Is it Feasible to Use Immunization Information Systems (IIS) as a Supplemental Sampling Frame for the National Immunization Survey (NIS)?

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Outline

- Background
  - CDC Immunization Program
  - National Immunization Surveys
  - Immunization Information Systems

- Challenges and Needs

- Sample Frame Project
  - Methods
  - Results
  - Conclusions

- Next Steps
National Center for Immunization and Respiratory Diseases (NCIRD)

**Mission**
- The prevention of disease, disability, and death through immunization and by control of respiratory and related diseases.
  - Cost savings combined for children born 1994-2013 over their lifetimes
    - Vaccination of each U.S. birth cohort with the current childhood immunization schedule
      - Prevents approximately
        - 732,000 deaths
        - 322 million cases of disease
        - 21 million hospitalizations
      - Net savings of nearly
        - $295 billion in direct costs
        - $1.38 trillion in total societal costs.
Vaccine-specific coverage* among children 19-35 months, National Immunization Survey (NIS), United States, 1994-2013

* The Healthy People 2020 target for coverage is 90% for all vaccines with the exception of rotavirus (80%) and HepA (85%).
† DTP (3+) is not a Healthy People 2020 objective. DTaP (4+) is used to assess Healthy People 2020 objectives.
§ Reflects 3+ doses through 2008, and Full Series (3 or 4 doses depending on type of vaccine received) 2009 and later.
National Immunization Survey (NIS)

- A probability-based random-digit-dial (RDD) dual-frame landline telephone and cell telephone survey with a follow-up survey mailed to vaccination provider (PRC)

**Family of surveys**
- NIS-Teen – adolescents 13-17 years (2006)

**Strength**
- National, state, and selected local area estimates of vaccination coverage using a standard methodology
Immunization Information System (IIS)

- State or local confidential, computerized, population-based, data systems that collect and consolidate vaccination doses administered by participating vaccination providers
  - Functional: IIS in 49 states, five large cities, the District of Columbia, and 8 territories

- Started in the 1970s
  - Common functional standards and core data elements were established in 2001 (and are evolving)

- Strengths
  - Clinical care: Provide a consolidated vaccination record and can forecast when recommended vaccinations are due
  - Population level: Provide aggregate information on vaccination coverage within a state or local area
  - Contains functionalities that assist the immunization program and its stakeholders
  - Many IIS have high levels of completeness for children and kindergarteners
Challenges

- **Pockets of under-vaccination**
  - Impoverished communities (socioeconomic barriers)
  - Vaccination acceptance concerns cluster (religious, cultural)
  - Low vaccination coverage increases the risk of disease transmission and outbreaks

- **Changing survey environment**
  - Decrease in landline telephones/increase use of cell telephones
  - Decrease in response rates
  - Increase in costs

- **Varied IIS environment**
  - May be variation in legislation, methods of populating the dataset, or administration of system

- **Perception**
  - Two systems funded to measure vaccination coverage
    - Varying objectives, perspectives, and stakeholder interests

- **Data sharing and confidentiality**
  - NIS: 308(d) – Assurance of Confidentiality
  - IIS: legislation, regulations, charters
Needs

- **Assess national and state level coverage (CDC)**
  - Valid and comparable estimates over time and across states

- **Enhance synergy**
  - Leverage the National Immunization Surveys and IIS
    - Minimize survey costs
    - Reduce survey respondent burden
    - Improve IIS completeness
    - Improve survey data validity
    - Manage funds entrusted to NCIRD to assess and evaluate the Immunization Program at the National, State, and selected local level

- **Manage national, state, and local data security issues**
NIS-IIS

- **Common element**
  - Provider reported vaccination
    - NIS – Immunization History Questionnaire (IHQ)
    - IIS
      - Mandatory reporting via state legislation, and
      - Voluntary reporting (in some cases required to administer government funded vaccines)

- **Data sets**
  - NIS and NIS-Teen
  - IIS from four U.S. states
NIS-IIS Sample Frame Study: Objective and Research Question

- **Primary purpose:**
  - Evaluate the feasibility of and methods for including an IIS sample as part of a NIS multi-frame (RDD and IIS) sample.

- **Research question:**
  - What is the most appropriate methodology for using the available IIS list to supplement the NIS sample frame without incurring large bias and sample variance?
2013-2014 NIS-IIS Sample Frame

- Objectives
  - Assess potential to use IIS as an NIS sample frame
  - Determine the costs of using an IIS sample frame on both the IIS and NIS
  - Identify factors that could indicate when an IIS could be used to provide support as a possible sample frame for the NIS (“IIS readiness”)

Four IISs with varying maturity were examined

People Finder was used to update the street address and telephone number in the IIS to facilitate locating the households (HH) of sampled children.

