METHODOLOGY OF THE NATIONAL IMMUNIZATION SURVEY

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This presentation describes the methodology of the National Immunization Survey (NIS) in layman's terms. The NIS is a CDC survey. Staff from the National Immunization Program and the National Center for Health Statistics designed and oversee the NIS. The contractor, Abt Associates, collects the data and plays a major role in calculating the estimates of vaccination coverage. The target population for the NIS is all noninstitutional children in the U.S. 19 to 35 months of age. The NIS covers the following individual vaccinations and vaccination series:

    DTP
    Polio
    Measles-Containing Vaccine (MCV)
    MMR
    Hib (*Haemophilus influenzae* type b)
    Hepatitis B
    Varicella (starting July 1996)
    4:3:1 (4+ DTP, 3+ Polio, and 1+ MMR)
    4:3:1:3 (4+ DTP, 3+ Polio, 1+ MMR, and 3+ Hib)
    3:3:1 (3+ DTP, 3+ Polio, and 1+ MMR).

The NIS covers all 78 Immunization Action Plan (IAP) areas. These include 28 urban areas. Quarterly telephone surveys are conducted in each IAP area. The first quarter was April 1994-June 1994. The NIS is intended to run at least through October 1998-December 1998.

The NIS has two key data collection components:

  I. <u>Household Telephone Survey</u>

      1) Random-digit-dialing sample (includes households with unlisted numbers)
         Specific RDD procedure is called list-assisted RDD
         Banks of 100 consecutive telephone numbers with no residential directory-listed telephone numbers are removed from the sampling frame.
         110 completed child interviews/IAP area/quarter.

      2) Screen to identify households that have a child 19-35 months of age (about 4% of households in the U.S.).

      3) Detailed interview for each child:
         Vaccinations (from "shot card" if possible)
         Demographic information on child and mother
         Name/address of providers of vaccinations
         Verbal consent to contact providers.

  Selected pages of the NIS questionnaire are included in the appendix.

II. Provider Record Check Survey

       Mail Survey
        Provider lists all vaccinations for child
        Indicates type of facility (e.g., private practice).

The first page of the provider record check form is included in the appendix.

For the estimation of vaccination coverage, the two main objectives of the NIS are to:

Estimate the percentage of children up-to-date in each of the 78 IAP areas (for each consecutive 4-quarter period).

Use the same methodology in all IAP areas to yield comparable estimates.

The formation of NIS estimates of vaccination coverage for a four-quarter period involves several steps. The initial steps yield weights that are used to form estimates for each IAP area.

1) For a given quarter, calculate base sampling weight for each IAP area (total number of telephone numbers in an IAP area divided by the number of sample telephone numbers in that IAP area). The base sampling weight is then adjusted for households with multiple phone lines and to account for unit nonresponse. The final base sampling weight allows for generalizations only to the population of children in households with telephones. The NIS, however, is interested in generalizing to all noninstitutional children in each IAP area.

2) Use Vital Statistics data on births in each IAP area, adjusted for immigration, migration and deaths, to make the weighted NIS four-quarter samples closely resemble the Vital Statistics population totals by race, Hispanic origin, education of mother, and age of child. This process, simple poststratification, aims to adjust for unit nonresponse and also to account for nontelephone children. Table 1 shows an example of simple poststratification.

The first problem that the NIS faces is accounting for children who live in households without telephones (12% of U.S. children live in households without telephones). The National Health Interview Survey (NHIS) indicates that telephone and nontelephone children differ considerably in terms of their vaccination coverage.

      1992 NHIS: nontelephone -- 44% with 4+ DTP versus telephone -- 61% with 4+ DTP .

A telephone survey will, therefore, tend to overestimate vaccination coverage levels. The degree of overestimation varies considerably among the 78 IAP areas, because as few as 2% and as many as 25% of children live in nontelephone households. Furthermore, the NHIS indicates that nontelephone and telephone children differ in vaccination coverage, even within the poststratification cells described above. This provides strong evidence that simple poststratification does not adjust very completely for the exclusion of nontelephone children from the NIS.

