COMPARISON OF THE NIS AND NHIS/NIPRCS ESTIMATION METHODS

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1. Introduction

Vaccines have been declared one of the Top 10 Public Health Achievements of the 20th Century [1] and have been responsible for the global eradication of smallpox and elimination of wild-virus poliomyelitis from the Americas. Although the morbidity of vaccine preventable diseases is at an all time low [2], outbreaks of vaccine preventable diseases continue in unvaccinated populations [3]. Between 1989-1991, over 55,000 cases of measles resulting in 123 deaths occurred in the United States [4], mainly affecting unvaccinated, preschool-aged children living in large urban centers [5]. During the measles outbreak, it was determined that adequate tools for monitoring vaccination coverage levels in the United States were lacking.

In order to measure immunization coverage levels for the U.S., as well as monitor progress towards reaching the Healthy People 2000 objective of 90% of children receiving all recommended vaccines by their second birthday, an immunization supplement was added to the National Health Interview Survey (NHIS) in 1991 [6]. The National Immunization Provider Record Check Study (NHIS/NIPRCS) which verifies with the health provider the immunization histories of children 19-35 months of age included in the NHIS, was introduced in 1994. The National Immunization Survey (NIS) was introduced in April, 1994. The NIS measures vaccination coverage levels of pre-school children in 78 Immunization Action Plan (IAP) areas including the 50 States, the District of Columbia, and 27 selected urban areas.

This paper briefly describes the methods for conducting both the NHIS/NIPRCS and NIS, describes differences in estimation methods used for determining childhood immunization coverage levels, and explores the feasibility of applying a variant of the NHIS/NIPRCS Best Values estimation method to the NIS.

2. NHIS/NIPRCS Methods

The NHIS/NIPRCS is a component of the NHIS. The NHIS is a cross-sectional, household, face-to-face interview of the civilian, non-institutionalized population of the United States. Since 1991, the NHIS includes immunization-related questions in order to produce national vaccination coverage estimates of children less than six years of age. During the immunization section of the NHIS, the respondent can choose to report from the child's written vaccination record all immunizations (type and date) received, or the respondent can report from memory the number of doses ("all" is an acceptable response) of each immunization the child received. The NHIS/NIPRCS was added to the NHIS in 1994 to reduce response bias associated with reporting immunizations from memory and the over- and under-reporting of vaccinations associated with written vaccination records [7]. For each data collection year, provided that consent was obtained from the respondent, immunization histories of children 19 through 35 months of age collected during the NHIS interview were compared with the health provider(s) vaccination report. Approximately 2,500 children aged 19-35 months complete the immunization supplement in the NHIS and are included in the NHIS/NIPRCS.

The NHIS/NIPRCS is conducted in three phases: the original provider survey; the non-response follow-up survey (NRFUS); and reconciliation. The original provider survey consists of mailing an immunization history questionnaire (IHQ) to the providers identified during the NHIS interview. The IHQ is a two-page survey which collects information on the date and type of each vaccine the child received as well as characteristics of the provider. Typically, 50% of the respondents who complete the immunization section of the NHIS give written consent to contact their child's immunization provider. The NRFUS consists of contacting respondents from the NHIS who did not previously give consent or did not provide adequate information to locate their child's immunization provider. Once consent and provider information are obtained from the respondent, an IHQ is sent to the identified provider(s). On average, 55% of children included in the NRFUS end up with provider-verified immunization histories. After all of the IHQ's are completed, the provider-reported immunization record for the child is compared to the parent-reported record. If any differences exist (e.g. household reports more immunization dates than the provider), then the parent and/or the provider is contacted to reconcile the discrepancy.