Independent samples of age-eligible children were drawn from the IISs.

NIS-like data collection (HH phone interview and a survey mailed to vaccination provider) was conducted.

Examined vaccination coverage rates and demographic characteristics:
  - Weighted pooled data
  - Traditional NIS
2013-2014 NIS-IIS Sample Frame Preliminary Results

- Four IIS sample frames fielded
  - There is variation in IIS in terms of the quality of the frame

### 2013-2014 NIS-IIS Sample Frame Disposition*

<table>
<thead>
<tr>
<th>IIS</th>
<th>No contact information</th>
<th>Disconnected/Modem/Non-Residential</th>
<th>Potential Reachable Households</th>
<th>Sample Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>22%</td>
<td>19%</td>
<td>58%</td>
<td>16,069</td>
</tr>
<tr>
<td>B</td>
<td>58%</td>
<td>8%</td>
<td>34%</td>
<td>19,032</td>
</tr>
<tr>
<td>C</td>
<td>9%</td>
<td>15%</td>
<td>77%</td>
<td>11,922</td>
</tr>
<tr>
<td>D</td>
<td>10%</td>
<td>18%</td>
<td>72%</td>
<td>12,920</td>
</tr>
</tbody>
</table>

* Percentages are out of total sample selected from IIS.
NIS-IIS Sample Frame Study: Progress and Key Eligibility Rates

- NIS-like household telephone data collection is complete for all four state IIS samples.
- Provider data collection complete for two state IIS

### NIS-IIS Household Eligibility Rates, Q1/2013-Q2/2013 Cohort

<table>
<thead>
<tr>
<th>Frame</th>
<th>Age Eligibility Rate*</th>
</tr>
</thead>
<tbody>
<tr>
<td>NIS**</td>
<td></td>
</tr>
<tr>
<td>Landline</td>
<td>1.9%</td>
</tr>
<tr>
<td>Cell</td>
<td>3.7%</td>
</tr>
<tr>
<td>IIS A</td>
<td>53.7%</td>
</tr>
<tr>
<td>IIS B</td>
<td>73.4%</td>
</tr>
<tr>
<td>IIS C</td>
<td>75.6%</td>
</tr>
<tr>
<td>IIS D</td>
<td>72.5%</td>
</tr>
</tbody>
</table>

Age eligibility rate = No. HH with an age eligible child/ No. households screened for presence of age-eligibility slide
**NIS Sample vs. IIS Sample (IIS A): Baseweighted Socio-Demographic Characteristics**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>IIS (n=1206)</th>
<th>NIS (n=207)</th>
<th>Pop</th>
<th>Pop - IIS</th>
<th>Pop - NIS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mother's Education</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High school or less</td>
<td>36.6</td>
<td>36.6</td>
<td>55.3</td>
<td>18.8</td>
<td>18.7</td>
</tr>
<tr>
<td>Higher than high school</td>
<td>63.4</td>
<td>63.4</td>
<td>44.7</td>
<td>-18.8</td>
<td>-18.7</td>
</tr>
<tr>
<td><strong>Mother's Age</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤ 29 years</td>
<td>34.7</td>
<td>41.5</td>
<td>50.2</td>
<td>15.5</td>
<td>8.7</td>
</tr>
<tr>
<td>≥ 30 years</td>
<td>65.3</td>
<td>58.5</td>
<td>49.8</td>
<td>-15.5</td>
<td>-8.7</td>
</tr>
<tr>
<td><strong>Mother's Race/Ethnicity</strong></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hispanic</td>
<td>35.8</td>
<td>31.2</td>
<td>38.1</td>
<td>2.3</td>
<td>6.9</td>
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<tr>
<td>Non-Hispanic black only</td>
<td>5.2</td>
<td>5.2</td>
<td>9.6</td>
<td>4.4</td>
<td>4.4</td>
</tr>
<tr>
<td>Non-Hispanic others</td>
<td>59.0</td>
<td>63.7</td>
<td>52.3</td>
<td>-6.7</td>
<td>-11.4</td>
</tr>
</tbody>
</table>
(Cont.) NIS Sample vs. IIS Sample (IIS A): Baseweighted Socio-Demographic Characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>IIS (n=1206)</th>
<th>NIS (n=207)</th>
<th>Pop</th>
<th>Pop - IIS</th>
<th>Pop - NIS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Household Income to Poverty Ratio</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ratio &lt; 1.33</td>
<td>36.4</td>
<td>32.5</td>
<td>33.1</td>
<td>-3.3</td>
<td>0.6</td>
</tr>
<tr>
<td>1.33 ≤ Ratio &lt; 4</td>
<td>42.2</td>
<td>39.8</td>
<td>49.2</td>
<td>7.0</td>
<td>9.4</td>
</tr>
<tr>
<td>Ratio ≥ 4</td>
<td>21.4</td>
<td>27.7</td>
<td>17.7</td>
<td>-3.7</td>
<td>-10.0</td>
</tr>
<tr>
<td><strong>Telephone Use Status</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cell-phone only</td>
<td>50.6</td>
<td>53.3</td>
<td>46.0</td>
<td>-4.6</td>
<td>-7.3</td>
</tr>
<tr>
<td>Dual users</td>
<td>46.0</td>
<td>43.9</td>
<td>44.8</td>
<td>-1.2</td>
<td>0.9</td>
</tr>
<tr>
<td>Landline only</td>
<td>3.4</td>
<td>2.8</td>
<td>7.0</td>
<td>3.6</td>
<td>4.2</td>
</tr>
</tbody>
</table>
NIS Sample vs. IIS Sample (IIS A): Differences in Distribution of Residency Status