The solution to this problem was to develop a weighting method called modified poststratification that allows the sample to be generalized to all children in an IAP area. The basic idea is to use independent information on the vaccination coverage of telephone and nontelephone children to split each simple-poststratification cell into two subcells -- 4:3:1 up-to-date and not 4:3:1 up-to-date. The weights of the children in a given poststratification cell are then adjusted separately for the up-to-date and not up-to-

date children. Because nontelephone children are more likely to not be up-to-date, the modified-poststratification weights of the not-up-to-date children in a poststratification cell will tend to be increased, relative to the modified-poststratification weights of the up-to-date children.

For a given poststratification cell, the NHIS can provide the national 4:3:1 up-to-date (UTD) ratio for nontelephone versus telephone children (e.g., 40% / 50% = 0.80). From the 1990 Census we know the percentage of children in the IAP area in a given poststratification cell that live in telephone households (e.g., 70%). From the NIS we have an IAP-area estimate (using the base sampling weight) of the percentage of telephone children in the poststratification cell who are 4:3:1 UTD (e.g., 60%). Table 2 illustrates the calculation for a poststratification cell using hypothetical data.   The modified-poststratification weight is used in calculating the vaccination coverage estimates published in the MMWR.

The 1994 NHIS indicated that there is substantial response bias in household (parental) vaccination reports. The second major problem, therefore, faced by the NIS relates to parental reports that often contain errors because of 1) faulty recall or 2) incomplete shot cards. Table 3 gives an indication of the reporting errors in the parental reports of 4:3:1:3 up-to-date status of their children.

The solution developed for the NIS is to collect vaccination information from providers for as many NIS children as possible. Currently, valid provider data are obtained for about 65% of the NIS children. Before using the provider responses, we go through a detailed procedure to assess the validity of the provider information for each child. We then combine household data and provider data to obtain provider-adjusted estimates of vaccination coverage for each IAP area. The provider-adjusted estimates use the household report on 4:3:1:3 UTD status to classify all children in an IAP area into 5 categories:

1. Shot card, 4:3:1:3 UTD
2. Shot card, Not 4:3:1:3 UTD
3. Recall, 4:3:1:3 UTD
4. Recall, Not 4:3:1:3 UTD
5. Don't Know (D.K.) whether 4:3:1:3 UTD.

Within each of these categories, we use the provider data to estimate the proportion of children who are up-to-date on a specific vaccination or series. Table 4 gives an example of the calculation of the provider-adjusted coverage estimate for 3+ Polio up-to-date.

The provider-adjusted percentage for 3+ Polio up-to-date is 87.3%. By contrast, the estimate based only on the household report is 76%. The use of the provider and household reports leads to much more accurate estimates of vaccination coverage than the households' reports alone. In general, the lack of provider data leads to substantial underestimates of vaccination coverage.

The NIS data are used to form four-quarter annualized estimates of vaccination coverage. Shown below are the NIS quarters for 1995 and 1996.

<div align="center">

NIS Quarters

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| Q1/1995 | Q2/1995 | Q3/1995 | Q4/1995 |
| Q1/1996 | Q2/1996 | Q3/1996 | Q4/1996 |

These eight quarters can be used to form five NIS four-quarter vaccination coverage estimates:

1. Q1/95 to Q4/95
2. Q2/95 to Q1/96
3. Q3/95 to Q2/96
4. Q4/95 to Q3/96
5. Q1/96 to Q4/96

The NIS is also used to measure and assess changes in vaccination coverage over time. For example one can compare Q1/96 to Q4/96 with Q1/95 to Q4/95. The next step is to determine whether the difference between the two time periods is statistically significant.

One can also examine the pattern of all four-quarter annualized estimates to see whether vaccination coverage shows a trend. The four graphs in Table 5 give four different examples of vaccination coverage trends.

It is hoped that this presentation of the key aspects of the NIS methodology has given users of the survey results a better understanding of how the NIS works. The NIS is an important tool for measuring vaccination coverage trends for the nation, the 50 states, and the 78 IAP areas. The use of the same methodology in all 78 IAP areas provides estimates that are comparable across all areas.

References for further information:

Battaglia, M., Malec, D., Spencer, B., Hoaglin, D., and Sedranak, J., "Adjusting for Noncoverage of Nontelephone Households in the State and Local Immunization Coverage and Health Survey," 1995 Proceedings of the Section on Survey Research Methods, American Statistical Association.