The simplest estimation method for NHIS/NIPRCS assumes the provider data are the truth, thus producing provider-adjusted estimates. Another estimation procedure used in the NHIS/NIPRCS uses both the provider and the household information to measure immunization coverage. Provider and household immunization records are compared and one record is chosen to be the most "complete". The complete record is then used to assign Best Values for the number of doses of vaccine the child received. The following rules are used to determine which record should be used for assigning the Best Values. If the household reported immunizations from memory, or if the provider reported more doses than the household record, or if the provider reported the child as up-to-date (UTD) for all vaccines, the provider report was used for assigning Best Values. If the household used a written record and reported the child as 4:3:1:3 (4 or more doses of diphtheria and tetanus toxoids and pertussis vaccine or acellular pertussis vaccine (DTP/DtaP), 3 or more doses of Polio vaccine, 1 or more dose of measles containing vaccine (MCV), and 3 or more doses of *Haemophilus influenzae* type b vaccine (HIB)) UTD and the provider record did not, or if the household used a written record and reported the child as 4:3:1:3 UTD and gave permission to contact the provider but the provider did not respond with immunization information, then the household record was used for assigning Best Values. Because not all children in the NHIS/NIPRCS sample are assigned Best Values (due to missing provider data or the household not using a shot card), the weights of the children with Best Values are adjusted to account for the children without Best Values. The impact that the Best Value method has on immunization coverage has been previously documented [8] and is also illustrated in Table 1. In 1996, the Best Value method increased the estimated immunization coverage by 1.5-2.3 percentage points.

Table 1. Estimated immunization coverage levels by source of immunization information for individual vaccines and vaccine series for children 19-35 months of age, 1996 National Immunization Provider Record Check Survey.

Vaccine	Provider Estimate (%)	Best Value Estimate (%)	Difference
4+ DTP	81.7	83.4	1.7
3+ Polio	91.3	93.4	2.1
1+ MCV	90.9	92.4	1.5
3+ HIB	92.0	94.0	2.0
3+ Hepatitis B	81.0	83.3	2.3
4:3:1	79.9	81.8	1.9

3. NIS Methods

The CDC-sponsored NIS also estimates vaccination levels for children 19 through 35 months of age in the United States [9]. Since April, 1994, the NIS data collection effort has conducted independent quarterly surveys in each of the 78 IAP areas. With this design, any four consecutive quarters of survey data can be combined to produce comparable annualized national estimates of vaccination coverage levels for the U.S., and in each of the 78 IAP areas.

The NIS annually collects immunization data on approximately 34,000 children from two complementary sources-a telephone survey of the eligible households and a mail survey of immunization providers identified by the household respondents. For the household survey, the NIS employs a list-assisted random-digit-dialing (RDD) sample design [10].

After screening a household for eligible children, an immunization interview is conducted with the adult in the household who is the most knowledgeable about the vaccination history of the child. For each eligible child in the target age range, the interviewers collect data on sociodemographic characteristics, immunization history of individual vaccines from a parent or guardian, date of birth, vaccine administration dates and/or numbers of vaccination events.. Household respondents are encouraged to use the written vaccination records (shot cards) to enhance the accuracy of the reported data, but reports from memory are accepted. Respondents are also asked for names and addresses of immunization providers, and for verbal permission to contact these providers to obtain immunization data from the child's medical records.

Immunization providers are the second source of information. All vaccination providers are contacted by mail and asked to complete an IHQ. Providers who do not respond to the initial request are mailed a second questionnaire and, if necessary, telephoned in order to increase provider participation in the survey.

Each completed IHQ is edited. Editing procedures include consistency checks (for example, comparing dates of birth with dates of vaccinations) and coding verbatim responses of shots (brand and generic names) into a classification of vaccines. Data entry procedures include 100% verification.

The NIS Provider Record-Check (PRC) program then compares the IHQs with the household report of vaccination status. The PRC program is largely an automated process for determining the quality and completeness of the provider vaccination data obtained for a child. Children may have one or more providers who return the IHQ. Disposition codes were developed to summarize the amount of provider data obtained for each child (that is, a response was

received from all or only some of the providers listed by the household respondent), the household respondent's use of a shot card or reliance on recall during the telephone interview, and the agreement of all provider and household dates.

Recently, the automated PRC procedures were augmented with manual review of specific household/provider matching sheets. Matching sheets display the household and provider(s) report of number of doses and vaccination dates, along with other identifying information. Matching sheets are reviewed for children who have: 1) date of birth, name or gender differences between the provider and household report; 2) date of birth differences between responding providers; 3) vaccination dates listed before the date of birth of the child; and 4) vaccination dates within a series that are less than 30 days apart. The matching sheet review is designed to: 1) improve the accuracy of the provider-reported number of doses and vaccination dates; 2) identify IHQs that were filled out for the incorrect child; 3) resolve issues related to the age eligibility of the sample child. After making edits to the IHQ and other data, the NIS PRC edit program is rerun and a final determination of whether each child has usable provider data for use in estimation is made. A description of the quality of the provider data collected in the NIS has been described elsewhere. [11]

Currently, in the NIS, provider data only are used to produce the weighted national, state, and IAP area vaccination coverage rates for a 4-quarter time period. The NIS weighting estimation methodology has been designed to adjust vaccination coverage estimates for provider non-response bias [12].

