IDENTIFYING IMMUNIZATION POCKETS OF NEED

SMALL AREA ANALYSIS OF IIS DATA TO DETECT UNDERVACCINATED POPULATIONS

AIRA
AMERICAN IMMUNIZATION REGISTRY ASSOCIATION

EXECUTIVE SUMMARY

Over the past several years, vaccine-preventable disease outbreaks have emerged from small populations with low vaccination coverage.

These populations of unimmunized or underimmunized individuals are referred to as "pockets of need." It can be challenging to identify low vaccination coverage in small populations. Fortunately, improvements in the quantity and quality of data in immunization information systems (IIS) have led to an increased ability to perform small area analysis that can identify pockets of need. By identifying pockets of need, immunization programs can strategically use limited resources to prevent or control vaccine-preventable disease outbreaks. Likewise, identification of pockets of need can help target resources to address health disparities and improve health equity.

This guide is one of a series of guides intended to help IIS and immunization programs use their IIS in meaningful ways to conduct coverage assessments. *The Analytic Guide to Assessing Vaccination Coverage Using an IIS* describes practical considerations and key decision points in designing a coverage assessment using an IIS. A subsequent addendum looks at five examples of coverage assessments using IIS data.

HIGHLIGHTS OF THIS GUIDE

- Overview of the concepts of pocket of need and small area analysis
- Step-by-step process for using small area analysis to identify pockets of need
- Explanation of the effects of differing data quality issues across subpopulations
- Description of how to adjust for bias
- Ideas for how to determine if your assessment indicates a pocket of need
- Methods of responding to a pocket of need

WHO SHOULD READ THIS GUIDE?

- IIS and immunization program staff
- Epidemiologists at the state and local level
- Public health staff who work with:
  - Specific geographic areas or populations
  - Vaccine hesitancy issues
  - School and childcare immunization laws
  - Surveillance or response to outbreaks of vaccine-preventable diseases

Our hope is that this guide will be useful to help identify pockets of need and respond in ways that decrease the risk of vaccine-preventable disease in our communities.

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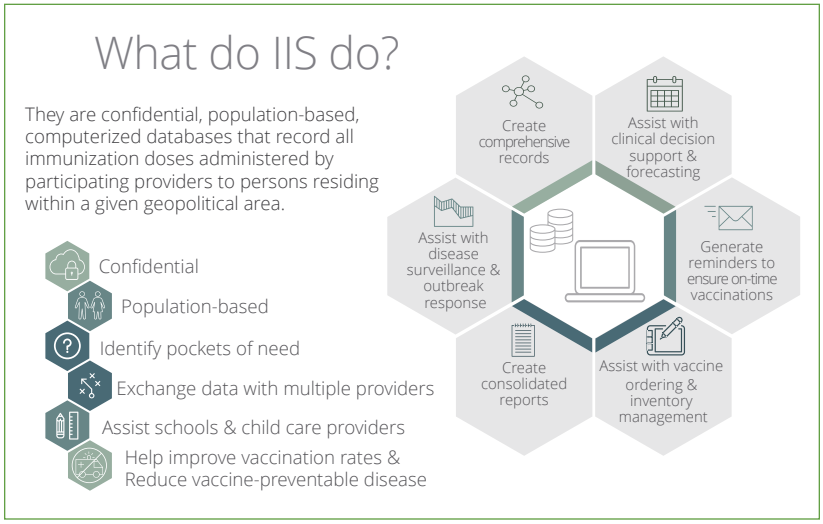
SECTION 1 INTRODUCTION TO GUIDE

1.1 BACKGROUND

The United States is fortunate to have high vaccination coverage for most routinely recommended immunizations; however, high aggregate vaccination coverage at state or national levels can mask lower coverage in smaller populations. While many subpopulations within the larger population have high vaccination coverage, subpopulations with lower vaccination coverage leave individuals vulnerable to potentially life-threatening vaccine-preventable diseases and have been associated with disease outbreaks.[1,2,3] A subpopulation of unimmunized or underimmunized individuals that presents an increased disease risk is referred to as a "pocket of need." These individuals can be clustered geographically, demographically, or based on a gathering point (e.g., a school or church). Pockets of need represent a significant challenge for public health because they can be difficult to identify and may require substantial outreach to improve vaccination coverage.

As immunization information systems (IIS) have grown increasingly robust and representative of their jurisdictions, IIS have become an essential tool for performing small area analyses that can identify pockets of need. By identifying pockets of need, immunization programs can strategically use limited resources and prevent or control vaccine-preventable disease outbreaks.



For background information about the process of creating this guide, please read Appendix A.

[1] Hall, V., Banerjee, E., et al. (2017). Measles Outbreak — Minnesota April–May 2017. Morbidity and Mortality Weekly Report, 66(27), 713-717. http://dx.doi.org/10.15585/mmwr.mm6627a1.
[2] Gastañaduy, P. A., Budd, J., et al. (2016). A Measles Outbreak in an Underimmunized Amish Community in Ohio. New England Journal of Medicine, 375(14), 1343-1354. doi:10.1056/nejmoa1602295.
[3] Robison, S.G., Liko, J. (2017). The Timing of Pertussis Cases in Unvaccinated Children in an Outbreak Year: Oregon 2012. The Journal of Pediatrics, 183, 159-163. doi:10.1016/j.jpeds.2016.12.047.

1.2 PURPOSE

The purpose of this guide is to:

- Assist IIS and immunization programs to identify pockets of need using small area analysis
- Offer practical tips on assessing data quality issues that impact the identification of pockets of need
- Provide strategies to help determine when and how to respond to pockets of need

1.3 TARGET AUDIENCE

The target audience for the guide is IIS staff, immunization program staff, and epidemiologists at the state and local level. This guide may also be useful for public health staff who work with specific geographic areas (e.g., rural health initiatives), specific populations (e.g., tribal health), or populations with high vaccine hesitancy. This topic may also be of interest to staff working with school and childcare immunization laws, performing surveillance, or responding to outbreaks of vaccine-preventable diseases. The intent is for the guide to be accessible and understandable to staff with a variety of roles and backgrounds.

1.4 SCOPE OF GUIDE

This guide focuses on identifying pockets of need using small area analysis and determining when and how to respond. This guide also includes examples and resources to help develop responses to pockets of need. While this guide offers suggestions for small area analysis, broader analytic strategies can be found in the *Analytic Guide to Assessing Vaccination Coverage Using an IIS.* Topics that may be of further interest to readers but were determined to be out of scope include the statistical process of understanding factors associated with pockets of need (e.g., maternal level of education); detailed information on improving data quality in an IIS; and in-depth instructions on how to respond to a pocket of need. However, Appendix C includes a list of useful resources related to these topics.

1.5 LIMITATIONS OF GUIDE

This guide is not prescriptive but intends to offer practical considerations and approaches that may be tailored to the needs of an IIS or immunization program. We hope this document will provide a foundation for further discussion and sharing of ideas about best practices in the use of IIS for identifying and responding to pockets of need.

SECTION 2 POCKETS OF NEED AND SMALL AREA ANALYSIS: DEFINITIONS AND PURPOSE

2.1 POCKETS OF NEED

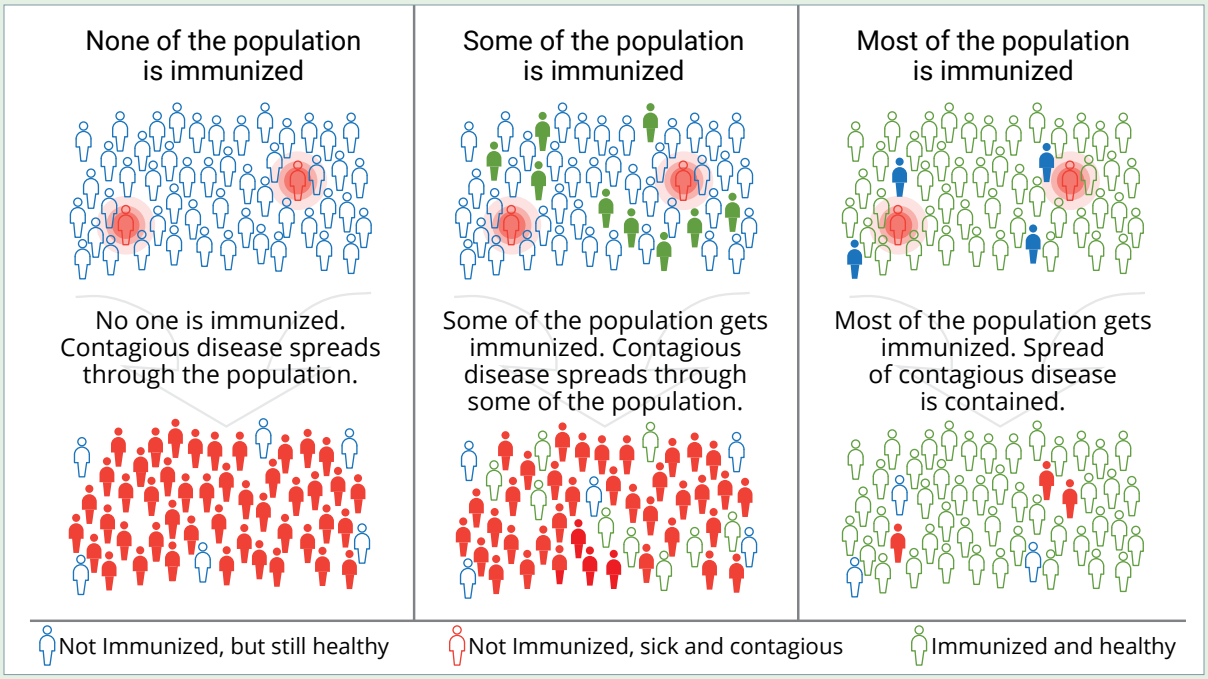
A population of unimmunized or underimmunized individuals that presents an increased disease risk is referred to as a pocket of need. The individuals can be clustered geographically, demographically, or based on a gathering point (e.g., a school or church).

A pocket of need can develop for many reasons. While some populations opt not to vaccinate for personal, cultural, or religious reasons, there are also populations that remain unvaccinated or undervaccinated due to a lack of easy, affordable access to vaccines. Similarly, a pocket of need can result from a medical provider intentionally or unintentionally failing to adhere to the Advisory Committee on Immunization Practices (ACIP) immunization schedule.

In all populations, there are individuals who are not able to receive certain vaccines (e.g., children do not routinely receive the MMR vaccine until 12 months). Even among vaccinated persons, the vaccine does not always lead to development of an immune response that provides protection from the disease. These individuals are at higher risk of disease when there is low vaccine coverage in the surrounding community. Fortunately, if most of the population is vaccinated against the disease, it decreases the likelihood that an individual without protection will be exposed to a vaccine-preventable disease. In a pocket of need, there is a higher proportion of people who are not protected from the disease, so it is more likely that disease will spread.

A pocket of need is a population of unimmunized or underimmunized individuals that presents an increased disease risk.

Figure 1 | *Comparison of disease spread in populations with varying levels of clustering of unimmunized individuals*



Based on an image from the National Institute of Allergy and Infectious Disease (NIAID)

Research suggests that a pocket of need poses a risk of disease not only to those within the pocket of need but also to the larger population as well.[4,5,6,7] For example, an outbreak of pertussis begins in a school with low vaccination coverage. During the outbreak, infected children from that school may ride the bus with children from other schools and participate in sporting events against other teams. This allows for the exposure of many people in the broader population and increases the risk of illness spreading beyond the pocket of need.

[4]Omer, S.B., Enger, K.S., Moulton, L.H., Halsey, N.A., Stokley, S., Salmon, D.A. (2008). Geographic Clustering of Nonmedical Exemptions to School Immunization Requirements and Associations With Geographic Clustering of Pertussis. American Journal of Epidemiology, 168(12), 1389-1396. doi:10.1093/aje/kwn263.
[5]Atwell, J., Van Otterloo, J., Zipprich, J. (2013). Nonmedical Vaccine Exemptions and Pertussis in California, 2010. Pediatrics, 132(4). doi:10.1542/peds.2013-0878d.
[6]Robison, S.G., Liko, J. (2017). The Timing of Pertussis Cases in Unvaccinated Children in an Outbreak Year: Oregon 2012. The Journal of Pediatrics, 183, 159-163. doi:10.1016/j.jpeds.2016.12.047.
[7]Danovaro-Holliday, M.C., LeBaron C.W., Allensworth, C., Raymond, R., Borden, T.G., Murray, A.B., Icenogle, J.P., Reef, S.E. A large rubella outbreak with spread from the workplace to the community. JAMA. 2000 Dec 6;284(21):2733-9.

Small area analysis is the study of a specific small area or population to identify measurable differences from the larger statistical pattern.

2.2 SMALL AREA ANALYSIS

Small area analysis[8] is the study of a specific small area or population to identify measurable differences from the larger population. This is useful for vaccination coverage, since we may see high coverage rates for an entire state but small areas (e.g., ZIP codes) that have significantly lower coverage than the state average. By performing small area analysis, it is possible to better identify and understand the true status of vaccination coverage in a defined area. Small area analyses can be used to look at a geographic area, demographic factors, or certain types of gathering points (e.g., schools). Likewise, small area analyses can be done via several different methodologies with the goal of better understanding a specific small area or population. IIS staff will want to consider the data that are available within their IIS (e.g., demographic and vaccine event records) and from outside sources (e.g., school data, Vital Records data) when deciding the types of small area analyses that are possible to perform.

Small area analysis can offer several benefits to IIS and immunization programs including:

- Information about areas or populations that are at risk for vaccine-preventable disease
- Data to support decisions about how to direct limited outreach and communications resources
- Statistics to evaluate the effect of communication or outreach initiatives
- Evidence about health disparities within a jurisdiction that supports targeting outreach related to health equity
- Direction on how to target outreach during an outbreak and the ability to monitor if coverage is improving
- Information to support policy changes or respond to legislative inquiries
- Statistics and maps to provide to the media or post on a health department website

Small area analysis offers a variety of methodologies that can be used to gain a more nuanced understanding of vaccination coverage and to direct public health activities.

[8]Small area analysis can also be referred to as local area analysis.

2.3 RELATIONSHIP BETWEEN POCKETS OF NEED AND SMALL AREA ANALYSIS

Small area analysis can be a powerful tool to identify pockets of need. Many researchers and public health staff have already begun using small area analysis to find pockets of need. As IIS have increasingly high-quality data, they have become an excellent source for detailed information about vaccination coverage.