Centers for Disease Control and Prevention, "Sample Design and Procedures to Produce Estimates of Vaccination Coverage in the National Immunization Survey," Unpublished memorandum, National Immunization Program, April 18, 1996.

Ezzati-Rice, T., Zell, E., Battaglia, M., Ching, P., and Wright, R., "The Design of the State and Local Area Immunization Coverage and Health Survey," 1995 Proceedings of the Section on Survey Research Methods, American Statistical Association.

Table 1: Example of Simple Poststratification

Cell	Weighted NIS Sample (using base sampling weight)	Vital Statistics Count	Adjustment Factor	Weighted NIS Sample after Adjustment
Hispanic.	1,800	2,000	1.11	2,000
Black, age 19-25 months.	2,500	3,000	1.20	3,000
Black, age 26-35 months.	3,500	4,000	1.14	4,000
White, education of mother less than or equal to 12 yrs., age 19-25 months.	3,500	3,000	0.86	3,000
White, education of mother less than or equal to 12 yrs., age 26-35 months.	5,500	5,000	0.91	5,000
White, education of mother 12 years or higher.	2,800	3,000	1.07	3,000
Total	19,600	20,000		20,000

Table 2: Example of Modified Poststratification

Poststratification Cell: Black, Age 26-35 Months

    Telephone children:

$$3{,}000 \times .70 = 2{,}100 \times .60^{a}$$
$$= 1{,}260 \text{ telephone children 4:3:1 Up-to-Date.}$$

    Nontelephone children:

$$3{,}000 - 2{,}100 = 900 \times .40^{b} = 360 \times (.60/.50)^{c}$$
$$= 432 \text{ nontelephone children 4:3:1 Up-to-Date.}$$

Total of $1{,}260 + 432 = 1{,}692$ 4:3:1 Up-to-Date.

$3{,}000 - 1{,}692 = 1{,}308$ children NOT 4:3:1 Up-to-Date.

Cell	Weighted NIS Sample (using base sampling weight)	Estimated Vital Statistics Count	Adjustment Factor	Weighted NIS Sample after Adjustment
4:3:1 UTD children	2,500 x .60 = 1,500	1,692	1.13	1,692
Not 4:3:1 UTD children	2,500 - 1,500 = 1,000	1,308	1.31	1,308
Total	2,500	3,000	1.20	3,000

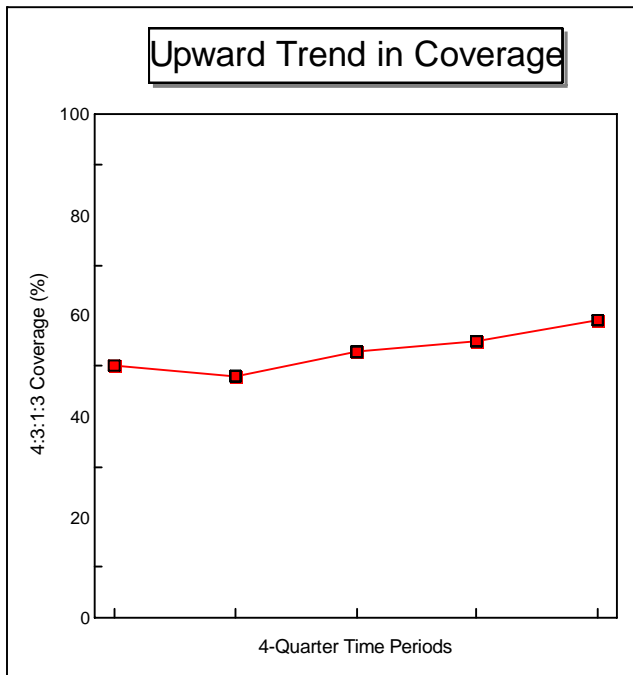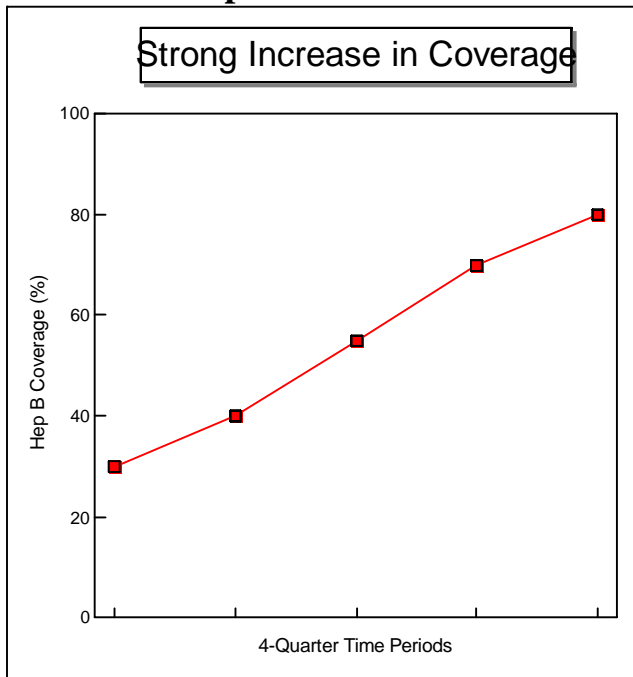**Table 3: Reporting Errors in Parental Reports of 4:3:1:3 Up-to-Date Status of their Children**