4. Applying Best Value Construction to NIS

As noted above, the NHIS/NIPRCS uses the results of the reconciliation and non-response follow-up to make an assessment of whether the household or provider report of the number of doses is more complete. For many children, the provider is used as the best value number of doses. In the NIS, there is interest in constructing not only Best Value number of doses but also Best Value vaccination dates. The procedures used in NHIS/NIPRCS cannot be directly applied to the NIS, because the NIS does not conduct reconciliation and non-response follow-up procedures. The NIS does, however, have the PRC edit procedures in place to assess and improve the accuracy of the provider-reported vaccination data. Furthermore, for those households that use a written vaccination record during the telephone interview, we do have an alternative set of vaccination dates for use in Best Value construction.

The construction of Best Value vaccination dates under investigation for the NIS would divide children with provider data into three main groups:

1. HH_UTD: children with provider data who are UTD on a vaccine as reported from a household vaccination record but are not UTD on that vaccine according to the provider data;
2. HEPB_BOX: children with provider data who are not UTD on Hepatitis B because the birth dose of Hepatitis B was not reported but the "Given at birth" check-off box on the IHQ was checked;
3. PROV_OK: all remaining children with provider data.

Household/provider matching sheets will be used to assign Best Value shot dates for children with provider data. For the HH_UTD group, matching sheets will be examined to determine which vaccination date(s) were not reported by the provider but appear in the household written vaccination record. Those "missing" vaccination dates will then be added to the provider-reported vaccination dates to form the Best Value shot dates for the child.

Due to the unique schedule of the Hepatitis B vaccine (the first dose is typically given at birth in the hospital), special considerations were made for the construction of Best Values. The HH_UTD group with provider data includes children for whom the household record shows a Hepatitis B vaccination given at birth but this vaccination date does not appear in the provider report. In this situation, the household reported date of vaccination would be added to the provider-reported vaccination dates. The HEPB_BOX group covers the situation where the household did not use a written vaccination record for the telephone interview but the provider IHQ indicates that a Hepatitis B vaccination was given at birth although no date is recorded on the IHQ. For these children, the date of birth of the child can be used to assign the date of the birth dose of Hepatitis B for Best Value construction purposes. For children with provider data included in the third group, the provider vaccination dates will be used as the Best Value dates.

Among children without provider data, one group (NO_PROV) is proposed for examination for Best Value construction. The NO_PROV group consists of children for whom verbal consent to contact providers was received but no providers responded with any vaccination data and the child was reported to be 4:3:1:3 UTD from a written record in the telephone interview.

The NO_PROV group is different from the previously named groups because no provider data were obtained. Empirical results from the NHIS/NIPRCS and NIS show that when a child is reported as being 4:3:1:3 UTD from a written vaccination record, over 90% of those children are 4:3:1:3 UTD according to the provider data. Therefore,

we have confidence that use of the household vaccination record to assign Best Value vaccination dates for these children will result in reasonably accurate Best Values.

5. Preliminary NIS Best Values Results

Of the 34,442 NIS interviews completed in 1999, 65% of the children had usable provider data (range by IAP area 52% - 78%). Nationally, 9% of the children with usable provider data were included in the HH_UTD group for Best Value construction. The change in 4:3:1:3 series coverage estimates based on the Best Values constructed for the HH_UTD group can be seen in Table 2. The increase in 4:3:1:3 series coverage for the nation was 3.5 percentage points. Connecticut had the lowest increase in coverage (0.3 percentage points) while Detroit had the highest increase (6.8 percentage points).

6. Summary

Given the large size of the NIS and the need for timely estimates of vaccination coverage, the NIS has no plans at this point to employ NHIS/NIPRCS reconciliation and non-response follow-up procedures. The use of household/provider matching sheets is, however, expected to result in reasonably accurate assignment of Best Value shot dates because, for many children, it supplements the provider data with the written household report of vaccination dates. The reliance on the household written vaccination report leads to some limitation in the proposed NIS best value construction. For example, overall shot card use is approximately 50% for any given four quarter period and it varies considerably across the IAP areas. The size of the HH_UTD group in an IAP area with high shot card use can potentially be larger than the size of the HH_UTD group in an IAP area with low shot card use. The same holds true for the NO_PROV group. Prior to adaptation of a Best Values methodology in the NIS, evaluation will be undertaken to examine vaccination coverage rates before and after Best Value construction at the IAP area level in order to assess the impact of Best Value construction on IAP area and state level estimates of vaccination coverage.