IIS data can be well suited to geographic analysis, since records include the patient's address. While the quality and completeness of addresses in an IIS might be imperfect, address cleansing and correction efforts can reduce this issue.

Similarly, IIS staff have found ways to determine or deduce demographic information using IIS data or data from other sources such as Vital Records. This allows for analysis of demographic factors like race and ethnicity. Given increased efforts to respond to health disparities, a clear understanding of demographic pockets of need can be especially useful.

IIS staff may find it more difficult to perform analysis of the third type of pocket of need, gathering place, since this information is less likely to be available in an IIS or through additional data sources. While it is unlikely that IIS data will ever be able to support analysis about pockets of need for many types of gathering places (e.g., churches or events), the growing relationship between IIS and childcare centers and schools may offer opportunities for more analyses. To identify pockets of need based on gathering points, IIS staff will generally need to supplement data in the IIS with data from other sources about the individuals. For example, school rosters could provide information about which children are enrolled in a school, while the IIS provides information about the vaccines they have received.

EXAMPLE

The Minnesota Department of Health analyzed IIS data because of anecdotal reports of Somali-American parents expressing concerns about the MMR vaccine. This analysis confirmed that pediatric MMR coverage was decreasing in this population. Likewise, ongoing analysis allowed the Minnesota Department of Health to look at coverage levels for other vaccine types in this population and identify differences in vaccine coverage levels in various areas of the state. This helped to guide outreach to the Somali-American community and evaluate outreach efforts. The ability to perform small area analysis using IIS data allows for rapid assessment of potential pockets of need and the ability to better target a response to low vaccination coverage.

As the key resource for immunization data, IIS have an important role to play in identifying pockets of need through small area analysis.

Potential pockets of need can also be initially discovered through alternate sources like school immunization data, county-level estimates from the National Immunization Survey, anecdotal information from partners, vaccine-preventable disease statistics, and outbreaks. In these situations, small area analysis using data from an IIS can help determine if there is an actual pocket of need and provide a greater understanding of the affected area or population.

Figure 2 | *Relationship between IIS data, small area analysis, and identification of pockets of need*

SECTION 3 HOW TO PERFORM SMALL AREA ANALYSIS TO IDENTIFY POCKETS OF NEED

This section provides a description of the steps involved in small area analysis to identify pockets of need

The first step is identifying the reason for your analysis. The second step is developing a plan for your analysis. In this step, you will select data for your analysis based on the type of pocket of need you are investigating and set the criteria for your analysis. The third step is assessing data quality to determine if there are differing data quality issues among the subpopulations that you are comparing. The fourth step is conducting the small area analysis, and the fifth step is determining whether the assessment indicates a pocket of need. The sixth and final step is responding to an identified pocket of need, which is described in Section 4. Responses to a pocket of need will vary and can range from carrying out additional analysis to performing outreach. On the following page, a diagram provides a visual overview of these steps. This diagram illustrates the common sequence of steps for small area analysis. In practice, the process can be tailored to the circumstances.

BEFORE YOU BEGIN SMALL AREA ANALYSIS

At the beginning of a small area analysis, it may be beneficial to include community members as well as individuals with knowledge of the local vaccination and reporting situation. Community members are likely to know more about their population and may be able to advise you on how to plan your analytical question or hypothesis.

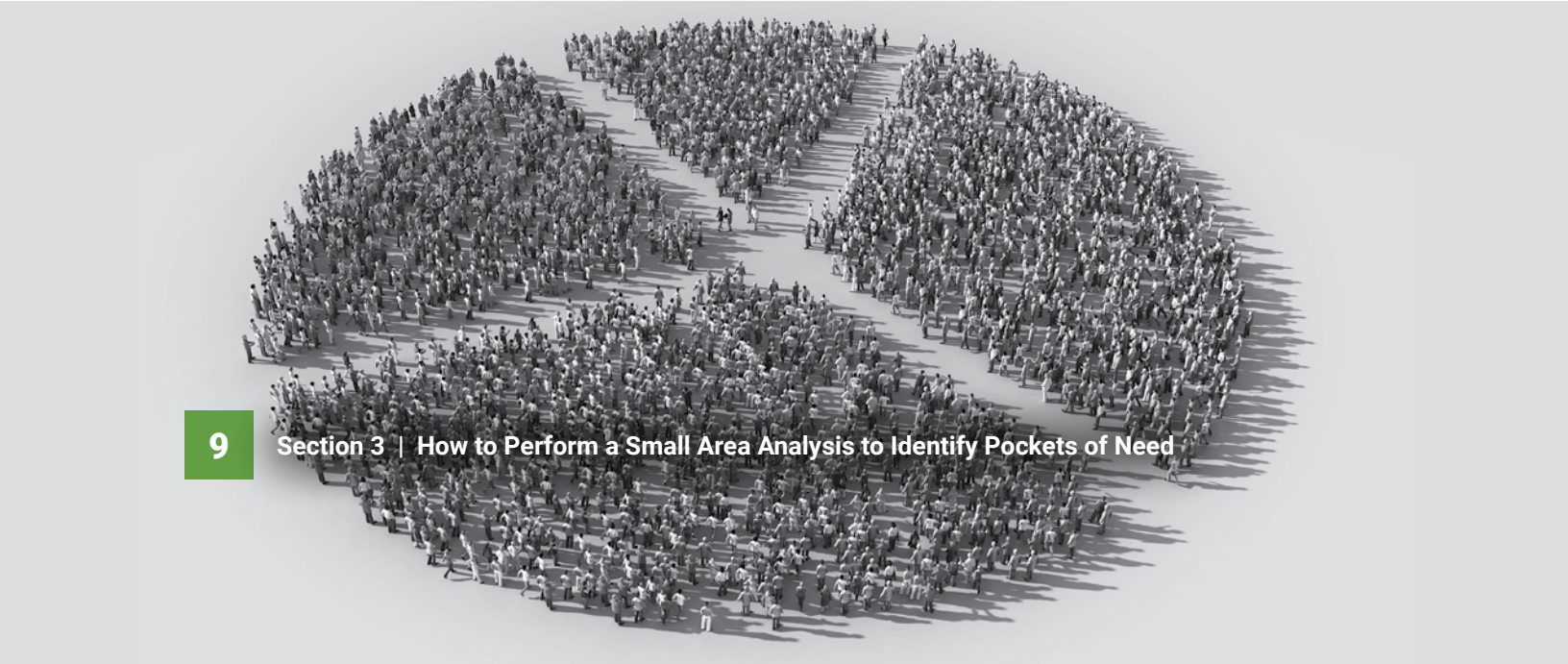
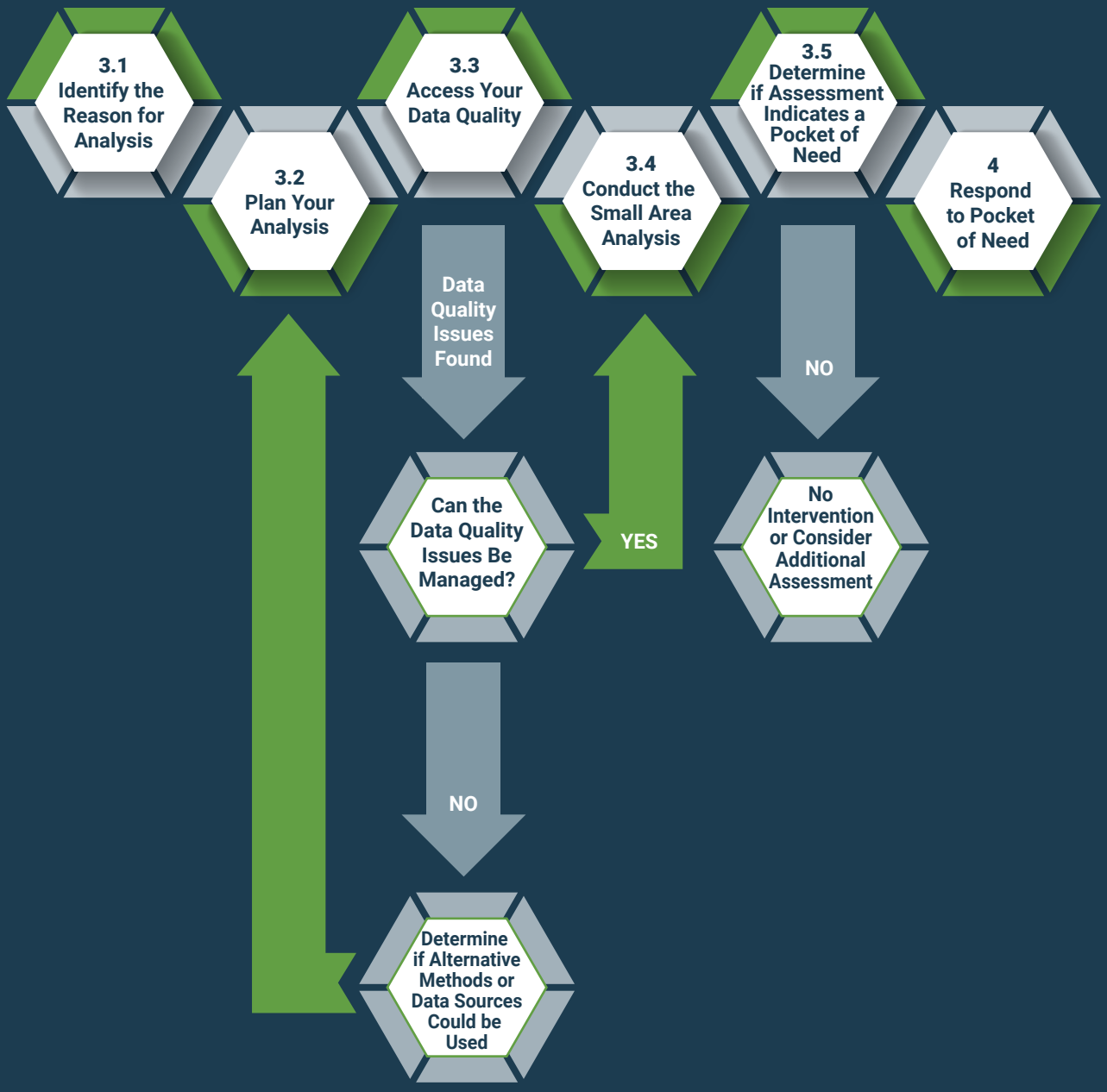


Figure 3 | *Diagram of the process of identifying pockets of need*



3.1 IDENTIFY THE REASON FOR YOUR ANALYSIS

There are several reasons to perform small area analysis: you may want to perform a broad analysis of IIS data searching for areas of need, or you may have a more specific hypothesis. The reason for your analysis will inform which data are needed and the appropriate analytic methods. Here are three common approaches to performing analysis to identify pockets of need.

A broad search of IIS data for signs of pockets of need

One approach to identifying pockets of need is to perform a broad analysis of data in your IIS. Many IIS staff already regularly assess county-level vaccination coverage. Since some counties have large populations, IIS staff may want to consider analyzing smaller areas like ZIP codes or Census tracts. Similarly, IIS staff may want to analyze their data using demographic information. By proactively looking for pockets of need, a health department can identify issues early and begin interventions before there is an increase in vaccine-preventable disease. This approach is also beneficial for targeting interventions. As an example, small area analysis could help determine in which areas of the state to perform reminder-recall for HPV vaccination. IIS staff could identify the ZIP codes with the lowest HPV vaccination coverage and send out reminder-recall letters to parents of adolescents that are due or past due for HPV vaccine.

A general hypothesis or assumption about low vaccine coverage

A second approach to identifying pockets of need is to start with a specific hypothesis or assumption about where there might be low vaccination coverage. For example, you learn a neighboring IIS is seeing a decrease in vaccination coverage for children on Medicaid, and you want to see if this is also an issue in your jurisdiction.

External signs point to a pocket of need that you can identify in your IIS

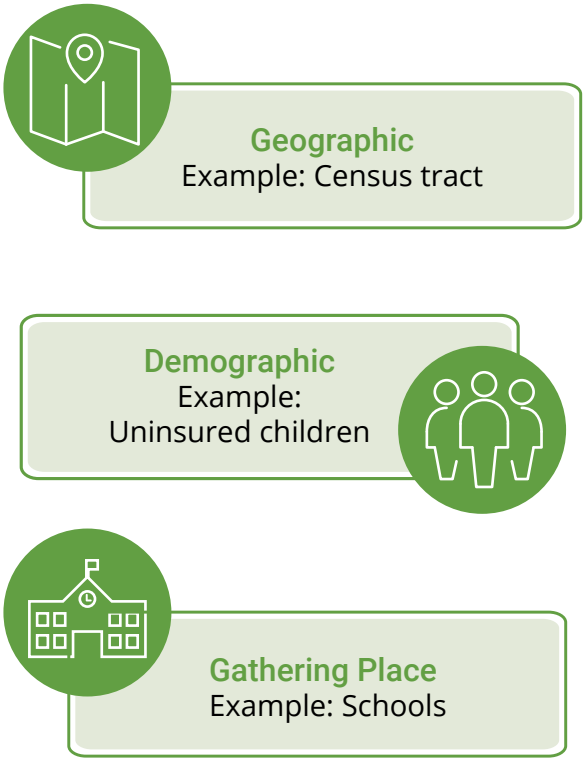
The third approach is to determine if external signs of low vaccination coverage or an increased risk of disease suggest that there may be a pocket of need. An area of low vaccination coverage can be identified via a change in disease incidence or anecdotal information. School data, particularly on immunization exemptions and compliance for kindergarteners, are also excellent guides to potential pockets of need. If a population can be identified using IIS data, it may be possible to determine if the population is a pocket of need and at risk for vaccine-preventable disease.

3.2 PLAN YOUR ANALYSIS

Planning your analysis is split into two activities:

- First, there are several questions that will guide decisions for the data that you will use (either from your IIS or additional data sources).
- Second, there is a description of how to set criteria for analysis, including selecting your cohort, determining vaccination criteria, and selecting the denominator.

SELECT DATA FOR YOUR ANALYSIS BASED ON THE TYPE OF POCKET OF NEED



Are you looking for pockets of need that are geographic, demographic, or based on a gathering point?

