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CHILDHOOD PERTUSSIS IMMUNIZATION STATUS AS REPORTED BY PARENTS AND THE COMPLETENESS OF PUBLIC-HEALTH AND PHYSICIAN RECORDS IN NOVA SCOTIA

Introduction

Recent outbreaks of pertussis in Canada have focused the attention of the public-health community on reports of low whole-cell vaccine efficacy[1-5], and subsequently on the possibility of inadequate immunization among children. An accurate assessment of immunization status is essential for studies of vaccine performance, but may be a challenge without reliable immunization records. Important considerations for selecting a source of immunization information include the validity, completeness, and accessibility of the data to be collected. In the absence of a central immunization data bank, retrospective studies of vaccine coverage are often based on multiple sources of information which include interviews with caregivers (most often parents), and reviews of immunization records maintained by physicians, public-health departments, or schools.

In some instances[6-8], immunization histories of children obtained from their caregivers have been reported as incomplete and inaccurate; however, little has been reported in Canada about the quality of immunization data. This was examined in a multi-phase study implemented in 1995 to investigate an outbreak of pertussis in Nova Scotia that occurred from July to December 1994. The study was a collaborative effort by the Nova Scotia Department of Health, the Izaak Walton Killam (IWK)-Grace Health Centre, and the federal Laboratory Centre for Disease Control. This report addresses one of the study objectives — to assess the availability and reliability of pertussis immunization data in Nova Scotia. Results are presented below on the validity of pertussis immunization histories given by parents, the completeness of immunization records, and estimated pertussis vaccine coverage among children 2 months to 10 years old.

Methods

Selection of subjects

Data presented were collected from a sample of 872 children who had been selected for potential enrolment in one of the two primary phases of the overall study (based on case-control study designs). The eligibility criteria for inclusion in the study were residence in the Halifax-Dartmouth region and an age of < 10 years during the outbreak period. Informed consent was obtained from parents prior to enrolment. The IWK Research Ethics Board approved the study protocol.

Data collection

Childhood immunizations in Nova Scotia are routinely provided by physicians who maintain individual immunization records. In addition, each health region of the Nova Scotia Department of Health maintains manual records of immunization for children residing in the region. Since there was no prior knowledge of which record-keeping system would provide more complete data, data were collected from parents (or legal guardians) as well as from public-health and physician records.

Information from parents was collected through telephone interviews conducted by a team of trained nurses using a standardized questionnaire. Close to 97% of the interviews were conducted with the mother. Parents were asked if their children had received vaccinations against whooping cough, and if their children had received all whooping cough vaccinations required for their ages. Information was collected from each parent about the source of information on immunization (memory only, a written record or both), dose-by-dose information about pertussis vaccines, and the primary immunization provider(s) for the each child. Public-health records were reviewed when a parent did not provide the appropriate number of vaccine doses for the child's age or when information was not provided from a written record at home. Similarly, physician records were reviewed when the first two stages in data collection did not yield the number of vaccine doses appropriate for age. To validate parental immunization histories, reviews of public-health and physician records were conducted for a random sample of 88 children among the 333 children whose parents reported a written record as a source of immunization data.

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Age-appropriate pertussis immunization was defined according to the provincial schedule of immunization at 2, 4, 6, and 18 months with a booster dose at 4 to 6 years of age, which is based on recommendations of the National Advisory Committee on Immunization[9]. At each stage of data collection, a *data-retrieval rate* was defined as the proportion of subjects with missing or incomplete records after the preceding stage(s), and for whom the appropriate number of vaccine doses were obtained.

Results

Demographics

The study subjects ranged in age from 2.8 months to 10 years and 6 months. The sample of 88 children, on whom validation of information obtained from parents was based, did not differ significantly from the rest of the study population with respect to age (mean $\pm$ S.D. of 5.3 $\pm$ 2.8 years versus 5.0 $\pm$ 2.6 years, respectively; 2-tailed p value = 0.31). However, there was a difference in gender distribution: 64% females in the validation sample compared to 51% in the rest of the group ($x^2 = 4.95$, $p = 0.03$).