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Table 2. Preliminary results of the change in estimated immunization coverage levels for the 4:3:1:3* series upon creation of Best Values for Group 1 children with provider data, 1999 National Immunization Survey

State/IAP Area	Provider Estimate	Best Value Estimate	Difference	State/IAP Area	Provider Estimate	Best Value Estimate	Difference
U.S. Total	78.4	81.9	3.5	Mississippi	81.7	83.7	2.0
Alabama	78.4	81.4	3.0	Missouri	75.0	79.6	4.6
Jefferson Cnty	85.2	87.3	2.1	Montana	82.5	85.3	2.8
Alaska	80.1	82.0	1.9	Nebraska	81.8	84.8	3.0
Arizona	72.4	77.6	5.2	Nevada	73.1	78.7	5.6
Maricopa Cnty	71.0	76.0	5.0	New Hampshire	84.5	86.5	2.0
Arkansas	77.1	79.3	2.2	New Jersey	80.8	83.3	2.5
California	75.3	80.7	5.4	Newark	66.5	72.4	5.9
Los Angeles Cnty	76.0	80.6	4.6	New Mexico	73.0	79.2	6.2
Santa Clara Cnty	81.8	86.3	4.5	New York	81.0	84.1	3.1
San Diego Cnty	74.5	80.1	5.6	New York City	78.3	83.2	4.9
Colorado	75.8	78.3	2.5	North Carolina	81.8	86.4	4.6
Connecticut	85.9	86.1	0.2	North Dakota	80.4	85.0	4.6
Delaware	78.2	80.1	1.9	Ohio	78.1	80.0	1.9
Dist. of Columbia	77.5	79.2	1.7	Cuyahoga Cnty	73.5	76.1	2.6
Florida	80.3	82.9	2.6	Franklin Cnty	77.9	81.4	3.5
Duval Cnty	77.7	80.4	2.7	Oklahoma	72.9	78.7	5.8
Dade Cnty	84.0	85.4	1.4	Oregon	72.3	74.9	2.6
Georgia	81.9	82.5	0.6	Pennsylvania	86.0	88.7	2.7
Fulton/Dekalb Cnties	83.4	85.6	2.2	Philadelphia	81.3	85.8	4.5
				Rhode Island	87.4	90.8	3.4
Hawaii	81.6	83.4	1.8	South Carolina	80.6	83.5	2.9
Idaho	69.4	75.0	5.6	South Dakota	81.7	86.2	4.5
Illinois	77.4	81.9	4.5	Tennessee	77.7	81.1	3.4
Chicago	71.4	76.5	5.1	Shelby Cnty	75.0	79.4	4.4
Indiana	74.3	78.2	3.9	Davidson Cnty	73.3	75.5	2.2
Marion Cnty	79.1	81.5	2.4	Texas	72.4	76.2	3.8
Iowa	83.4	86.1	2.7	Dallas Cnty	71.6	76.7	5.1
Kansas	78.9	84.1	5.2	El Paso Cnty	72.7	77.9	5.2
Kentucky	87.6	88.7	1.1	City of Houston	63.3	69.5	6.2
Louisiana	76.8	80.0	3.2	Bexar Cnty	69.9	75.6	5.7
Orleans Parish	71.5	77.1	5.6	Utah	80.2	83.3	3.1
Maine	82.9	84.9	2.0	Vermont	90.5	92.3	1.8
Maryland	79.4	82.1	2.7	Virginia	80.3	84.0	3.7
Baltimore City	71.9	73.8	1.9	Washington	74.9	79.3	4.4
Massachusetts	85.2	88.0	2.8	King Cnty	77.4	81.4	4.0
City of Boston	83.6	86.6	3.0	West Virginia	81.0	83.6	2.6
Michigan	74.4	77.8	3.4	Wisconsin	84.5	87.0	2.5
Detroit	66.4	73.2	6.8	Milwaukee Cnty	74.1	76.6	2.5
Minnesota	85.2	87.9	2.7	Wyoming	82.8	84.2	1.4

*4:3:1:3 is defined as 4 DTP, 3 Polio, 1 MCV, and 3 HIB.