison, all the other age groups appear as if they contributed similar proportions. However, after analyzing these age groups with a smaller scale, the proportion of cases among the 1–4 age group has been decreasing while the proportion of cases in the 5–14 and 25+ age groups has been steadily increasing. After the year 2000, the proportion of cases contributed by each of the older age groups surpassed the contribution of the 1–4 age group.

Figure 1. Reported cases of pertussis by age group,
LAC calendar year 1991-2002



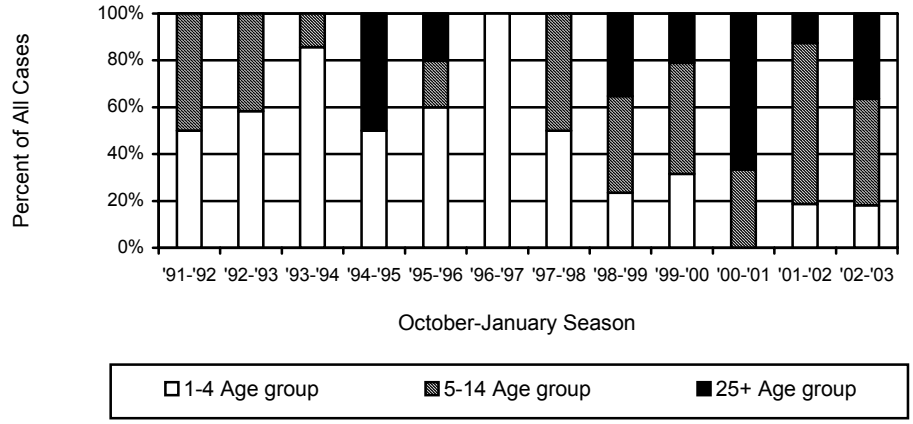
Investigating the seasonal correlation among these age groups indicated an interesting pattern (Figure 2). The average yearly number of cases in the <1 age group starts to rise in February, peaking in August-September, following a high proportion of cases in the 5–14 year olds in the winter season and the 25+ age group during April–July.

Figure 2. Reported cases of pertussis by age group and month of
disease onset, LAC 1991-2002



Because the calendar year disease onset analysis appeared to be masking an unusual epidemiological pattern in the cases reported by age group throughout the year, case totals among three age groups (1–4, 5–14, 25+) were analyzed during the last 12 winter seasons from October through January (Figure 3). The 5–14 age group has accounted for the highest proportion of all ≥1-year old cases reported during every winter season since the 1996–1997 winter season. Particularly in the 2001–2002 winter season, the 5–14 age group accounted for 20% (*n* = 11) of all reported cases, up from the average contribution of 7.2% during the same time periods in 1991–2001. In the 5–14 age group, three select winter seasons also showed evidence of higher than baseline case totals and would require further analysis: 1992–1993, 1998–1999, 2001–2002.

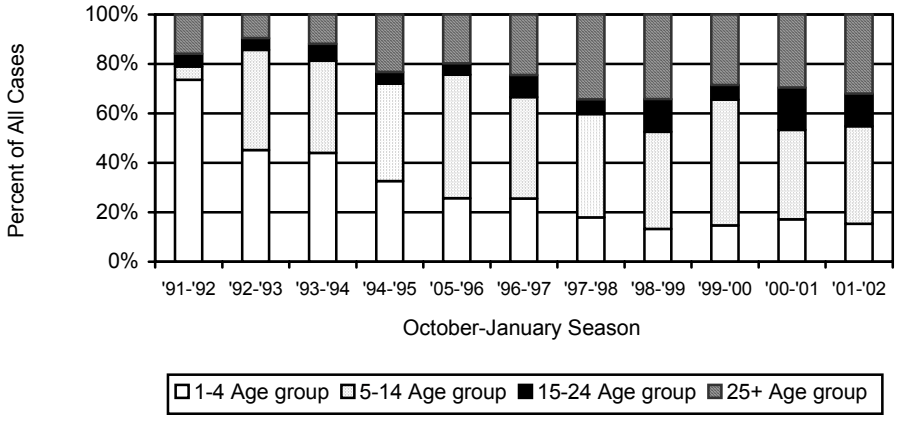
Figure 3. Reported cases of pertussis by age group, October-January, LAC 1991-2003