Different types of pockets of need require the analysis of different types of data. The figure shows the three categories of pockets of need and examples of data. Not all the examples listed in the figure are available in an IIS.

How are you defining the "small area"?

When determining the small area that you will use, it is important to consider whether the identified subpopulation is an appropriate size to offer meaningful results. It is optimal to use the smallest measurable area that could contain the population of interest. For example, a county of three million people is likely too heterogeneous to identify measurable differences from the larger statistical pattern, and a pocket of need could remain hidden. In this example, it would be more valuable to use a smaller area that would be more homogenous like a ZIP code, Census tract, or school district.

There are also a variety of pros and cons related to each type of small area. For example, ZIP codes are convenient to use for analysis because ZIP codes are included in existing address data. However, since the main purpose of ZIP codes is to allow for efficient mail delivery, they may not be the most representative small area to use to analyze vaccination coverage. Likewise, ZIP codes can change over time, which can complicate analysis of trends. As a second example, Census tract data is beneficial because it is easy to access. However, Census data are estimates which can have large confidence intervals for small areas. An additional challenge related to Census data is that it may quickly become outdated for areas where the population is in flux. Other types of small areas have their own caveats that are important to explore before beginning your analysis.

Do you have the type of data you need in your IIS?

IIS data is very useful for finding certain types of pockets of need and not useful for finding other types. Since IIS store patient address information, the data is well suited to identify geographic pockets of need. IIS also contain some demographic data like age, gender, and race/ethnicity; however, IIS would not likely have information about an individual's religion or socioeconomic status without support from an external source. The most difficult category of pockets of need for an IIS to identify are those based on gathering point. While it is unlikely that an IIS will be able to perform analysis about pockets of need for many types of gathering places (e.g., churches or events), the growing relationship between IIS and childcare centers and schools may offer opportunities for more small area analysis. For example, Michigan's immunization program uses IIS and school data to assess children's compliance with vaccine requirements for kindergarten, seventh grade, and new entrants to a school district and posts waiver and completion rates by school on its public website.[9]

[9]http://www.michigan.gov/mdhhs/0,5885,7-339-73971_4911_4914_68361-335711--,00.html

WHO ARE YOU MISSING?

Not all populations are equally likely to be represented in your IIS data or in other data sources. Children and adults who are homeless, have undocumented status, or move often may not have records in your IIS. The lack of data about certain populations can present a challenge in identifying pockets of need, directing outreach, and responding to outbreaks. It is important to be aware of what populations may not be visible in IIS data and consider options for how to assess the immunization status of these populations (e.g., partnering with community organizations that help these populations).

Even if you do not have the exact information you want in your IIS, you may have data that can act as a proxy. For example, an IIS would not have information about socioeconomic status; however, Vaccines for Children program eligibility data may act as an imperfect but acceptable proxy. In another example of using a proxy measurement, the North Dakota Department of Health looked at ZIP codes that overlapped with approximate tribal reservation boundaries to analyze HPV coverage on reservations.

TIP: A beneficial method of supplementing IIS data is the use of geographic information systems (GIS). Geocoding services can translate IIS address data into geographical information like ZIP code tabulation areas or Census tract information. GIS data can also be helpful if you want to create a map showing the overlay of IIS data and various types of GIS data (e.g., hospitals, doctor offices, socioeconomic data from the Census). AIRA member IIS programs can sign up for SmartyStreets and geocode addresses at no cost (www.immregistries.org/address-cleansing).

Are you able to supplement your IIS data with data from external sources to perform the analysis?

An alternative option to using a proxy measure is using data from an external source to supplement your data. This can involve matching individual records to external data. For example, the Minnesota Department of Health matched vital records to IIS patient data to analyze HPV vaccine coverage in Native American adolescents. You can also match your results for local areas, on an aggregate level, to external data. For example, Census tract data on poverty could be used to analyze vaccination coverage by socioeconomic status. Whenever using proxy or supplemental data, it is important to think critically about the data that are being used and how it affects the interpretation of your results. For example, if you are using Vital Records data to supplement your analysis, you will want to talk to staff who are familiar with the data to learn about caveats to how the data are interpreted.

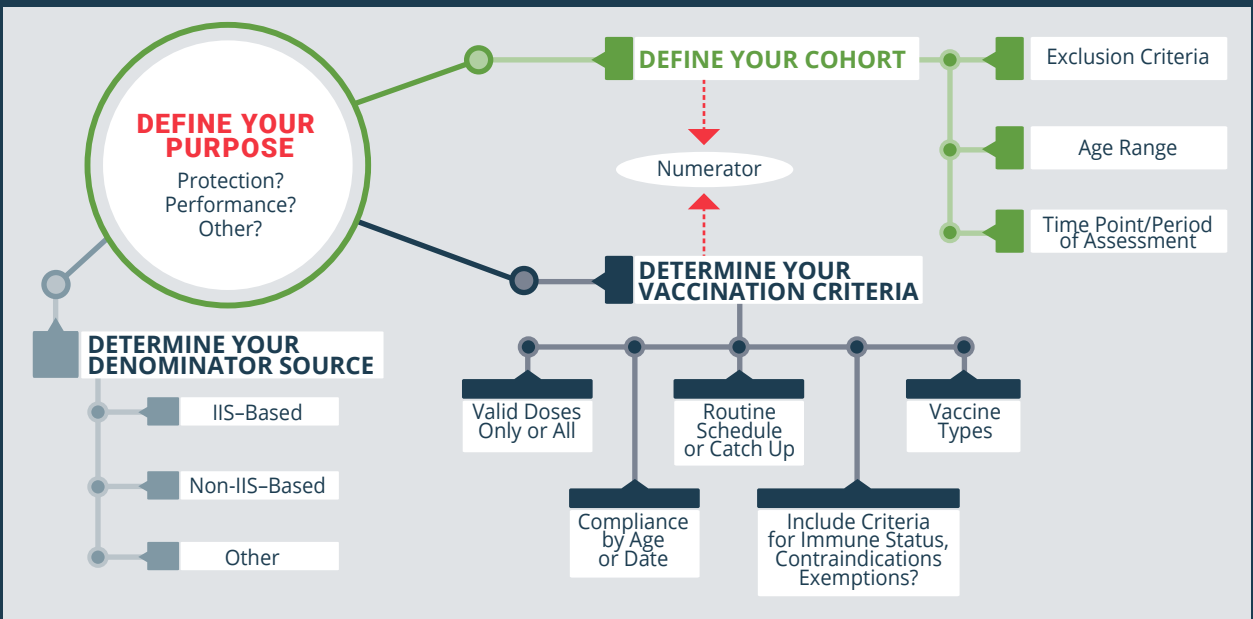
After considering these questions, you may determine that IIS data cannot support the analysis you want to conduct. For example, it is unlikely that IIS data alone could support analysis of whether people who attend the same church are a pocket of need for vaccination coverage. Similarly, it is nearly impossible to use an IIS to identify a pocket of need based around a social network. There may be other ways to research these questions, and some ideas about alternative steps to identify pockets of need are included in Section 4: Responding to a Pocket of Need.

SET THE CRITERIA FOR YOUR ANALYSIS

Performing reliable small area analysis requires a clear delineation of the population you wish to study and the vaccination criteria you wish to assess. Section 3 of the *Analytic Guide for Assessing Vaccination Coverage* provides a comprehensive description of how to set criteria for analysis, including selecting your cohort, determining vaccination criteria, and selecting the denominator. You are encouraged to use the *Analytic Guide for Assessing Vaccination Coverage* to set the criteria for your analysis. The process for determining criteria for analysis is the same for small area analysis as it is for other types of assessment. The process includes these steps:

- Define your cohort
  - Age range
  - Time point or period of assessment
  - Exclusion criteria (e.g., address outside target area, deceased status)
- Determine your vaccination criteria
  - Vaccine types
  - Valid doses only or all doses regardless of validity of dose
  - Compliance by age or date
  - Recommended routine schedule only or catch-up schedule with fewer doses
  - Immune status considered as equivalent to vaccination or not
- Determine your denominator source
  - IIS-based
  - Non-IIS-based (e.g., Census data, school rosters)

Figure 4 | ***Key decision points in designing a vaccination coverage assessment***[10]



[10]This diagram can be found in AIRA's *Analytic Guide for Assessing Vaccination Coverage Using an IIS* along with details about the coverage assessment process.

3.3 ASSESS YOUR DATA QUALITY

Once you have determined the criteria to select your data and the source of your data, the next step is to assess data quality. This will allow you to be confident that results are not affected by errors in the data or a lack of reporting to the IIS. Data quality issues affect all IIS to some degree. Poor data quality leads to assessment results that may not reflect what is truly happening in the jurisdiction. Since no IIS is perfect in recording every person and vaccination administered, there are differences between actual and calculated vaccination rates. Estimating the extent to which an IIS over-counts or under-counts people and vaccinations is helpful for assessing data quality and potential bias, especially biases that might differ between groups that are being compared. Before looking at data quality issues among subpopulations, it is helpful to understand the broader data quality issues affecting your IIS. Your organization likely has staff with expertise about the data quality in the IIS. They can be very helpful in understanding statewide data quality issues as well as data quality issues impacting the subpopulations in your analysis.

The degree of data accuracy, completeness, and timeliness impacts assessment results and may vary from one area or population to another. For example, some areas have more issues with duplicate patient or vaccination records, and other areas have issues with completeness of reporting. Timeliness of immunization reporting to an IIS also varies and can affect coverage results. Overall completeness of records in the IIS, at both the population and vaccination level, may depend on the proportion of providers that consistently report vaccinations, local requirements for reporting to the IIS, and the reliability and capacity of providers to submit high-quality, complete vaccination and demographic information. Identifying individuals who have moved out of the geographic area remains challenging for many IIS, and there is variation in how well areas do at identifying and flagging these individuals. In this section, you can learn about data quality distribution, effects, and under- and overestimates of population and vaccination coverage. Background information about IIS data quality is also included in Appendix E.

ARE DATA QUALITY ISSUES EVENLY DISTRIBUTED ACROSS SUBPOPULATIONS?

If errors are similar across subpopulations, you will likely still be able to perform a relative comparison of the subpopulations. For example, if statewide there is a consistent rate of approximately 1% underreporting vaccination data, then a relative comparison of subpopulations would still be useful for identifying pockets of need. However, if the percentage of underreporting is 15% in ZIP code A because a clinic is not reporting to the IIS and 1% in ZIP code B where all clinics are reporting to the IIS, identifying a pocket of need would be difficult due to the data quality differences.

You can assess whether you have data quality issues by performing external or internal comparisons of your data. An example of an external comparison is looking at the number of individuals in the IIS for the ZIP code compared to the number in the Census. An example of an internal comparison is comparing the vaccination coverage for the vaccine you are assessing (e.g., hepatitis A) to the vaccination coverage for a very commonly administered vaccine (e.g., first dose of DTaP) in the IIS. In addition to performing analyses to identify data quality issues, it is also important to utilize knowledge of local vaccination and reporting issues. State, regional, and local public health staff may be able to offer useful insights about vaccination trends and reporting issues in their jurisdiction.

EFFECTS OF DIFFERING DATA QUALITY ISSUES ACROSS SUBPOPULATIONS

It is important to recognize that bias can potentially result in an underestimate or overestimate of vaccination coverage in a subpopulation. An underestimate of coverage could lead to a subpopulation appearing to be a pocket of need with low coverage when that is not the case. Likewise, an overestimate of vaccination coverage can disguise a real pocket of need since the inflated results will make the coverage look normal or high. It becomes increasingly difficult to predict the direction of error when there are multiple sources of errors. Appendix F includes a table with specific data quality issues, the potential impact on coverage estimates, and examples of situations where the issues may occur in small area analysis.

DOES YOUR DATA UNDERESTIMATE OR OVERESTIMATE THE POPULATION?

The accuracy of population size can be assessed by comparing your data to external population sources (e.g., the IIS population for a county could be compared to the Census estimates for the county). If you find that some counties have a much smaller population in the IIS than the expected population documented in the Census, it would suggest underreporting of the population. If an IIS population count is higher than the Census population in counties that have high migration, this could suggest incomplete documentation of individuals who have moved or gone elsewhere or, potentially, duplicate records. For this comparison to be useful, the external population source must be reasonably accurate for the small area. For example, it might be problematic to use Census data for a comparison to IIS data when looking at an area with a large population change since the last Census (e.g., the oil fields in North Dakota which contain a highly mobile population).

DOES YOUR DATA UNDERESTIMATE OR OVERESTIMATE VACCINATION COVERAGE?

Bias related to vaccination coverage is more difficult to ascertain since it requires the existence of another source of vaccination coverage information. For example, you could compare the data from your IIS to estimates from the National Immunization Survey or other surveys for a similar vaccine and age group in the population of interest. Similarly, you could look at vaccination data collected by schools and reported to the health department.

Two examples of underestimates of vaccination coverage are:

- Certain organizations delay reporting influenza vaccinations until the end of the influenza season. This can cause difficulties when trying to accurately assess influenza vaccination coverage during the current season.
- Counties or ZIP codes on the border of a state may have underestimated coverage if many of the residents receive care in the neighboring state and the data does not get reported to your jurisdiction's IIS.

DOES THE DATA QUALITY IN YOUR IIS ALLOW YOU TO IDENTIFY A POCKET OF NEED?

Once you have looked at your data and identified potential data quality issues, you may ask yourself, "Can my data be used to identify pockets of need?" To answer this question, it is helpful to ask a few other questions.

1. **Can I easily fix the data quality issue?**
   Not all data quality issues are easy to solve, but, if possible, it's helpful to fix them. By correcting these issues, you will improve your ability to identify pockets of need and benefit the overall quality of your IIS data. For example, if you discover that a clinic in the small area you are analyzing has been incorrectly entering meningococcal ACWY vaccine as meningococcal B vaccine, you or other staff in your IIS may want to work with the clinic to correct that data before performing further analysis.
2. **Are the data quality issues uniform across subpopulations?**
   If so, you can look at relative coverage between subpopulations. While your data may not be of sufficient quality to determine the true absolute coverage, it may be acceptable to compare the relative coverage in relation to other populations. For example, Census tract A is in the bottom quintile of Census tracts in the state; thus, the health department plans to perform additional Assessment, Feedback, Incentives, and eXchange (AFIX) visits in this Census tract.
3. **Can I adjust for this issue during analysis?**
   Once you have identified an issue, you may be able to adjust the data to manage the bias. The next subsection identifies methods to adjust your data to manage bias.
4. **Can I determine the likely direction and magnitude of the bias?**
   It may not be possible to completely adjust for bias in the analysis, but you may be able to determine if IIS estimates are likely to be an overestimate or underestimate. Likewise, it may be possible to determine an upper estimate or range for the bias. This information can be used to determine an estimate or range for the actual vaccination coverage and is useful in determining if there should be a response to a possible pocket of need.