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a   NIS IAP-area telephone 4:3:1 estimate for poststratification cell.

b   National NHIS nontelephone 4:3:1 estimate for poststratification cell.

c   Ratio of NIS IAP-area telephone 4:3:1 estimate to national NHIS telephone 4:3:1 estimate for poststratification cell. This ratio calibrates the national NHIS nontelephone 4:3:1 estimate for the poststratification cell to more accurately reflect IAP-area conditions.

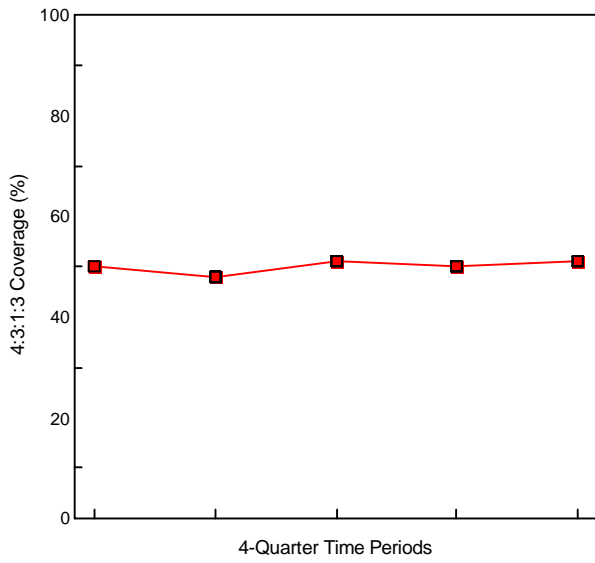| Household Report Category	Percentage of Children 4:3:1:3 Up-to-Date According to Households	Percentage of Children 4:3:1:3 Up-to-Date According to Providers
Shot Card, 4:3:1:3 up-to-date	100%	90%
Shot Card, Not 4:3:1:3 up-to-date	0%	62%
Recall, 4:3:1:3 up-to-date	100%	75%
Recall, Not 4:3:1:3 up-to-date	0%	66%
D.K. 4:3:1:3 Status of Child	D.K.	70%

Table 4: Example of Calculation of Provider-Adjusted Coverage Estimate for 3+ Polio Up-to-Date

Category	Provider Proportion of Children with 3+ Polio Shots	Weighted Proportion of NIS Children in RDD Sample	Product
Shot Card, 4:3:1:3 UTD	.962	.268	.258
Shot Card, Not 4:3:1:3 UTD	.860	.190	.163
Recall, 4:3:1:3 UTD	.897	.137	.123
Recall, Not 4:3:1:3 UTD	.806	.207	.167
D.K. whether 4:3:1:3 UTD	.816	.199	.162
		1.000	0.873

Table 5: Examples of Trends in Vaccination Coverage over Time

Strong Increase in Coverage

Upward Trend in Coverage

No Trend in Coverage

4:3:1:3 Coverage (%)

4-Quarter Time Periods

Downward Trend in Coverage

4:3:1:3 Coverage (%)