Type and source of immunization data

Approximately 97% of the immunization doses were recorded as a quadrivalent vaccine of pertussis antigen combined with adsorbed diphtheria and tetanus toxoids, and inactivated polio. Approximately 3% were recorded as a pertussis, diphtheria, and tetanus vaccine. The quadrivalent vaccine combined with *Haemophilus influenzae* b (used in Nova Scotia since April 1994) and monovalent pertussis vaccine were each recorded for < 0.1% of doses. For 10 subjects, one or more doses were recorded as a vaccine that did not include a pertussis antigen. These doses were included in the validation of immunization data, but were omitted from the analysis of vaccine coverage since they constituted missed pertussis doses.

Parents reported available written records at home for 333 (38.0%) of the 872 children and no records for 539 (62.0%) children. The *data-retrieval rate* by parental interview was significantly higher when parents used written records (69.4% of 333 children) than when they relied on memory only (4.0% of 539 children); ($x^2 = 426$, $p < 0.001$). Comparable *data-retrieval rates* were obtained for public-health records (37.6%) and physician records (32.9%) when data were incomplete or missing from a preceding stage. However, the overall *data-retrieval rates* (i.e. including the records reviewed for validation) were 54.5% for the review of public-health records (n = 539), and 42.7% for review of physician records (n = 443, $x^2 = 13.7$, $p < 0.001$).

Overall, complete age-appropriate immunization data were obtained for 148 (17.0%) subjects from parental sources only, and for 456 (52.3%) subjects from public-health and/or physician records irrespective of parental sources. Immunization data were incomplete for age from the three sources for 243 (27.9%) subjects and unavailable for 25 (2.9%) subjects.

Physician records were the most reliable source of information on dates of immunization, with complete dates recorded for 98.4% of documented immunizations compared to 88.1% in public-health records and 84.1% of immunizations reported by parents. Almost all public-health records (96.0%) and physician records (93.0%) did not document specific lot numbers for vaccines administered. Information on lot number was not sought during parental interviews.

Validation of immunization histories reported by parents

Parents reported some pertussis immunization for 764 (87.6%) children, no immunization for 25 (2.9%), and an unknown status for 83 (9.5%). Of the 764 children whose parents believed that they had received some pertussis immunization, 97% had vaccine-specific data (from parental sources or record reviews) to confirm immunization. Data on one or more pertussis doses were also obtained for 96% of those children whose parents said that they had not received any pertussis vaccine, and for 95% of those whose parents were not sure. Among the 764 children reported to have received some immunization, the immunization status was reported as complete for age for 747 (97.8%) children, incomplete for 16 (2.1%), and unknown for one (0.1%). Parents were able to provide data supporting age-appropriate immunization for only 31% of the 747 children, but supporting data were obtained for approximately 72% from the three sources of information.

As with the entire study population, *data-retrieval rates* for the validation sample of 88 children were comparable for public-health records (38.6%) and physician records (39.8%) but were much lower than parental information from written records (65.9%). Table 1 shows the agreement in data from all sources, irrespective of the type of pertussis vaccine reported. In general, agreement was highest between parental data and public-health records, and lowest between public-health records and physician records. Agreement among the three sources was higher when compared on single doses than for the full series of five doses. Also, agreement was higher for the fifth dose of vaccine than for preceding doses. Validation of specific pertussis vaccines showed only slight differences from these results and the trends remained as described (results not presented).

Table 1
Concordance on dose-specific pertussis immunization information from three sources for validation sample of 88 children

Dose number in series	Percent of subjects with agreement on dose-specific vaccination between:		
	Parental data[a] and public-health records	Parental data and physician records	Public-health and physician records
1	79.5	55.7	42.0
2	79.5	63.6	45.5
3	73.9	63.6	42.0
4	70.5	73.9	51.1
5	92.0	78.4	72.7
All doses	45.5	**37.5**	**23.9**

[a] Parental data from a written record.