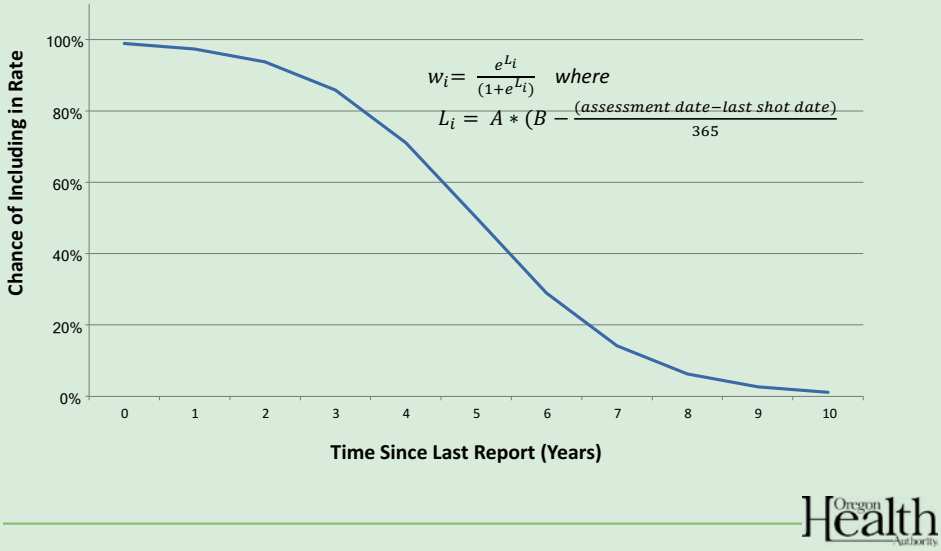
If you determine that the data quality issues are too significant to allow for identification of pockets of need, you are encouraged to investigate if alternative methods or data sources could be used for this purpose.

ADJUST FOR BIAS IF NEEDED

If you determine that there are differing levels of data quality issues among the subpopulations that you are comparing, you will want to consider adjusting for any known biases. For example, if the percentage of underreporting is 15% in ZIP code A, 1% in ZIP code B, and 1% in ZIP code C, you would want to adjust your data to decrease or remove this bias. Two recent real-world examples of adjusting for bias are from Oregon and New York City.

- The Oregon Health Authority explored options for addressing the issue of individuals who have moved or gone elsewhere. Oregon IIS staff weighted individual records based on the amount of time since the last reported vaccination date. Data from individuals with a more recent vaccination date were weighted more heavily than those with a distant vaccination date (i.e., more emphasis was given to data from individuals who appeared to still live in the area). This helped decrease the bias from individuals who had moved or gone elsewhere.[11]

Figure 5 | *Hybrid (Ogive) teen weight formula and graph*



[11]Robison, S.G. (2015) "Addressing immunization registry population inflation in adolescent immunization rates." Public Health Rep. 2015 Mar-Apr; 130(2):161-6.

- In New York City, Bureau of Immunization staff developed a method of estimating HPV vaccine coverage by ZIP code that takes into account reporting biases in its IIS, the Citywide Immunization Registry (CIR). The staff started by selecting a reference vaccine, Tdap, which was required for school attendance and was recorded in the "Automate the Schools" (ATS) database, which captures school immunization compliance data. They then compared Tdap vaccination coverage in the ATS database to Tdap coverage in the CIR. A reporting score was created for each ZIP code based on the ratio of CIR Tdap coverage to ATS Tdap coverage. This reporting score was then used to adjust the CIR-based HPV vaccination coverage for each ZIP code, to adjust for biases in reporting to the IIS.[12] This data was then used to visualize pockets of need for HPV in New York City.

Figure 6 | *Equations to create a reporting score*

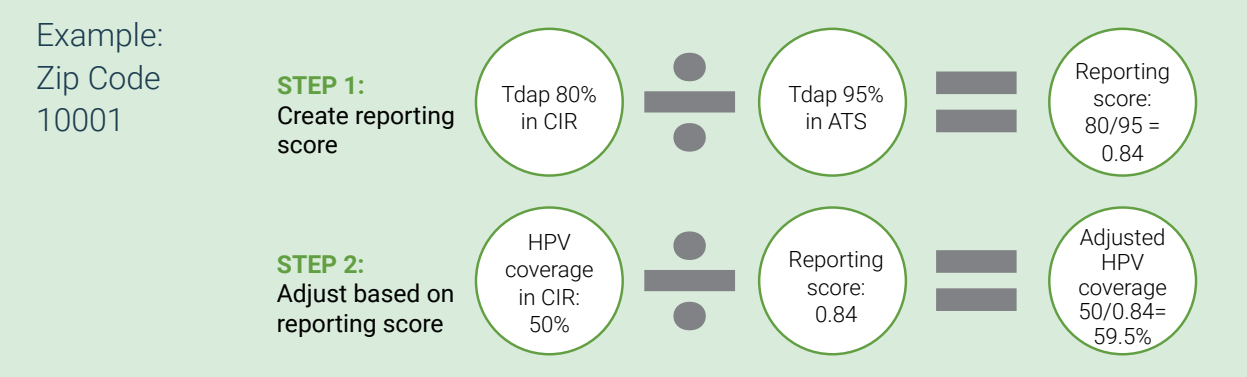
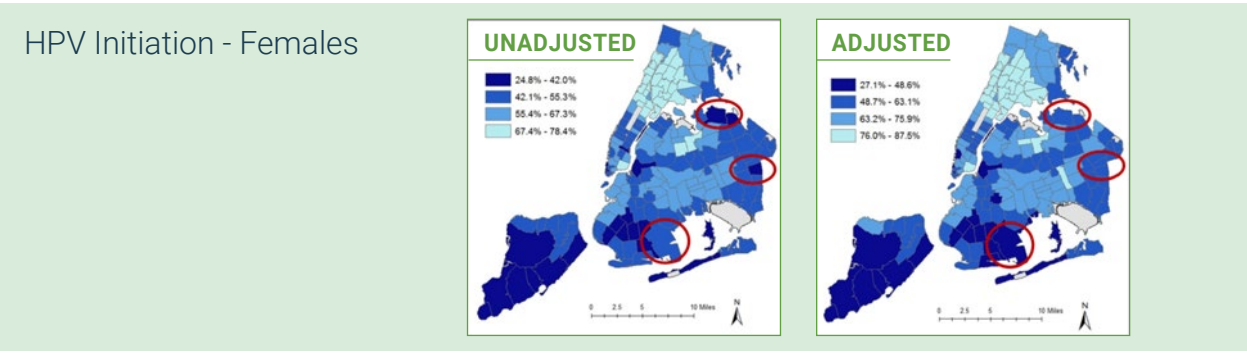


Figure 7 | *HPV initiation of adolescent females in New York City*



[12]Papadouka, V. (2017) Human Papillomavirus Vaccination Coverage in New York City: a Geographical Analysis (within the presentation Going Small: Strategies for Identifying Local Pockets of Need). Presentation. http://repository.immregistries.org/resource/going-small-strategies-for-identifying-local-pockets-of-need/.

TIP: An alternate approach is to identify data quality issues after analyzing the data. Once you have performed your analysis and identified small areas with low coverage estimates, follow-up can be done to determine the extent to which apparent low coverage is due to truly low vaccination coverage versus poor data quality. There is a large value to the IIS program in identifying pockets of poor reporting and data quality, since it provides the opportunity to fix these issues.

For example, you could use your analysis to identify the ZIP codes that are in the lowest quartile for HPV coverage. You could then look in depth at each of those ZIP codes to determine if the problem is related to low vaccination coverage or reporting issues. This process identifies ZIP codes that:

- Require outreach to improve vaccination coverage
- Need assistance with data quality
- Require both types of assistance

Note: A risk of using this approach is that you may not identify pockets of need where data quality issues have led to an overestimate of vaccination coverage.

3.4 CONDUCT THE SMALL AREA ANALYSIS

Using the criteria for analysis that were identified in step 3.2 and the data quality adjustments determined in step 3.3, you can now perform the small area analysis.

You will want to calculate the vaccination coverage for each area that is included in the analysis. The specific processes and tools for performing analysis will vary by organization; however, the *Analytic Guide for Assessing Vaccination Coverage Using an IIS* can provide useful tips for planning and conducting the analysis. The *Analytic Guide* describes practical considerations and key decision points in designing a population-based assessment using an IIS. Appendix F of the *Analytic Guide* provides examples of real-life coverage assessments that may be helpful in planning your analysis. You are also encouraged to review the research articles that are referenced in this guide, which provide detailed descriptions of their methods for analysis.

The vaccination coverage results can be sorted or statistically assessed to identify if there are results that show low coverage. This may be in comparison to state or local vaccination averages or goals, NIS coverage levels, or the distribution of results for areas in the analysis.

3.5 DETERMINE IF YOUR ASSESSMENT INDICATES A POCKET OF NEED

There is no specific rule for what qualifies as a pocket of need. A small area does not need to have a statistically significant difference from other small areas or from the state or national level. Consider the purpose of your analysis in deciding how you want to define a pocket of need. If you are trying to identify a subset of school districts with low adolescent vaccination coverage so you can pay for promotional messaging at high school sporting events, you may want to use your budget to determine if you should select the bottom third or quartile or quintile of school districts for the intervention. If you are planning to publish a paper about health equity disparities in your state, you will likely want a stricter statistical definition for pocket of need.

- **Yes, we believe we see evidence of a pocket of need.**
  What do you do next? Section 4: Responding to a Pocket of Need includes information on types of responses, highlights real-life examples, and provides references to helpful tools and documents. Responses will vary based on many factors, including your confidence that a pocket of need is real, the scope of the pocket of need, and the resources allocated to respond. You will want to select which responses best fit your situation.
- **No, we do not see a pocket of need (or we are not sure if we see a pocket of need).**
  Hopefully, this means you do not have a pocket of need, which is a very good finding. Now that you have done small area analysis looking for one type of pocket of need, you may want to perform additional small area analysis to look for other types of pockets of need. For example, if you looked for geographic pockets of need, you might want to analyze demographic variables next. You are also encouraged to repeat your analysis on an annual or semiannual basis to watch for changing trends. It is also important to remember that IIS data is not well suited to find all types of pockets of need. Thus, it is possible for a pocket of need to exist and not be reflected in IIS data. If you have reason to believe that there may be a pocket of need that was not shown in this analysis, you may want to perform additional analysis of data in your IIS or from external sources. Several options for further analyses are included in Section 4: Responding to a Pocket of Need.

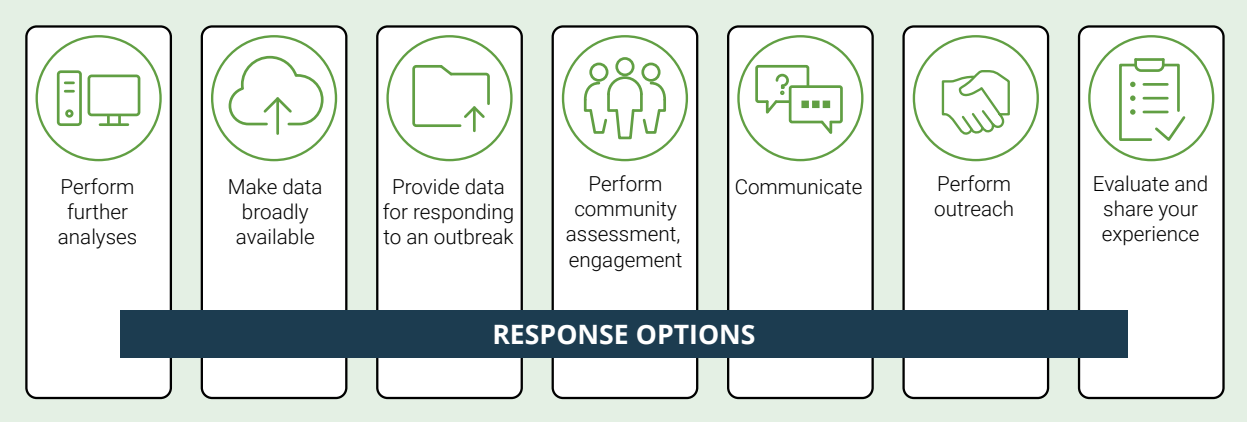
SECTION 4 RESPONDING TO A POCKET OF NEED

This section provides brief descriptions of processes to respond to a pocket of need. This guide does not attempt to provide a handbook for how to perform these processes but instead highlights examples of the processes and directs you to helpful resources.

The following set of responses is not a prescription for responding to a pocket of need. You will want to select which responses best fit your situation. Similarly, you might select the type of response based on your certainty about a pocket of need's being real. If you are planning to send vaccine reminders to families living in ZIP codes that are in the lowest quintile of vaccination coverage, there may be little negative effect on the population if a ZIP code is incorrectly categorized. However, if you are planning to do a press release about a pocket of need, there is a greater need to ensure that your data are accurate.

It is highly recommended that you work with the experts at your organization when designing and performing community assessment, community engagement, communication, or outreach. If you do not have staff at your organization who can help you, you can often get support from experts at other health departments or the Centers for Disease Control and Prevention (CDC).