4-Quarter Time Periods
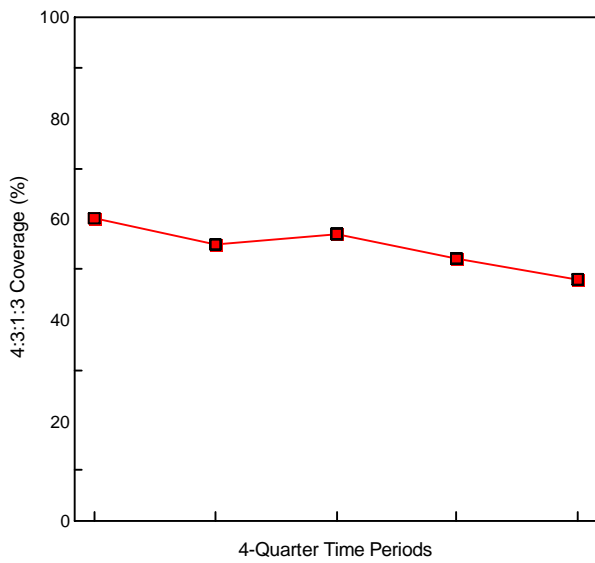
APPENDIX

SHOT RECORD FOR POLIO (DROPS OR SHOTS)	

	1. Looking at the shot record, please tell me how many times **[FILL VAR: NAME OF FIRST/SECOND… /SIXTH CHILD, FROM S3.5]** has received a polio vaccine -- pink drops -- or a polio shot.
	Shots . . . . ☐ RECORD DATES BELOW de NONE . . . . 0 GO TO A3 de DON'T KNOW . . . . 6 GO TO A3 de REFUSED . . . . 7 GO TO A3
	a. What is the date (on the record) for the [FILL VAR: (First/Second/…Eighth)] polio vaccine?
1st Shot	___ / ___ / ____ de DON'T KNOW 9996 GO TO A3 MO DAY YEAR de REFUSED . . . . 9997 GO TO A3
2nd Shot	___ / ___ / ____ de DON'T KNOW 9996 GO TO A3 MO DAY YEAR de REFUSED . . . . 9997 GO TO A3
3rd Shot	___ / ___ / ____ de DON'T KNOW 9996 GO TO A3 MO DAY YEAR de REFUSED . . . . 9997 GO TO A3
4th Shot	___ / ___ / ____ de DON'T KNOW 9996 GO TO A3 MO DAY YEAR de REFUSED . . . . 9997 GO TO A3
5th Shot	___ / ___ / ____ de DON'T KNOW 9996 GO TO A3 MO DAY YEAR de REFUSED . . . . 9997 GO TO A3
6th Shot	___ / ___ / ____ de DON'T KNOW 9996 GO TO A3 MO DAY YEAR de REFUSED . . . . 9997 GO TO A3
7th Shot	___ / ___ / ____ de DON'T KNOW 9996 GO TO A3 MO DAY YEAR de REFUSED . . . . 9997 GO TO A3
8th Shot	___ / ___ / ____ de DON'T KNOW 9996 GO TO A3 MO DAY YEAR de REFUSED . . . . 9997 GO TO A3 GO TO A3

B2.   Has [FILL VAR: NAME OF FIRST/SECOND... /NINTH CHILD, FROM S3.5] ever received a polio vaccine by mouth, pink drops or by a polio shot?

        YES   1
        NO   2
        DON'T KNOW 6   GO TO B4
        REFUSED 7   **A**

B2.A.   How many polio vaccine shots did [FILL VAR: NAME OF FIRST/SECOND... /NINTH CHILD, FROM S3.5] ever receive?

        NUMBER OF VACCINES . . . . ☐
        ALL   50
        DON'T KNOW 96
        REFUSED 97

B3.   Has [FILL VAR: NAME OF FIRST/SECOND... /NINTH CHILD, FROM S3.5] ever received a measles or M-M-R (Measles-Mumps-Rubella) shot?

        YES   1

        NO   2
        DON'T KNOW 6   GO TO B5
        REFUSED 7   **A**

B3.A.   How many measles or M-M-R shots did [FILL VAR: NAME OF FIRST/SECOND... /NINTH CHILD, FROM S3.5] ever receive?

        NUMBER OF SHOTS . . . . ☐   IF = 1 GO TO B4.B IF = 2 OR
                                                                         MORE GO TO B5

        ALL   50
        DON'T KNOW 96
        REFUSED 97

SECTION D

Provider Questions

D5   To get a complete picture of the vaccinations received by your (children/child), we would like to contact doctors or health clinics to obtain a copy of the vaccination records for your (children/child). This study is voluntary and is authorized by the U.S. Public Health Service Act. It's all right to skip any questions you don't want to answer. The information you give will be kept in strict confidence and will be summarized for research purposes only.