Unweighted Distribution by Residency Status Since Birth for Children with Complete HH Interviews
NIS Sample vs. IIS Sample (IIS B): Differences in Distribution of Residency Status

Unweighted Distribution by Residency Status Since Birth for Children with Complete HH Interviews

- Same address: 67.8% (NIS), 69.8% (IIS)
- Moved within state: 21.5% (NIS), 25.8% (IIS)
- Moved from another state: 9.9% (NIS), 4.3% (IIS)
- Missing, don't know: 0.8% (NIS), 0.2% (IIS)
NIS Sample vs. IIS Sample (IIS A):
Weighted Vaccination Coverage Rates

![Graph showing vaccination coverage rates for different vaccines and vaccine series for NIS and IIS samples.](image)
NIS Sample vs. IIS Sample (IIS B): Weighted Vaccination Coverage Rates

Vaccine and Vaccine Series
NIS, 2 Quarter (n=80) 95% CI, NIS 2 Quarter
IIS (n=885) 95% CI, IIS
Combined data and adjusted for composite factors:

C1 : Proportional Weighting:

\[ W' = W \times \frac{n}{N}, \quad \text{Ex:} \quad \frac{n}{N} = \frac{800}{200+800} = .80 \]

where \( n \) is the size of the IIS sample in pooled data, and \( N \) is the size of the pooled total.
NIS Sample vs. Combined Sample (NIS-IIS A): Weighted Vaccination Coverage Rates
NIS Sample vs. Combined Sample (NIS-IIS B): Weighted Vaccination Coverage Rates
Results: Vaccination Coverage Estimates, Combined (NIS-IIS) vs. the NIS

- 7 vaccines or vaccine series
- 15 socio-demographic subgroups
  - Gender: Male, Female
  - Child’s race/ethnicity: Hispanic, Non-Hispanic White, Non-Hispanic Others
  - Mother’s education: High school or less, More than high school
  - HH income to poverty ratio: <1.33, 1.33~4, 4+
  - MSA status: MSA Central City, MSA Non-Central City, Non MSA
  - Telephone use status: Cell phone only, not cell phone only
Results: Vaccination Coverage Estimates, Combined (NIS-IIS) vs. the NIS

- Estimated vaccination coverage rates for 7 vaccines or vaccine series across 15 socio-demographic subgroups using the Proportional Weighting (C1) approach and compared to the NIS estimates.

- Absolute value of the difference in vaccination coverage (percentage points)
  - C1 Difference = |C1 Estimate – NIS Estimate|

- Example: 3+ Polio by Gender

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>NIS Estimate*</th>
<th>C1 Estimate</th>
<th>C1 Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>81%</td>
<td>92%</td>
<td>11%</td>
</tr>
<tr>
<td>Female</td>
<td>93%</td>
<td>95%</td>
<td>2%</td>
</tr>
</tbody>
</table>

* Q1 and Q2, 2013
Absolute Difference in Vaccination Coverage Rates within Socio Demographic Subgroups for Combined (NIS-IIS) vs. the NIS, IIS A

Female, 2% pts
Male, 11% pts
Results: Absolute Difference in 7 Vaccination Coverage Rates across 15 Socio Demographic Subgroups