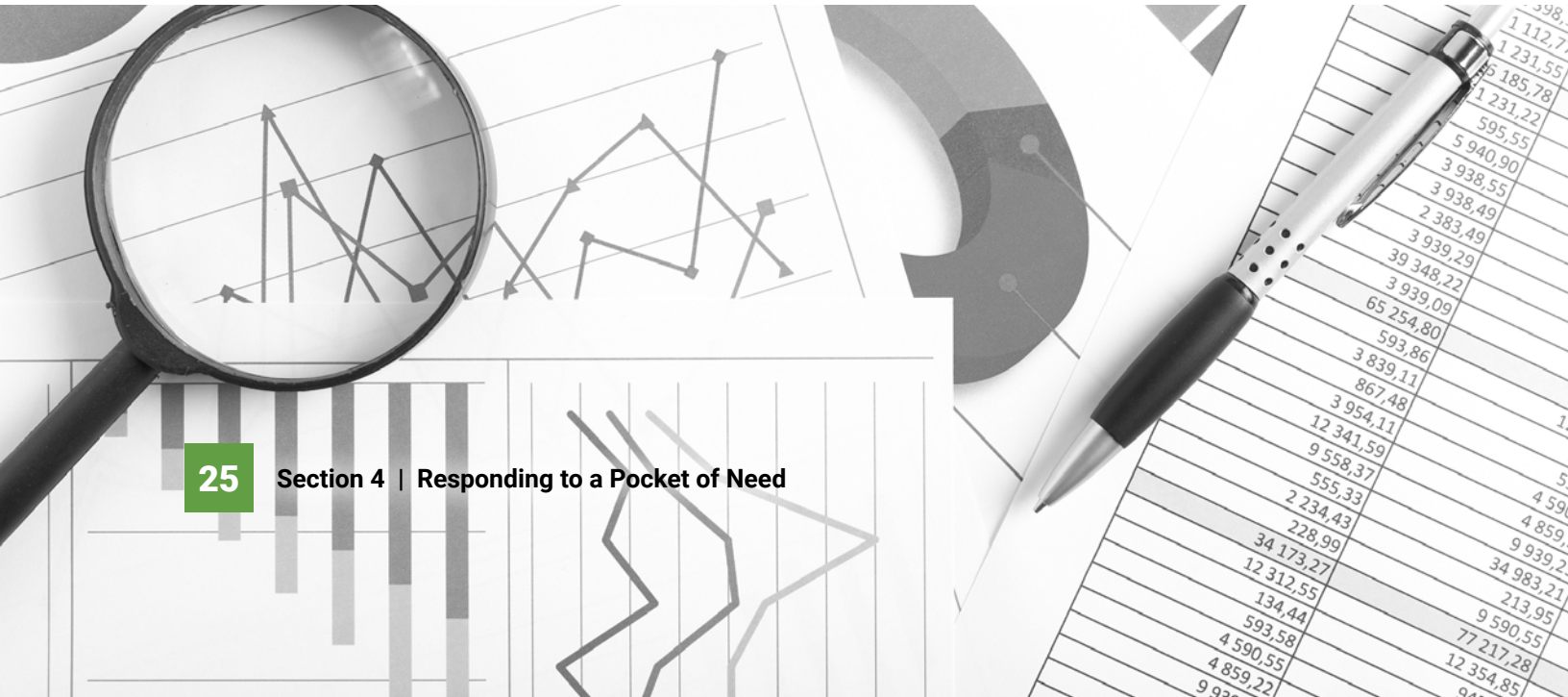
Figure 8 | *Processes to respond to a pocket of need*



4.1 PERFORM FURTHER ANALYSES

Once you have identified a pocket of need, you may want to do additional research to gain a more detailed understanding of vaccination coverage in the population. Additional approaches to exploring your data include:

- Look at changes in coverage in the pocket of need over time to understand the factors influencing low coverage. If you are looking at a small population and you find that there is significant variability in coverage from year to year, you may want to do additional analyses and conduct community assessment or engagement to better understand what the data are telling you.
- Analyze additional factors related to the pocket of need. For example, if you identified low influenza vaccination coverage in African-American adults in City A, it could prompt you to analyze several other relationships to better understand the pocket of need. This could include looking at coverage for other vaccines (e.g., pneumococcal vaccine), other age ranges (e.g., adolescents), or other geographic areas (e.g., African-American adults in Cities B and C). By expanding your analysis, you can gain a more comprehensive understanding of the pocket of need.
- Perform advanced analyses to produce more statistically robust results or identify factors causing low coverage. Several advanced small area analysis studies involve mapping techniques, which can be helpful in identifying statistically significant clusters of unvaccinated or undervaccinated individuals. In the resources below, there are several published studies which include helpful descriptions of methods to perform more complex statistical analysis of pockets of need. If you decide to perform more advanced statistical analysis, you may want to consider working with staff within your health department with a high level of expertise in statistics or reaching out to staff at CDC or a college or university for assistance.



Beyond performing additional analyses of IIS data, there are alternative methods for identifying and confirming a pocket of need, including:

- Analyses of other data sources: Compare your results with results from other datasets to see if the results of your initial analysis are replicated in other data. School immunization data can be a helpful indicator of low vaccination coverage. Similarly, data from disease reporting systems can help determine if you are seeing an increase in the incidence of a vaccine-preventable disease. Additional data sources can also be helpful in identifying trends that might not be apparent in IIS data. For example, if a charter school with students from various neighborhoods has low vaccination coverage, the pocket of need would not be visible in IIS data alone.
- Key informant interviews: This process involves interviewing individuals who have first-hand knowledge about the population of interest. This could include speaking with local public health staff, community workers, medical professionals, or community leaders.
- Focus groups: This activity involves bringing small groups of individuals from the population of interest together to ask them questions about their knowledge, perceptions, attitudes, and beliefs towards immunization or a specific vaccine.

PRACTICAL EXAMPLES OF PERFORMING ADDITIONAL ANALYSES

- After finding low vaccination coverage in the Somali-American population in Minnesota, the Minnesota Department of Health (MDH) further analyzed coverage rates across race, ethnicity, and parental birth country. MDH used information from the IIS and Vital Records to link immunization records with race, ethnicity, and parental birth country data from birth certificates. The analysis examined early childhood immunization rates and found that children with at least one foreign-born parent were less likely to be up to date on recommended immunizations at ages 2, 6, 18, and 36 months than were children with two U.S.-born parents. MDH is using these results to gain a better understanding of which communities need additional outreach.[13]

- The 2015 National Immunization Survey data showed a 5% decrease in the point estimate for Michigan's vaccination coverage for the primary 4-3-1-3-3-1-4 series for children 19 through 35 months of age. One possible reason for the decrease in vaccination coverage was that parents with concerns about vaccines were limiting the number of shots that their child could receive at

[13]Leeds, M., Halstead Muscoplat, M. (2017). Timeliness of Receipt of Early Childhood Vaccinations Among Children of Immigrants — Minnesota, 2016. MMWR. Morbidity and Mortality Weekly Report. 66. 1125-1129.

a medical visit. The Michigan Care Improvement Registry (MCIR) staff linked IIS data to electronic birth records to estimate the prevalence of children whose parents limited the number of shots received per visit. Likewise, MCIR staff looked at the characteristics of these children, assessed whether the children were up to date on recommended vaccinations, and investigated possible intervention points for vaccination education. The study found that shot-limited children were less likely to be up to date on vaccinations. In addition, parents who limited vaccines were more likely to use a midwife, and children with midwife-attendant births were more likely to be delayed in receiving vaccinations. Based on this information, the study suggested that learning more about the knowledge, attitudes, and behaviors of midwives toward vaccinations could be beneficial in developing a health education approach that emphasizes the importance of being up to date and discusses the challenges associated with shot-limiting. This study helped the Michigan Department of Health and Human Services better understand an undervaccinated population and determine methods to better target outreach.[14]

- The Oregon Health Authority had concerns about vaccine hesitancy and increases in parental adoption of alternative schedules. They performed a study on the prevalence and trends in alternative schedule usage by measuring consistent shot-limiting. Analysis was performed using data from the ALERT IIS to track children born between 2003 and 2009 in the Portland metropolitan area. The study found that the proportion of consistent shot-limiters increased to 9.5% from 2.5% between 2006 and 2009. This suggested an increase in acceptance of alternative vaccine schedules in the Portland metropolitan area.[15]

[14]Weinberg, M., et al. "Vaccine Shot-Limiting: Estimating the Prevalence, Indicators, and Impact on Vaccination Status — Michigan, 2012." Vaccine, vol. 35, no. 7, 2017, pp. 1018–1023., doi:10.1016/j.vaccine.2017.01.013.
[15]Robison, S.G., Groom, H., Young, C. (2012). Frequency of Alternative Immunization Schedule Use in a Metropolitan Area. Pediatrics, 130(1). doi:10.1542/peds.2011-3154d.

RESOURCES FOR PERFORMING ADDITIONAL ANALYSES

- Analytic Guide for Assessing Vaccination Coverage Using an IIS (http://repository.immregistries.org/resource/analytic-guide-for-assessing-vaccination-coverage-using-an-iis/)
- Examples of advanced statistical analyses:

ARTICLES	CONCLUSIONS
Lieu, T.A., Ray, G.T., Klein, N.P., Chung, C., Kulldorff, M. (2015). Geographic Clusters in Underimmunization and Vaccine Refusal. Pediatrics, 135(2), 280-289.	"Underimmunization and vaccine refusal cluster geographically. Spatial scan statistics may be a useful tool to identify locations with challenges to achieving high immunization rates, which deserve focused intervention."
Omer, S.B., Enger, K.S., Moulton, L.H., Halsey, N.A., Stokley, S., Salmon, D.A. (2008). Geographic Clustering of Nonmedical Exemptions to School Immunization Requirements and Associations with Geographic Clustering of Pertussis. American Journal of Epidemiology, 168(12), 1389-1396.	"Geographic pockets of vaccine exemptors pose a risk to the whole community. In addition to monitoring state-level exemption rates, health authorities should be mindful of within-state heterogeneity."
Trogdon, J.G., Ahn, T. (2015). Geospatial patterns in influenza vaccination: Evidence from uninsured and publicly insured children in North Carolina. American Journal of Infection Control, 43(3), 234-240.	"To the extent that the geospatial clustering of vaccination rates is the result of social influences, targeting interventions to increase influenza vaccination among school-aged children in one area could also lead to increases in neighboring areas."

4.2 MAKE DATA BROADLY AVAILABLE

There are many benefits to making your data available to partners or the public. By displaying and promoting your data, you support transparency and draw attention to issues. Community members may not be aware of low vaccination coverage, and sharing data may prompt community members and leaders to partner with your organization to find solutions to improve coverage.

Many health departments regularly post geographic small area data on their websites. There are a variety of methods for displaying this data, including reports, report cards, and interactive maps. Appendix G includes several examples. Section 4 of *Comparing and Communicating Vaccination Coverage Estimates from IIS, NIS, and Related Assessments* includes helpful information about how to create graphical representations of your data.

You can also share your data in targeted ways. For example, if you have concerns about the vaccination coverage in a specific city, you may want to share your results with local public health staff who work with that city rather than releasing the data more broadly. You can also target the release of results to medical providers, medical organizations, or nonprofits if you think it may help them direct their activities.

If releasing results that identify a pocket of need could damage your organization's relationship with a community or lead to stigmatization of that community, you will want to be thoughtful about whether releasing results to the public is the best method to improve vaccination coverage in that situation. You may want to explore other processes of responding to a pocket of need—either before releasing the results or as an alternative to releasing the results.

TIP: Privacy is an important concern when working with small populations. It is important to ensure that no individual can be identified based on publicly released data. Many organizations have policies regarding releasing data about small populations. The North Dakota Department of Health's *Policy on Small Numbers Release* specifies that it would not permit release of certain stratified data (e.g., number of African Americans with x condition) since the population of the subgroup may be small enough to become identifiable. You are encouraged to review your organization's policy before making data broadly available. An additional example of a small numbers policy is from the Rhode Island Department of Health and is available at http://health.ri.gov/publications/policies/SmallNumbersReporting.pdf.

PRACTICAL EXAMPLES OF MAKING DATA BROADLY AVAILABLE

See Appendix G for several examples of how health departments have made data available on their websites.

RESOURCES FOR MAKING DATA BROADLY AVAILABLE

- *Comparing and Communicating Vaccination Coverage Estimates from IIS, NIS, and Related Assessments* – Section 4: Practical Strategies for Communicating NIS and IIS Results with Examples (http://repository.immregistries.org/resource/comparing-and-communicating-vaccination-coverage-estimates-from-iis-nis-and-related-assessments/)

4.3 PROVIDE DATA FOR RESPONDING TO AN OUTBREAK

When you find a pocket of need that overlaps with an outbreak, there are several ways that you can use IIS data to support staff who are responding to the outbreak. You can provide the staff with the results of your analysis, which can help target communication and outreach related to the outbreak. Reminder-recall messages can be sent to individuals who are unvaccinated within your pocket of need to encourage vaccination. IIS data can be used to monitor vaccination coverage levels and changes in vaccination trends during the outbreak. Likewise, the IIS can provide granular data about which specific communities are getting vaccinated during the outbreak and which provider organizations have had an increase in vaccination during the outbreak.

PRACTICAL EXAMPLE OF PROVIDING DATA FOR RESPONDING TO AN OUTBREAK

In August 2016, a hepatitis A outbreak began in four southeastern Michigan jurisdictions. Between August 2016 and March 21, 2018, the outbreak spread to 19 southeastern and central Michigan jurisdictions with 789 cases and 25 deaths. MCIR was used to produce adult hepatitis A coverage estimate reports to inform public health outreach efforts. Additional information used from MCIR included the facility type of sites reporting hepatitis A doses, dose eligibility (i.e., private insurance or public), and reported immune globulin doses. Beginning in April 2017, a monthly report of adult hepatitis A doses was developed to inform local and state public health staff of vaccine administration in outbreak jurisdictions. MCIR data were also used in response to ad hoc queries from stakeholders involved in the outbreak. By providing timely, accurate vaccination data to responders, MCIR was able to inform and support the outbreak response.

RESOURCES FOR PROVIDING DATA FOR RESPONDING TO AN OUTBREAK

- Minnesota's Use of the IIS in Measles Outbreak Response – an AIRA *SnapShots* article (http://repository.immregistries.org/resource/snapshots-june-2017/)
- The Guide to Community Preventive Services' *Immunization Information Systems to Increase Vaccination Rates: A Community Guide Systematic Review*, page 7 (https://www.thecommunityguide.org/sites/default/files/publications/vpd-jphpm-evrev-IIS.pdf)

4.4 PERFORM COMMUNITY ASSESSMENT AND ENGAGEMENT

A fundamental step in working with any community is engaging with the population to understand its knowledge, attitudes, beliefs, goals, and concerns. There are two levels to how you can engage with a community:

- Community assessment—a process of working with community members and leaders to gather input about a specific issue
- Community engagement—a long-term process that involves community members as partners in determining steps that can be implemented to improve health and wellness

Community assessment allows you to better understand the community and the issues leading to low vaccination coverage. This is valuable because assumptions about why a community has low coverage are often incorrect and actions based on incorrect assumptions are, at best, a waste of time and resources and, at worst, offensive to the community and counterproductive. You can learn more about a community by performing surveys, key informant interviews, or focus groups. The resources below will connect you with many good ideas for assessing the needs of a community.