D6   How many doctors or clinics have provided vaccinations for your child named [NAME OF (FIRST) ELIGIBLE CHILD] whose birth date is [DATE OF BIRTH OF (FIRST) ELIGIBLE CHILD]?

       NUMBER: |___|___|

D6A.1 Starting with the most recent, please tell me the name, address and telephone number for each doctor or clinic. (Would you take a moment to find shot cards, appointment cards or other records you may have?)

       YES, CONTINUE ON 1
       NO, CAN'T FIND, CONTINUE 2
       REFUSED 7   GO TO D14

D6B.1.1.1 What is the last name of the doctor?

       LAST_____

D6B.2.1.1 Do you know the doctor's first name?

       FIRST_____

D6B.3.1.1 Please tell me the name of the office or the clinic.

       OFFICE_____

D6B.4.1.1 What is the street address of the office or the clinic?

       STREET_____

D6B.5.1.1 Is there a suite, floor, or room number?

NATIONAL IMMUNIZATION SURVEY PROVIDER STUDY
IMMUNIZATION HISTORY QUESTIONNAIRE

INSTRUCTIONS: Please review your records and complete this questionnaire for the child identified below. Then, mail it in the postage-paid envelope provided or fax it to: . . . . *Victor G. Coronado, MD, MPH,   FAX #: (312) 621-3840*

1.   Which of the following best describes your records of immunization for this child? (Check only one box.).

   ₁ **G** a.   Have immunization record for this child. (Go to question 2a below.)
   ₂ **G** b.   Have provided care to this child, but do not have his/her immunization record. (Go to question 10 on next page.)
   ₄ **G** c.   Have no record of providing care to this child. (Return questionnaire to CDC as instructed above.)
   ₅ **G** d.   Other: _____

2a.   Referring to all sources of immunization history, please specify below the month, day and year that each of the following immunizations was given, either by your office or another provider (OP), as documented in your records. If you prefer, you may attach a copy of the complete immunization history and complete Page 2.

   Circle the "OP" for any immunization given by another provider, after the date for that immunization.

	Dates of immunization:				
	(1) mm-dd-yy	(2) mm-dd-yy	(3) mm-dd-yy	(4) mm-dd-yy	(5) mm-dd-yy
DT/DTP/DTaP (check one box per date)	__-__-__ OP **9** *DT* **9** *DTP* **9** *DTaP*	__-__-__ OP **9** *DT* **9** *DTP* **9** *DTaP*	__-__-__ OP **9** *DT* **9** *DTP* **9** *DTaP*	__-__-__ OP **9** *DT* **9** *DTP* **9** *DTaP*	__-__-__ OP **9** *DT* **9** *DTP* **9** *DTaP*
DTP-Hib (Tetramune or Acthib)	__-__-__ OP	__-__-__ OP	__-__-__ OP	__-__-__ OP	__-__-__ OP
Hib	__-__-__ OP	__-__-__ OP	__-__-__ OP	__-__-__ OP	__-__-__ OP
Hep-B (enter date or check box)	__-__-__ OP **9** *Administered at birth*	__-__-__ OP	__-__-__ OP	__-__-__ OP	__-__-__ OP
Polio (OPV or IPV) (check one box per date)	__-__-__ OP **9** *OPV* **9** *IPV*	__-__-__ OP **9** *OPV* **9** *IPV*	__-__-__ OP **9** *OPV* **9** *IPV*	__-__-__ OP **9** *OPV* **9** *IPV*	__-__-__ OP **9** *OPV* **9** *IPV*
MMR	__-__-__ OP	__-__-__ OP	__-__-__ OP	__-__-__ OP	__-__-__ OP
Measles only	__-__-__ OP	__-__-__ OP	__-__-__ OP	__-__-__ OP	__-__-__ OP
Varicella	__-__-__ OP	__-__-__ OP	__-__-__ OP	__-__-__ OP	__-__-__ OP
Other Vaccines (Specify)	__-__-__ OP	__-__-__ OP	__-__-__ OP	__-__-__ OP	__-__-__ OP