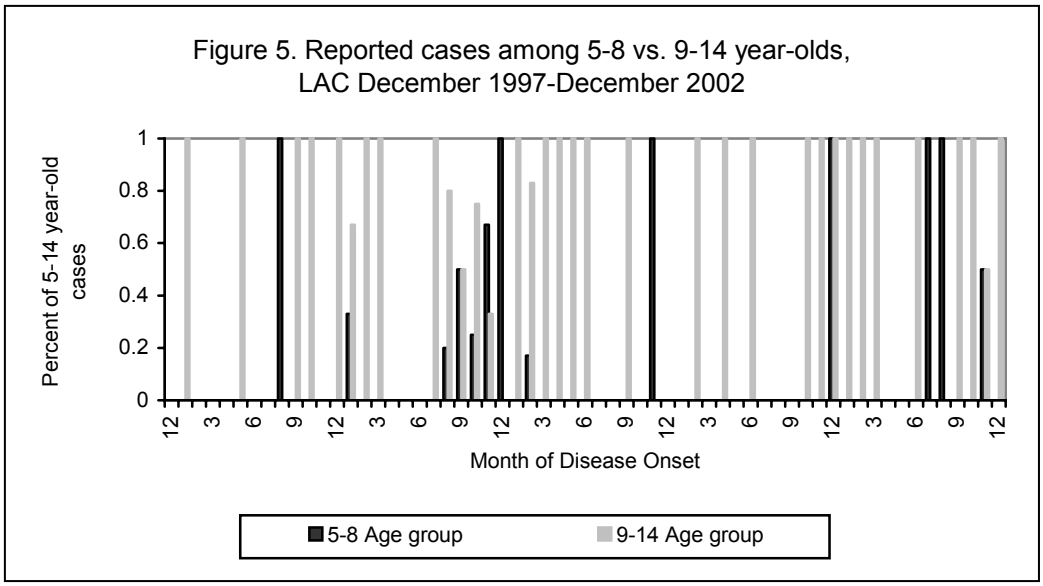


To examine whether a similar pattern was evidenced throughout the state, the proportion of reported cases of pertussis in California by the same age groups during the winter seasons 1991–2002 was analyzed (Figure 4). Similar to LAC, the proportion of cases in the 5-14 age group has surpassed each of the other age groups since 1992—with the 25+ age group following in close second.

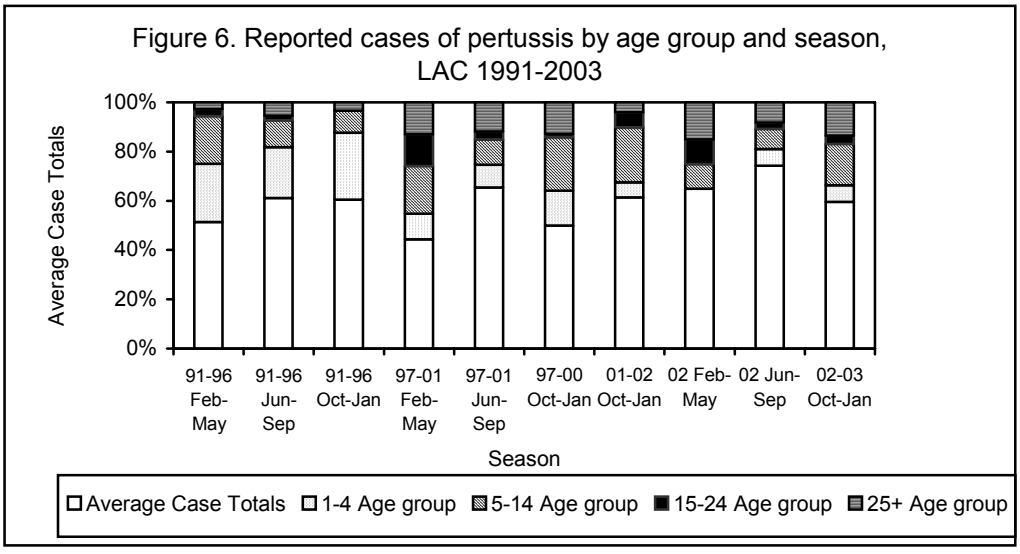
To further understand the phenomenon occurring in the 5–14 age group, closer examination was given to the specific ages within this group by month of disease onset from December 1997 to December 2002

Figure 4. Reported cases of pertussis by age group, October-January, California1991-2002





(Figure 5). The 5–14 age group case totals appear to rise primarily during the winter months, with the 9–14 age group accounting for the majority of the 5–14 year old cases, consistent with the expected age range of waning immunity.