Community engagement is thought to be the gold standard for working with a population because it emphasizes building relationships and trust with the community over an extended period. Community engagement is based on the belief that communities have a right to be involved in decisions involving their health. By creating a meaningful, long-term relationship with a community, an organization can increase two-way communication, and the community can determine the interventions that its members feel are most beneficial. It is important to realize that community engagement might not lead to the actions you want to take. For example, your organization may feel that reminder-recall would be the best method to improve vaccination coverage, but community members may believe that they need longer visits with their medical provider to ask more questions. In this situation, community engagement requires listening to the community and supporting the actions its members want to pursue. It is important to recognize that community engagement can be time and resource intensive, so organizations should make sure that they will have ongoing support and commitment from their leadership before engaging the community.

PRACTICAL EXAMPLE OF THE VALUE OF COMMUNITY ASSESSMENT AND ENGAGEMENT

The following example demonstrates the challenges associated with assumptions regarding low vaccination coverage. In Oregon, a community known for alternative health beliefs had low 2-year-old vaccine series completion rates. This was initially assumed to be caused by the community beliefs about health care. On further investigation, it was discovered that children were missing their fourth DTaP in the vaccine series and that very few children had any immunizations given between 12 months and 24 months of age. This information was shared in the local newspaper, and the subsequent community dialogue found that the local insurer was discouraging the families from attending a 15- to 18-month visit, since the insurer's medical director did not feel it was a needed visit. Once the specific issue was discovered, the Oregon Health Authority was able to respond to it directly and, in collaboration with the community, solved the problem of low coverage levels.

RESOURCES FOR COMMUNITY ASSESSMENT AND ENGAGEMENT

- Minnesota Department of Health's *Community Engagement Unit* (http://www.health.state.mn.us/divs/opi/community)
- University of Kansas Center for Community Health and Development's Community Tool Box – Chapter 3. Assessing Community Needs and Resources (https://ctb.ku.edu/en/table-of-contents/assessment/assessing-community-needs-and-resources)
- Wilder Foundation's Community Engagement to Advance Health Equity: Strategies and Tips (http://www.health.state.mn.us/divs/opi/healthequity/resources/wilder-engagement.html)

4.5 COMMUNICATE

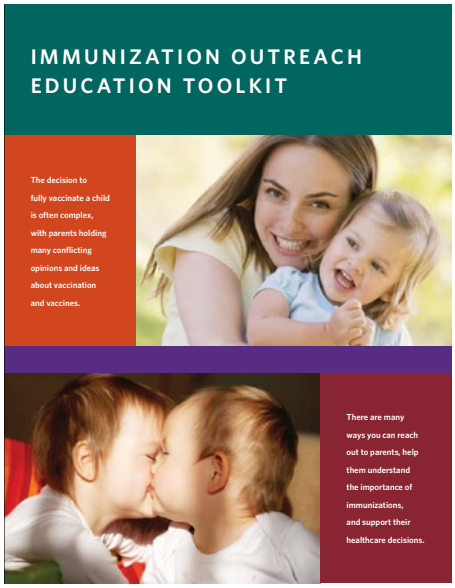
By communicating about low vaccination coverage, you can bring attention to the problem and, if possible, provide guidance about how the problem can be resolved. A common misconception about communication is that it involves just releasing messages to partners, the public, or the media. A comprehensive communication plan involves an in-depth understanding of your goals, audiences, and the process of developing and delivering your messages. You are encouraged to perform community assessment or engagement before developing your communication plan to ensure that your messaging addresses the actual issue leading to low coverage. It is also important to remember that a communication plan may include different messaging strategies for different audiences. For example, if you discover low influenza vaccine coverage for young children in a county, you will likely want to have one message developed for medical providers and another message for parents. Likewise, you may want different messengers depending on the audience (e.g., a doctor or public health leader to communicate with medical providers versus a local doctor, community leader, or parent to communicate to parents). If your organization has communications staff, you are highly encouraged to involve them in developing and implementing a communication plan. There are many excellent resources available to assist you in developing communication plans, creating messages, using social media, and working with specific audiences. The list of resources below includes tools, toolkits, and guides to support your work. An additional set of resources includes websites with communication pieces for a variety of audiences that you may want to provide or reference during your communication and outreach.

PRACTICAL EXAMPLES OF COMMUNICATION

- In response to high exemption rates, the Michigan Department of Health and Human Services created a series of communication pieces for local health departments to use to address vaccine hesitancy. Each communication piece addressed a different topic like pain, number of doses, amount of antigens, and how vaccines are produced.[16]

[16]Michigan Department of Health and Human Services Immunization Waiver Information. Retrieved from http://www.michigan.gov/mdhhs/0,5885,7-339-73971_4911_4914_68361-344843--,00.html.

- In response to an increase in the number of parents choosing to exempt their children from required immunizations, the Maine Immunization Program (MIP) undertook a process to better understand the concerns of parents and developed targeted messaging strategies. Additional research into these exemptions revealed that they were not focused in geographic areas of Maine but broadly dispersed throughout the state. To address this challenge, the MIP contracted with Policy Studies Inc. (PSI), a public health service company with expertise in social marketing, for a joint project. This project involved additional analysis of parents' vaccine hesitancy; categorization of vaccine-hesitant parents geographically at the sub-county level using population analysis tools; and development of specific outreach and education strategies for each identified category of vaccine-hesitant parent. A description of this project and the developed messages is available in the report *Parents' Immunization Hesitancies In Maine And Social Marketing Strategies To Overcome Them*.[17] The *Immunization Outreach Education Toolkit* was developed to help implement the findings of the project.[18]



RESOURCES FOR COMMUNICATION

- Association of State and Territorial Health Officials (ASTHO) Communicating Effectively About Vaccines web page (http://www.astho.org/Communicating_Effectively_About_Vaccines/)
- CDC Social Media Tools, Guidelines & Best Practices (https://www.cdc.gov/socialmedia/tools/guidelines/index.html)
- The Guide to Community Preventive Services' *What Works Fact Sheet: Health Communication and Health Information Technology* (https://www.thecommunityguide.org/resources/what-works-health-communication-health-information-technology)
- *Comparing and Communicating Vaccination Coverage Estimates from IIS, NIS, and Related Assessments* – Section 3: Developing Communication Messages, Section 4: Practical Strategies for Communicating NIS and IIS Results with Examples, and Appendix F: Quick Reference Guide for Improving Readability (http://repository.immregistries.org/resource/comparing-and-communicating-vaccination-coverage-estimates-from-iis-nis-and-related-assessments/)

[17]Parents' Immunization Hesitancies In Maine And Social Marketing Strategies To Overcome Them. Retrieved from http://www.maine.gov/dhhs/mecdc/infectious-disease/immunization/providers/documents/maine-immunization-report.pdf.
[18]Immunization Outreach Education Toolkit. Retrieved from http://www.maine.gov/dhhs/mecdc/infectious-disease/immunization/providers/documents/immunization-outreach-toolkit.pdf.

- Department of Health and Human Services, Public Health Service, National Institutes of Health. *Making health communication programs work: A planners guide* (https://www.cancer.gov/publications/health-communication/pink-book.pdf)
- National Association of County and City Health Officials (NACCHO) Guide to Human Papillomavirus Resources for Local Health Departments (http://essentialelements.naccho.org/archives/7751)
- National Public Health Information Coalition Ethnic Media Toolkit (https://www.nphic.org/toolkits/ethnic-media)
- Smart Chart – A free online tool that provides a step-by-step process for creating a communication plan (https://smartchart.org/)

EXISTING RESOURCES THAT CAN BE PROVIDED TO PARTNERS OR THE PUBLIC

- CDC Educational and Promotional Resources for Partners (https://www.cdc.gov/vaccines/partners/index.html)
- Immunization Action Coalition: Handouts for Patients and Staff (http://www.immunize.org/handouts/)
- National Public Health Information Coalition Immunization Toolkit (https://www.nphic.org/niam?utm_source=NPHICORG&utm_medium=ToolkitHomePage+HorizontalSlide+Text&utm_content=NIAM+HomePage&utm_campaign=NIAM17)

4.6 PERFORM OUTREACH

The term "outreach" is used to describe a wide variety of initiatives in public health which can range from spreading information to providing services. Communications can be a part of the outreach process if the goal of the communications is to improve vaccination coverage. Outreach can also work to change relationships between the community and providers, increase access to services, or encourage the use of tools and strategies to support immunization (e.g., reminder-recall). There is a wide variety of outreach activities that have been used to respond to low vaccination coverage including reminder-recall, AFIX, promotional campaigns, targeted communications, and partnerships with local clinics/local public health to increase access to immunization. The Guide to Community Preventive Services' *What Works Fact Sheet: Increasing Appropriate Vaccination* includes an excellent summary of findings for how to increase vaccination. That summary is included below for your convenience, and you are also encouraged to read the full fact sheet.

Quick Tips from the *What Works Fact Sheet: Increasing Appropriate Vaccination*

The following content is from the *Guide to Community Preventive Services. What Works: Increasing Appropriate Vaccination*. You are encouraged to read the full document.

- Enhancing access to services. Interventions that make it easier for people to get vaccinated can increase rates. Interventions that have proven successful include the following:
  - Reducing out-of-pocket costs by paying for vaccinations, providing insurance coverage, or reducing co-payments.
  - Providing vaccinations in schools and organized childcare centers.
  - Coordinated vaccination interventions in Special Supplemental Nutrition Program for Women, Infants and Children (WIC) settings, where assessment of children's immunization status and referral to a vaccination provider were combined with additional interventions or provision of vaccinations on-site.
  - Home visits can also increase vaccination rates but may be expensive and labor-intensive.
- Increasing community demand. Programs and systems that encourage people to get vaccinated can increase coverage.
  - Notifying people when they are due or late for a vaccination can remind them to follow through. These reminders and recalls can work in a range of settings, from individual health care centers to entire communities.
  - Providing people with incentives such as food vouchers, gift cards, and other prizes for keeping up with their vaccinations can also boost rates.
  - Laws and policies that require vaccinations as a prerequisite for attending child care, school, or college can increase coverage and reduce vaccine-preventable diseases in the community.
- Using provider- or system-based interventions. Putting systems, tools, or protocols in place in health care settings can improve vaccination rates. These may be particularly effective when combined with other vaccination interventions. Strong evidence supports the following health care-based interventions:
  - Establishing computerized immunization information systems for tracking vaccinations
  - Evaluating providers' vaccination records and giving feedback on their performance
  - Using chart notes, computerized alerts, checklists, or other tools to remind providers when patients are due for vaccinations
  - Establishing standing orders or policies that allow non-physician personnel to administer vaccines
- Combining interventions at the community level. A coordinated approach that combines interventions that enhance access to services, increase community demand, or support providers can increase vaccination rates in a community. For example, combining community-wide education with client incentives can be particularly effective for promoting vaccinations in targeted populations, like children under 2 or older adults.

Like preparing to communicate, it is essential that you think critically about your plan for outreach. Once again, there is a tremendous benefit to performing community assessment or engagement before planning your outreach. Even well implemented outreach will be of little use if it does not address the real issue causing low immunization coverage. Likewise, you will want to create a specific outreach plan that identifies your goals and objectives and clearly describes how the outreach will be performed and how it will help meet your goals. If you have staff at your organization with expertise in performing public health outreach, you are encouraged to involve them in the planning and implementation of the process of outreach. The example and resources listed below offer additional information about performing outreach and interventions that have been successful in increasing vaccination coverage.

PRACTICAL EXAMPLE OF OUTREACH

In Minnesota, the High-Risk ZIP Code Project used IIS data to find ZIP codes with historic and currently low immunization rates in comparison to other ZIP codes in Minnesota. To increase immunization rates in the 12 identified ZIP codes, the Minnesota Department of Health performed reminder-recall activities for children aged 24 to 35 months who were not up to date for the 4-3-1-3-3-1-4 series. Parents of children who were not up to date were initially sent personalized letters encouraging them to vaccinate their children. This was repeated with quarterly follow-up letters to parents of children who remained not up to date. The overall percentage of children who were up to date for the series increased by over 16.4% in the targeted ZIP codes compared with a 4.2% increase in the control ZIP codes.[19]

RESOURCES FOR OUTREACH

- Association of Immunization Managers (AIM) Program Practices Database (https://practices.immunizationmanagers.org/)
- Association of State and Territorial Health Officials (ASTHO) Immunization Resource Guide (http://www.astho.org/Immunization-Resource-Guide/)
- The Guide to Community Preventive Services' What Works Fact Sheet: Increasing Appropriate Vaccination (https://www.thecommunityguide.org/resources/what-works-increasing-appropriate-vaccination) and Vaccination web page (https://www.thecommunityguide.org/topic/vaccination)

[19]Muscoplat, M. H., Rajamani, S. (2017). Immunization Information System and Informatics to Promote Immunizations: Perspective From Minnesota Immunization Information Connection. Biomedical Informatics Insights, 9, 117822261668889. doi:10.1177/1178222616688893.

- National Association of County and City Health Organizations (NACCHO) Mobilizing for Action through Planning and Partnerships (MAPP) (https://www.naccho.org/programs/public-health-infrastructure/performance-improvement/community-health-assessment/mapp)
- National Association of County and City Health Organizations (NACCHO) Model Practices Database (https://www.naccho.org/resources/model-practices/database)
- University of Kansas Center for Community Health and Development's Community Tool Box – Implementing Promising Community Interventions (https://ctb.ku.edu/en/implementing-promising-community-interventions)

4.7 EVALUATE AND SHARE YOUR EXPERIENCE

Evaluation should be incorporated into your plan for small area analysis and responding to identified pockets of need. You are encouraged to regularly evaluate the status of your activities and document what is working and what could be done better in the future. At the end of any response activity (e.g., a reminder-recall project or a community forum), it is beneficial to gather feedback from internal and external partners. Once you have evaluated and documented your work, consider sharing your experience with the broader IIS and immunization community. This can be done in a variety of ways, including:

- Describe your project in a newsletter or online community forum.
  - Consider submitting your story to SnapShots, AIRA's newsletter about the progress, best practices, and accomplishments of IIS across the country.
  - Similarly, health departments can share their experiences via the Association of Immunization Managers Community of Practice (https://practices.immunizationmanagers.org/).[20]
- Present about your work at a conference like the National Immunization Conference or the AIRA National Meeting.
- Publish your findings in a journal.