The overall correlation of immunization status between information obtained from parents and record reviews was 77.3%. However, in all age groups, there were moderate to large differences between the estimates derived from the three sources (Table 2). Public-health records and physician records produced much lower estimates of age-appropriate immunization (42.0% and 40.9%, respectively for children ≥ 6 months) than parental information with written records (68.2%). Thus, information from parents was the single best source of documented age-appropriate immunization in this study.

Immunization status of study population

Only 67.6% of children aged 18 months to < 4 years (n = 250) had received the recommended number of doses. Age-appropriate immunization was higher in the other age groups, but the levels were still less than optimal. Only 74.7% of children aged 6 months to < 18 months (n = 75), 77.0% of children aged 4 years to < 6 years (n = 231), and 77.6% of children aged ≥ 6 years (n = 304) were appropriately immunized for their ages.

Discussion

When interviewed, almost two-thirds of the parents in this study had no written vaccination record at home for children enrolled in the study. The availability of a written record increased the likelihood of obtaining immunization information, particularly information to confirm age-appropriate immunization. In general, parents were well informed as to whether their children received any pertussis immunization but were less accurately informed about the completeness of their immunization. This suggests potential underestimation of immunization coverage of children when based solely on undocumented information from parents. It is important to note that almost all interviews with parents were conducted with the mother; therefore, the information from that source could be expected to be as reliable and complete as possible.

Parents with access to documentation provided more current information than that obtained from public-health or physician records. It is possible that written records kept by parents are updated from both public-health and physician records as opportunities arise, whereas the latter two records are not checked against each other. Inconsistency in data could also be due to lapses in record-keeping, possibly because of changes in residence or changes in the providers of immunization services. The higher agreement in data for the fifth dose suggests greater regard for documenting that vaccination, possibly because of a perceived requirement for school entry. Although there is no legislated provincial immunization requirement, it was not clear whether some schools may have requested a minimum level of coverage for school entry. The incompleteness of data was further compounded by a lack of documented vaccine administration dates and lot numbers which are particularly relevant for accurate monitoring and reporting of vaccine-associated adverse events.

It should be noted that although written records available to parents in this study appeared to be more comprehensive, only 77% of the data provided from that source was validated by public-health records or physician records. Thus, all three sources of information were required to ensure maximum reliability of immunization data for the overall study. The Nova Scotia Department of Health is developing plans for a central, computerized system for immunization records that will monitor coverage and also provide feedback to public-health officials, health-care providers, and individuals receiving immunization. Such a system will present opportunities for health-care providers to assess immunization status, and to administer catch-up doses when appropriate and as recommended for pertussis outbreak control[10].

Despite the comprehensive review of immunization data in this study, less than sub-optimal coverage against pertussis for children < 10 years old was found in Nova Scotia: the lowest level recorded was in the 18- to 47-month age group, which suggests that the fourth dose is the one most likely to be delayed. Local studies should be encouraged in jurisdictions with similarly underimmunized populations to determine the major risk factors for immunization delays or non-compliance. Such studies should help to focus attention on improving dose-specific as well as overall vaccination levels.

Table 2
Concordance on age-appropriate pertussis immunization (AAI) information from three sources for validation sample of 88 children

Age in months	Percentage of subjects with documented AAI				Percent difference in estimates between:	
	Parental data[a]	Public-health records	Physician records	All sources combined	Parental data and public-health records	Parental data and physician records
6-17	75.0	0.0	62.5	87.5	-75.0 **	-12.5
18-47	60.0	24.0	40.0	60.0	-36.0 **	-20.0
48-71	75.0	50.0	37.6	75.0	-25.0	-37.4 *
72+	69.2	59.0	38.5	79.5	-10.2	-30.7 **
All	**68.2**	**42.0**	**40.9**	**73.9****	**-26.2****	**-27.3**

[a] Parental data from a written record.
* p value < 0.05 on x^2 test; Fisher's exact test used for expected cell values < 5.
** p value < 0.01 on x^2 test; Fisher's exact test used for expected cell values < 5.

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