<table>
<thead>
<tr>
<th>Summary Measures</th>
<th>C1 Difference</th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>IIS A</td>
<td>IIS B</td>
<td></td>
</tr>
<tr>
<td>Minimum</td>
<td>0.1</td>
<td>0.0</td>
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</tr>
<tr>
<td>Median</td>
<td>5.0</td>
<td>4.2</td>
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</tr>
<tr>
<td>Maximum</td>
<td>33.1</td>
<td>57.4</td>
<td></td>
</tr>
</tbody>
</table>
Conclusions

- IIS offers opportunity for substantial cost reductions due to its exceptionally high eligibility rate.
  - Time consuming and complex to deal with each state individually.
  - Telephone contact information not complete.
  - Coverage by state and ability to use state information varies widely.

- Demographic comparisons between the NIS and IIS showed a fairly high level of comparability, but some differences still exist.
  - Sampling and weighting approaches for a single IIS or multi-frame NIS-IIS design will need to account for demographic differences such as for mover status.

- The combined NIS-IIS vaccination rates for IIS A and IIS B are within 7 percentage points of the NIS estimates for the vaccines and vaccine series.
  - There were no statistically significant differences between the NIS and IIS estimates at the state level for IIS A or IIS B.
Next Steps

- Develop optimum sample design and data collection methodology for combining NIS and IIS samples:
  - Identify key measures to determine whether an IIS has sufficient population coverage and sufficient contact information for use as a sample frame in the NIS (assessing state-level IIS readiness).
  - Control potential bias at the state level (relative to the NIS).
  - Use cost-savings to increase the precision of state-level estimates.
  - Meet minimum NIS variance requirements at the estimation area level.
  - Investigate an optimum allocation sample design that takes into account population distributions, variance differences and cost differentials.
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Xian Tao
Nada Ganesh
Sari Schy
Margrethe Montgomery
### NIS Sample vs. IIS Sample (IIS B): Baseweighted Socio-Demographic Characteristics

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<tr>
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<th>IIS</th>
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<tbody>
<tr>
<td></td>
<td>(n=1266)</td>
<td>(n=121)</td>
<td></td>
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<tr>
<td><strong>Mother's Education</strong></td>
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<tr>
<td>Higher than high school</td>
<td>82.2</td>
<td>86.3</td>
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<td>-21.0</td>
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<td>41.6</td>
<td>20.9</td>
<td>14.6</td>
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<tr>
<td>≥ 30 years</td>
<td>79.3</td>
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<td>-14.6</td>
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<td>7.9</td>
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<td>5.3</td>
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<td>22.5</td>
<td>1.8</td>
<td>8.4</td>
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<tr>
<td>1.33 ≤ Ratio &lt; 4</td>
<td>45.0</td>
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<td>47.7</td>
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<td>1.4</td>
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<td>46.3</td>
<td>9.7</td>
<td>3.3</td>
</tr>
<tr>
<td>Dual users</td>
<td>60.3</td>
<td>57.0</td>
<td>51.0</td>
<td>-9.3</td>
<td>-6.0</td>
</tr>
<tr>
<td>Landline only</td>
<td>3.1</td>
<td>0.0</td>
<td>1.2</td>
<td>-1.9</td>
<td>1.2</td>
</tr>
</tbody>
</table>
Absolute Difference in Vaccination Coverage Rates within Socio Demographic Subgroups for Combined (NIS-IIS) vs. the NIS, IIS B
Vaccines and Vaccine Series

1. 4+ DTaP - 4 or more doses of Diphtheria and tetanus toxoids and acellular pertussis/Diphtheria and tetanus toxoids and per tussis /Diphtheria and tetanus toxoids vaccine
2. 3+ Pol - 3 or more doses of Polio
3. 1+ MMR - 1 or more doses of Measles, Mumps, and Rubella vaccine
4. Hib (full series) – 3 or more or 4 or more doses of *Haemophilus influenzae* type b vaccine (Hib) of any product type received (primary series and booster dose).
Vaccines and Vaccine Series

5. 3+ HepB - 3 or more Hepatitis B
6. 1+ Var - 1 or more Varicella
7. 4+ PCV - 4 or more Pneumoccocal vaccine
8. Rot – Rotavirus
9. 2+ HepA – 2 or more doses of Hepatitis A vaccine
10. 2+ - 2 or more doses of Hepatitis A vaccine
11. 4:3:1:3:3:1 – Combination of 1 to 6
12. 4:3:1:3:3:1:4 – Combination of 1 to 7