RESOURCES FOR EVALUATING AND SHARING YOUR EXPERIENCE

- CDC Program Performance and Evaluation Office (PPEO) (https://www.cdc.gov/eval/)
- University of Kansas Center for Community Health and Development's Community Tool Box Chapter 36. Introduction to Evaluation (https://ctb.ku.edu/en/table-of-contents/evaluate/evaluation)

[20]Immunization programs working at the global level may wish to share their experiences at Technet-21 (https://www.technet-21.org/en/).

SECTION 5 CONCLUSION

In the past few years, there have been several large outbreaks of vaccine-preventable disease due to low vaccination coverage in pockets of need.[21,22] As IIS have increasingly high-quality data, they have become an excellent source for detailed information about vaccination coverage.

Many researchers and public health staff have already begun using small area analysis to identify pockets of need for vaccination coverage. However, such knowledge has been fragmented and has lacked standardized methodology. Development of this guide allowed AIRA to bring together a group of subject matter experts who shared, reviewed, and assessed current knowledge. The experience of the subject matter experts, together with related information from existing publications, resulted in the creation of this guide. Our hope is that this guide will be useful for IIS and immunization program staff in identifying pockets of need and responding in ways that decrease the risk of disease in our communities.

Your IIS can be a valuable source of information. Even imperfect or incomplete information can be valuable for informing public health decisions. We recommend you use this guide and your IIS to identify pockets of need. Furthermore, we encourage you to write up your methodologies, present, and publish whenever possible.

[21]Hall, V., Banerjee, E., et al. (2017). Measles Outbreak — Minnesota April–May 2017. Morbidity and Mortality Weekly Report, 66(27), 713-717. http://dx.doi.org/10.15585/mmwr.mm6627a1.

[22]Gastañaduy, P.A., Budd, J., et al. (2016). A Measles Outbreak in an Underimmunized Amish Community in Ohio. New England Journal of Medicine, 375(14), 1343-1354. doi:10.1056/nejmoa1602295.

APPENDIX A ADDITIONAL BACKGROUND AND THE PROCESS OF CREATING THE GUIDE

The American Immunization Registry Association (AIRA) supports IIS in their use of data for coverage assessments. AIRA's 2016-2021 Capacity Cooperative Agreement with the Centers for Disease Control and Prevention (CDC) calls for identifying strategies that support the development and dissemination of methodologies for population-based coverage assessments.[23]

Past AIRA efforts in this area have included the production of the *Analytic Guide to Assessing Vaccination Coverage Using an IIS,* a subsequent addendum, and *Comparing and Communicating Vaccination Coverage Estimates*. For several years, the IIS community has expressed interest in a guide that would support identifying and responding to pockets of need. In September 2017, AIRA's Assessment Steering Committee (ASC) agreed to develop a guide that provides recommendations and practical strategies for using small area analysis to identify pockets of need and increasing vaccination coverage within identified pockets of need. Thus, *Small Area Analysis to Identify Pockets of Need* was created to provide clear guidance on this topic.

To create this guide, AIRA assembled a workgroup of subject matter experts from the IIS and immunization program community, as well as CDC partners, public health consultants, and AIRA staff (see list of participants in the Acknowledgements section.) During the initial phase of the project, AIRA staff gathered and reviewed existing materials describing small area analyses and pockets of need. The workgroup contributed materials and descriptions of projects relevant to the topic. Members reviewed documents and made recommendations on strategies, tips, and tools to include in the guide. AIRA staff drafted and revised the guide based on input and feedback from the workgroup. Finally, the document was reviewed by the AIRA board of directors and the IIS community, with the final version completed in September 2018.

[23]AIRA's Capacity Cooperative Agreement, Strategy 1b.

APPENDIX B GLOSSARY AND ACRONYMS

GLOSSARY

TERM	DEFINITION
4-3-1-3-3-1-4	Primary vaccination series for children typically completed between 15 and 19 months of age. Series is comprised of 4 DTaP, 3 polio, 1 MMR, 3 HIB, 3 Hep B, 1 VAR, and 4 PCV
Catch-up Schedule	For persons aged 4 months through 18 years who start vaccinations late or who are more than one month behind, the catch-up schedule provides information on minimum interval and minimum age, and for some vaccines, fewer doses are required.
Cohort	Part of the population (individuals) within given parameters.
Community Assessment	A process of working with community members and leaders to gather input about a specific issue.
Community Engagement	A long-term process that involves community members as partners in determining steps that can be implemented to improve health and wellness.
Data Quality Accuracy	In relation to an IIS, accuracy encompasses the concept that data recorded in the IIS should accurately reflect an individual's demographic information and match exactly what happens in a clinical encounter, whether or not it is clinically appropriate.
Data Quality Completeness	In relation to an IIS, completeness encompasses the concepts that information submitted to the IIS should contain the minimum/mandatory set of data items and that all individuals in the jurisdiction should have a record in the IIS that contains all vaccinations administered to the individual.
Date Quality Timeliness	In relation to an IIS, timeliness encompasses the concept that data should be reported and recorded in the IIS, as well as be available to users, in a timely manner.
Deduplication	Patient-level deduplication is the process of determining if similar patient records in the IIS represent the same patient and, if they do, consolidating the records. Vaccination-level deduplication is the process of determining if similar vaccinations on a patient's IIS record represent the same vaccination event and, if they do, merging, correcting, or deleting one of the vaccines.
Pocket of Need	A population of unimmunized or underimmunized individuals who present an increased disease risk.
Small Area Analysis	The study of a specific small area or population to identify measurable differences from the larger statistical pattern.
Up to Date	Patient is current on vaccinations, meeting Advisory Committee on Immunization Practices recommendation for age, intervals, and other requirements.
Vaccination Coverage	A proportion describing the frequency at which vaccination events occur in a defined population. The components of a vaccination coverage proportion are the numerator, the denominator, and the specified time period in which immunization events can occur.

ACRONYMS

ACRONYM	FULL DESCRIPTION
ACIP	Advisory Committee on Immunization Practices
AFIX	Assessment, Feedback, Incentives, and eXchange
AIM	Association of Immunization Managers
AIRA	American Immunization Registry Association
CDC	Centers for Disease Control and Prevention
CIR	Citywide Immunization Registry
IIS	Immunization Information System
MIROW	Modeling of Immunization Registry Operations Workgroup
MCIR	Michigan Care Improvement Registry
NCIRD	National Center for Immunization and Respiratory Diseases (CDC)
NIS	National Immunization Surveys

APPENDIX C RESOURCES

The following resources were used in the development of this guide and contain additional information for the reader.

COVERAGE ASSESSMENT

- *Analytic Guide for Assessing Vaccination Coverage Using an IIS:* http://repository.immregistries.org/resource/analytic-guide-for-assessing-vaccination-coverage-using-an-iis/
- *Comparing and Communicating Vaccination Coverage Estimates:* http://repository.immregistries.org/resource/comparing-and-communicating-vaccination-coverage-estimates-from-iis-nis-and-related-assessments/
- *Practical Examples of IIS Population-Based Coverage Assessments:* http://repository.immregistries.org/resource/practical-examples-of-iis-population-based-coverage-assessments/

DATA QUALITY

- CDC's IIS Deduplication web page: https://www.cdc.gov/vaccines/programs/iis/technical-guidance/deduplication.html
- *Data Validation Guide for the IIS Onboarding Process:* http://repository.immregistries.org/resource/data-validation-guide-for-the-iis-onboarding-process/
- *IIS Data Quality Practices – Monitoring and Evaluating Data Submissions:* http://repository.immregistries.org/resource/iis-data-quality-practices-monitoring-and-evaluating-data-submissions/
- *MIROW Consolidating Demographic Records and Vaccination Event Records:* http://repository.immregistries.org/resource/consolidating-demographic-records-and-vaccination-event-records/
- *MIROW Data Quality Assurance in Immunization Information Systems:* Incoming Data: http://repository.immregistries.org/resource/data-quality-assurance-in-immunization-information-systems-incoming-data-1/
- *MIROW Data Quality Assurance in Immunization Information Systems:* Selected Aspects: http://repository.immregistries.org/resource/data-quality-assurance-in-immunization-information-systems-selected-aspects/
- *MIROW Management of Patient Active/Inactive Status in IIS:* http://repository.immregistries.org/resource/management-of-patient-active-inactive-status-in-immunization-information-systems-1/
- *MIROW Vaccination Level Deduplication in IIS:* http://repository.immregistries.org/resource/vaccination-level-deduplication-in-immunization-information-systems-1/

COMMUNITY ASSESSMENT, COMMUNITY ENGAGEMENT, COMMUNICATION, OUTREACH AND EVALUATION

- Association of Immunization Managers (AIM) program practices database: https://practices.immunizationmanagers.org/
- Association of State and Territorial Health Officials (ASTHO)
  - Communicating Effectively About Vaccines web page: http://www.astho.org/Communicating_Effectively_About_Vaccines/
  - Immunization Resource Guide: http://www.astho.org/Immunization-Resource-Guide/
- CDC
  - Program Performance and Evaluation Office (PPEO): https://www.cdc.gov/eval/
  - Social Media Tools, Guidelines, & Best Practices: https://www.cdc.gov/socialmedia/tools/guidelines/index.html
- The Community Guide
  - *What Works Fact Sheet: Health Communication and Health Information Technology:* https://www.thecommunityguide.org/resources/what-works-health-communication-health-information-technology
  - *What Works Fact Sheet: Increasing Appropriate Vaccination:* https://www.thecommunityguide.org/resources/what-works-increasing-appropriate-vaccination
  - Vaccination web page: https://www.thecommunityguide.org/topic/vaccination
- *Comparing and Communicating Vaccination Coverage Estimates from IIS, NIS, and Related Assessments:* http://repository.immregistries.org/resource/comparing-and-communicating-vaccination-coverage-estimates-from-iis-nis-and-related-assessments/
- Department of Health and Human Services, Public Health Service, National Institutes of Health. *Making health communication programs work: A planners guide:* https://www.cancer.gov/publications/health-communication/pink-book.pdf
- Minnesota Department of Health *Community Engagement Unit:* http://www.health.state.mn.us/divs/opi/community/
- National Association of County and City Health Officials (NACCHO) *Guide to Human Papillomavirus Resources for Local Health Departments:* http://essentialelements.naccho.org/archives/7751

- National Association of County and City Health Organizations (NACCHO) Mobilizing for Action through Planning and Partnerships (MAPP): https://www.naccho.org/programs/public-health-infrastructure/performance-improvement/community-health-assessment/mapp
- National Association of County and City Health Organizations (NACCHO) Model Practices Database: https://www.naccho.org/resources/model-practices/database
- National Public Health Information Coalition *Ethnic Media Toolkit:* https://www.nphic.org/toolkits/ethnic-media
- Smart Chart: https://smartchart.org/
- University of Kansas Center for Community Health and Development's Community Tool Box: https://ctb.ku.edu/en/table-of-contents/assessment/assessing-community-needs-and-resources
- Wilder Foundation *Community Engagement to Advance Health Equity: Strategies and Tips:* www.health.state.mn.us/divs/opi/healthequity/resources/wilder-engagement.html

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APPENDIX E DATA QUALITY

There are three primary data quality challenges that impact data in the IIS: accuracy, completeness, and timeliness. If not identified and addressed appropriately, these challenges can significantly affect the quality of small area analysis.

CATEGORIES OF DATA QUALITY

Accuracy: The degree to which the data mirrors the characteristics of the real-world object or objects it represents. The data in the IIS should match what happens in a clinical encounter, regardless of whether it is clinically appropriate. Likewise, patient records recorded in the IIS should reflect patients currently living in the jurisdiction and not include those who have moved or gone elsewhere.

Completeness: The degree to which full information about a dataset, record, or individual data element is captured in the IIS. Many immunization measures are based on a series of shots given over time, so anything that makes it challenging to capture or merge records over time can lead to fragmented and incomplete records. The data recorded in the IIS should reflect a complete history of all vaccinations ever administered to an individual. Similarly, the IIS should not be missing people who are a part of the subpopulation.

Timeliness: The amount of time between an event of interest and when the related data were posted in the IIS. The example of data quality analysis from Michigan below highlights the risks associated with delayed submission of data. The *IIS Data Quality Practices: Monitoring and Evaluating Data Submissions* guide offers practical guidance on ways to improve each category of data quality and more in the IIS.

DATA QUALITY IN BORDER COUNTIES

Michigan analyzed border counties that had low immunization coverage compared to other counties in the state. To determine if coverage was truly low or due to underreporting to the IIS by providers in a border state, Michigan generated two 4-3-1-3-3-1-4 coverage estimates for children 19 through 35 months old.

- In the first method, staff analyzed immunizations administered and reported to the registry at the time the children were 19 through 35 months old.
- In the second method, staff looked at immunizations administered when the children were 19 through 35 months old but reported up to three years later.

Since Michigan schools use IIS data to assess children's compliance with vaccine requirements for kindergarten entry, medical providers and the local health jurisdiction are prompted to report immunization records that are not in the IIS when the children are approximately 5 years old. In one county, the supplemental data increased documented coverage rates by 10%, with greater increases closer to the border and lesser increases farther away. Historical data reported to the IIS were helpful in better understanding how data quality had created a perceived pocket of need.

SUBCATEGORIES OF DATA QUALITY

Deduplication: Patient-level deduplication is the process of determining if similar patient records in the IIS represent the same patient and, if they do, consolidating the records. Vaccination-level deduplication is the process of determining if similar vaccinations on a patient's IIS record represent the same vaccination event and, if they do, merging, correcting, or deleting one of the vaccines.

Good deduplication processes are essential for good data quality. This applies to both patient record deduplication and vaccination-level deduplication.

Before starting a new assessment, be sure to ask the following questions:

- Is your patient deduplication process up to date for the age group selected for analysis?
- Do you have records that cannot be resolved through automated processes languishing in limbo as they wait for human intervention?
- Is your vaccination deduplication process up to date for vaccines routinely administered to the age group selected for analysis?