Since the 5–14 age group did not account for cases uniformly in a calendar year, the proportion of reported cases of pertussis by age group and season was analyzed (Figure 6). Because the proportion of cases in 5–14 year olds increased dramatically after the 1996–1997 winter season (Figure 3), the seasons of February–May, June–September, and October–January in 1991–2002 were aggregated according to whether the season occurred before or after the 1996–1997 winter season. The number of cases reported in October–January 2001–2002 (*n* = 55) was up 77% from the same seasonal average in 1991–2000. Barring the inclusion of the <1 age group, the 5–14 age group has contributed the highest proportion of cases in nearly every season since the end of the 1996–1997 winter season.

Possible explanations for this observed temporal and age association needed to be examined. Two winter seasons with high case numbers (October–January 1992–1993, 1999–2000) were compared to the 2001–2002 winter season. Compared to 25% of 1999–2000 and 1992–1993 cases, only 3% of 2001–

2002 cases had contact to a pertussis case, thus indicating that parents, siblings, and other household contacts were not the cause of the increase in cases in 2001–2002.

During the 2002 calendar year, 170 cases were reported, up 66% from the calendar year average in 1991–2001. The proportion of cases with disease onset in specific seasons in 2002 was compared. The majority of cases with onset in February–May and June–September were linked to pertussis cases (none of whom were the 5–14 year old winter cases in 2001–2002) and/or in contact with someone with a cough (95% and 100%, respectively). This association was not evidenced in the winter season 2001–2002.

CONCLUSIONS

The 5–14 year-olds (in particular 9–14 year-olds) appear to be emerging as an age group disproportionately affected by pertussis morbidity, with no reported evidence of epidemiological links. More information will be needed about the epidemiological link or social networking of this age group of cases with other age groups in order to firmly support the hypothesis that the 5–14 age group could be driving the summer seasonal increase in cases in the <1 year-olds due to a high contribution of cases during the winter seasons. Furthermore, this age group contributed to a large proportion of cases in the winter season of 1998–1999, preceding a 30-year record high of 238 cases that was reported during calendar year 1999. It appears that the contribution of cases by this age group could be influencing the 3–4 year cyclical rise in cases evidenced in LAC since 1997.

In addition, all older age groups are not of equal importance in the current epidemiology of LAC pertussis. The 25+ and 5–14 age group seasonal increases may be driving pertussis incidence among the most severely affected age groups, as has been reported in previous studies. This finding can't be explained as parents and siblings transmitting the infection to infants since there is no reported evidence. Vaccinating adults and teenagers in order to maintain herd immunity in the community could be a cost-effective approach; an adult vaccine is currently being investigated for selective use in the United States.

Several factors were ruled out that could have artificially elevated the number of reported cases in the 2001–2002 winter season and into 2002. First, no changes in testing or the vaccination schedule were adopted and no intervention activities were performed during one year prior to and during this period. In addition, vaccine shortages were experienced nationally from the last quarter of 2000 through the second quarter of 2002. However, the interim schedule would not have put any children at risk of contracting pertussis, and the majority of providers in LAC did not have to adopt the schedule. Other than the 1995 institution of the epidemiological linked case, which could possibly have contributed to the misclassification of pertussis cases ever since, there have been no changes in the case definition prior to the 2001–2002 winter season.

More research is needed in order to identify etiologic factors for the proportion of cases in the 5–14 age group. Information is needed on the social network patterns of age groups by incorporating active surveillance activities (e.g., active screening projects during the winter season at specific sites/schools looking for contacts to pertussis cases outside of the household). The most important finding that this study addresses is that this complicated epidemiology of pertussis in LAC would not have been discovered if surveillance data had only been analyzed by calendar year, which is the standardized time measure public health epidemiologists employ to identify trends in surveillance data.

REFERENCES

1. Farizo KM, Cochi SL, Zell ER, Patriarca PA, Wassilak SCF, Brink E. Epidemiologic features of pertussis in the United States, 1980-1989. Clin Infect Dis 1992; 14:708-719.
2. Fine PEM, Clarkson, JA. Seasonal influences on pertussis. International Journal of Epidemiology 1986;15(2): 237-247.
3. Department of Health and Human Services Centers for Disease control and Prevention. Epidemiology and Prevention of Vaccine-Preventable Diseases 2002; 7th Edition: 58-70.
4. Centers for Disease Control and Prevention. Pertussis—United States, 1997-2000. MMWR February 1, 2002;51(4):73-76.