At a minimum, you should look at the number of records awaiting manual resolution for your target age group(s) to see the potential impact on your results. If you can devote resources to resolving record issues prior to your data pull or query, your results will be more accurate.

Moved or gone elsewhere: When individuals have left the subpopulation that you are analyzing but that information is not reflected in the IIS, it negatively affects your data quality. The *MIROW Management of Patient Active/Inactive Status in Immunization Information Systems* describes how to properly identify individuals as inactive for a provider organization or a jurisdiction so they will not be included in analysis.

Helpful resources to improve IIS data quality are listed in Appendix C: Resources.

APPENDIX F TABLES OF SPECIFIC DATA QUALITY ISSUES IMPACTING SMALL AREA ANALYSIS

These tables include data quality issues, the impact on coverage estimates, and examples of situations causing these issues.

Table 1 | *Vaccination-based data quality issues*

DATA QUALITY ISSUE	IMPACT ON COVERAGE ESTIMATE[24]		EXAMPLE
	DENOMINATOR: IIS	DENOMINATOR: EXTERNAL DATA	
Vaccination duplication issues[25]	May be ↑ than actual coverage	May be ↑ than actual coverage	An IIS does not adequately deduplicate vaccination records information, so there appear to be more vaccines given than were given.
People incorrectly identified as up to date	May be ↑ than actual coverage	May be ↑ than actual coverage	An organization sends in vaccinations that were not administered, and the IIS does not identify the vaccinations as a data quality issue.
People incorrectly identified as not up to date	May be ↓ than actual coverage	May be ↓ than actual coverage	An organization fails to report some or all vaccinations to the IIS.

[24]All other factors being equal. The impact is estimated as most commonly occurs due to recognized data quality issues.
[25]Coverage will appear higher than actual coverage if the duplicate vaccine record results in a person's being counted as up to date for the vaccination outcome being assessed, but without the duplicate vaccine record that person would not be considered up to date.

Table 2 | *Vaccination-based data quality issues*

DATA QUALITY ISSUE	IMPACT ON COVERAGE ESTIMATE[26,27]		EXAMPLE
	DENOMINATOR: IIS	DENOMINATOR: EXTERNAL DATA	
Missing people that should be included in the population	May be ↑ or ↓ than actual coverage	May be ↓ than actual coverage	Children born outside of the geographic area move into the area, but this change is not reflected in the IIS.
Including people that have moved out of the area	May be ↓ than actual coverage	May be ↑ than actual coverage	Children born in the geographic area move outside of the area, but this change is not reflected in the IIS. Since moved or gone elsewhere records will often have less complete reporting, this would lead to an underestimate when using a denominator from the IIS.
Including people that are deceased	May be ↓ than actual coverage	May be ↑ than actual coverage	An IIS receives death notices from Vital Records only for in-state deaths, so people who died outside of the state are not marked as deceased. Since records of deceased persons will reflect only vaccinations received before death, this could lead to an underestimate when using a denominator from the IIS.
Including duplicate patient records	May be ↓ than actual coverage	May be ↑ than actual coverage	An IIS does not adequately deduplicate patient records, so there appear to be more people in an area than exist.

Table 3 | *Other types of data quality issues*

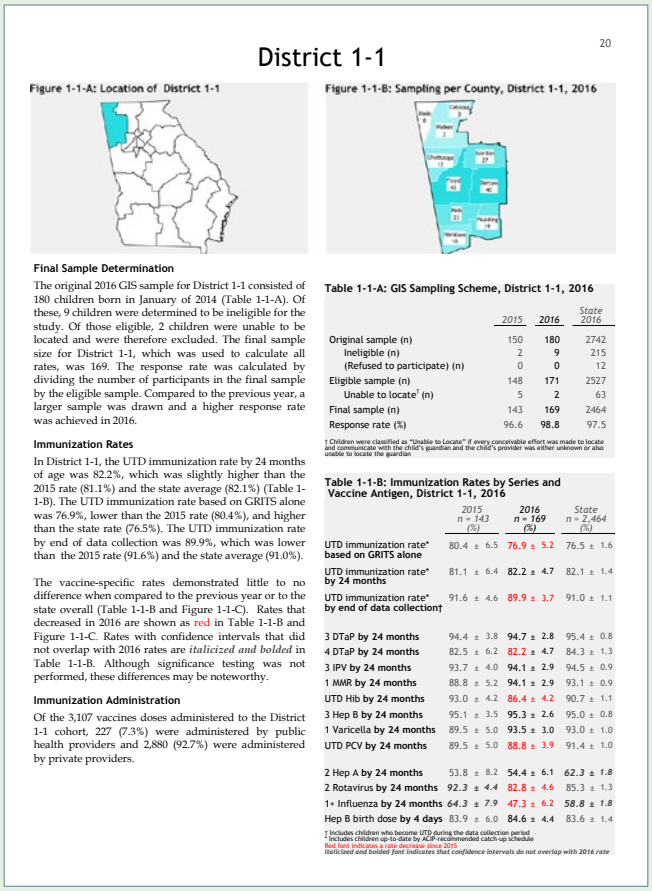
DATA QUALITY ISSUE	IMPACT ON COVERAGE ESTIMATE[28]		EXAMPLE
	DENOMINATOR: IIS	DENOMINATOR: EXTERNAL DATA	
An external denominator is not an accurate count of the population.	Not applicable	May be ↑ or ↓ than actual coverage	Many people moved into an area since the last Census, so using Census data for the denominator would make the denominator smaller than the actual population.
IIS technical errors alter the population count or vaccination status.	May be ↑ or ↓ than actual coverage	May be ↑ or ↓ than actual coverage	The IIS incorrectly rejects valid messages, leading to an underestimate of the population or vaccinations.
Human errors alter the population count or vaccination status.	May be ↑ or ↓ than actual coverage	May be ↑ or ↓ than actual coverage	Staff at a local clinic incorrectly enter DTaP as Tdap for their vaccinations, and the IIS does not identify the issue. This leads to an underestimate of DTaP and an overestimate of Tdap.
Timeliness issues alter the population count or vaccination status.[29]	May be ↑ or ↓ than actual coverage	May be ↑ or ↓ than actual coverage	A community vaccinator submits flu vaccination data only at the end of the flu season, leading to an underestimate of flu vaccine coverage in the area.

[26]All other factors being equal. The impact is estimated as most commonly occurs due to recognized data quality issues.
[27]For the bottom three rows, the estimate will be higher than actual coverage to the extent that the unidentified non-eligible records are up to date with the vaccination outcome being measured.
[28]All other factors being equal. The impact is estimated as most commonly occurs due to recognized data quality issues.
[29]Delays in vaccination status are expected to cause an underestimate of coverage. Delayed patient reporting has a less predictable effect.

APPENDIX G EXAMPLES OF SHARING SMALL AREA DATA ON AWARDEE WEBSITES

Examples of small area data displayed on health department websites

Figure 9 | *Georgia Immunization Study 2016*[30]



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District 1-1

Figure 1-1-A: Location of District 1-1

Figure 1-1-B: Sampling per County, District 1-1, 2016

Final Sample Determination

The original 2016 GIS sample for District 1-1 consisted of 180 children born in January of 2014 (Table 1-1-A). Of these, 9 children were determined to be ineligible for the study. Of those eligible, 2 children were unable to be located and were therefore excluded. The final sample size for District 1-1, which was used to calculate all rates, was 169. The response rate was calculated by dividing the number of participants in the final sample by the eligible sample. Compared to the previous year, a larger sample was drawn and a higher response rate was achieved in 2016.

Immunization Rates

In District 1-1, the UTD immunization rate by 24 months of age was 82.2%, which was slightly higher than the 2015 rate (81.1%) and the state average (82.1%) (Table 1-1-B). The UTD immunization rate based on GRITS alone was 76.9%, lower than the 2015 rate (80.4%), and higher than the state rate (76.5%). The UTD immunization rate by end of data collection was 89.9%, which was lower than the 2015 rate (91.6%) and the state average (91.0%).

The vaccine-specific rates demonstrated little to no difference when compared to the previous year or to the state overall (Table 1-1-B and Figure 1-1-C). Rates that decreased in 2016 are shown as red in Table 1-1-B and Figure 1-1-C. Rates with confidence intervals that did not overlap with 2016 rates are *italicized and bolded* in Table 1-1-B. Although significance testing was not performed, these differences may be noteworthy.

Immunization Administration

Of the 3,107 vaccines doses administered to the District 1-1 cohort, 227 (7.3%) were administered by public health providers and 2,880 (92.7%) were administered by private providers.

Table 1-1-A: GIS Sampling Scheme, District 1-1, 2016

	2015	2016	State 2016
Original sample (n)	150	180	2742
Ineligible (n)	2	9	215
(Refused to participate) (n)	0	0	12
Eligible sample (n)	148	171	2527
Unable to locate† (n)	5	2	63
Final sample (n)	143	169	2464
Response rate (%)	96.6	98.8	97.5

† Children were classified as "Unable to Locate" if every conceivable effort was made to locate and communicate with the child's guardian and the child's provider was either unknown or also unable to locate the guardian

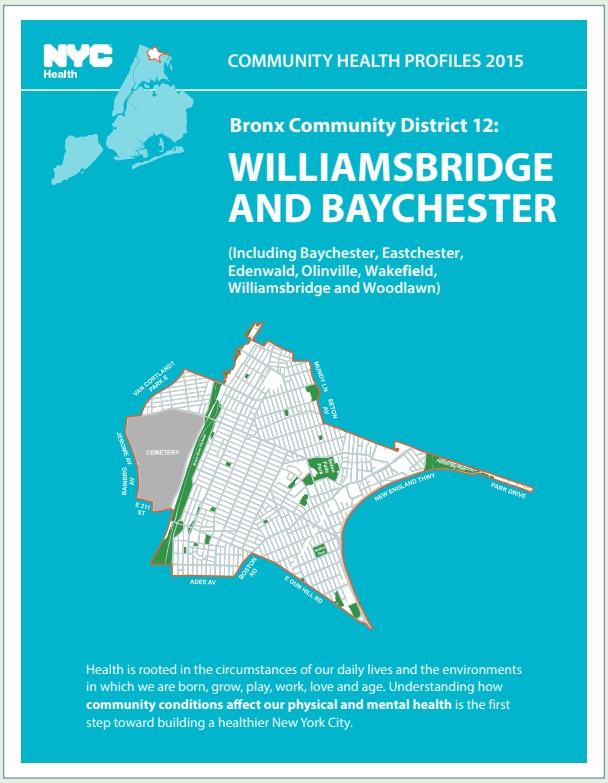
Table 1-1-B: Immunization Rates by Series and Vaccine Antigen, District 1-1, 2016

	2015 n = 143 (%)	2016 n = 169 (%)	State n = 2,464 (%)
UTD immunization rate* based on GRITS alone	80.4 ± 6.5	76.9 ± 5.2	76.5 ± 1.6
UTD immunization rate* by 24 months	81.1 ± 6.4	82.2 ± 4.7	82.1 ± 1.4
UTD immunization rate* by end of data collection†	91.6 ± 4.6	89.9 ± 3.7	91.0 ± 1.1
3 DTaP by 24 months	94.4 ± 3.8	94.7 ± 2.8	95.4 ± 0.8
4 DTaP by 24 months	82.5 ± 6.2	82.2 ± 4.7	84.3 ± 1.3
3 IPV by 24 months	93.7 ± 4.0	94.1 ± 2.9	94.5 ± 0.9
1 MMR by 24 months	88.8 ± 5.2	94.1 ± 2.9	93.1 ± 0.9
UTD Hib by 24 months	93.0 ± 4.2	86.4 ± 4.2	90.7 ± 1.1
3 Hep B by 24 months	95.1 ± 3.5	95.3 ± 2.6	95.0 ± 0.8
1 Varicella by 24 months	89.5 ± 5.0	93.5 ± 3.0	93.0 ± 1.0
UTD PCV by 24 months	89.5 ± 5.0	88.8 ± 3.9	91.4 ± 1.0
2 Hep A by 24 months	53.8 ± 8.2	54.4 ± 6.1	*62.3 ± 1.8*
2 Rotavirus by 24 months	*92.3 ± 4.4*	82.8 ± 4.6	85.3 ± 1.3
1+ Influenza by 24 months	*64.3 ± 7.9*	47.3 ± 6.2	*58.8 ± 1.8*
Hep B birth dose by 4 days	83.9 ± 6.0	84.6 ± 4.4	83.6 ± 1.4

† Includes children who become UTD during the data collection period
* Includes children up-to-date by ACIP-recommended catch-up schedule
Red font indicates a rate decrease since 2015
Italicized and bolded font indicates that confidence intervals do not overlap with 2016 rate

[30]Georgia Immunization Study 2016. Retrieved from https://dph.georgia.gov/immunization-publications.

Figure 10 | *New York City Community Health Profiles*[31]



HPV infection causes cancers that can be prevented by the HPV vaccine. Boys and girls should receive the vaccine at 11 to 12 years of age, prior to HPV exposure and when the vaccine is most effective.

Prevention and screening

Compared with teens citywide, teenaged girls from **Williamsbridge and Baychester** are less likely to receive the full human papillomavirus (HPV) vaccine series. However, **Williamsbridge and Baychester** adults are more likely to get tested for HIV than adults citywide.

	HPV vaccination (Percent of girls ages 13-17 years who have received all 3 doses of the HPV vaccine)	Flu vaccination (Percent of adults)	Ever tested for HIV (Percent of adults)
Williamsbridge and Baychester	36% (RANKS 33RD)	42% (RANKS 23RD)	75% (RANKS 13TH)
Best-performing district	63% Hunts Point and Longwood (RANKS 1ST)	50% Mott Haven and Melrose & Hunts Point and Longwood (RANKS 1ST)	83% Fordham and University Heights (RANKS 1ST)
Bronx	53%	46%	75%
NYC	43%	40%	62%

[31] New York City Community Health Profiles. Retrieved from https://www1.nyc.gov/site/doh/data/data-publications/profiles.page.

Figure 11 | *Michigan Department of Health and Human Services County Immunization Report Card*[32]

COUNTY QUARTERLY IMMUNIZATION REPORT CARD

Kalamazoo — *Data as of: June 30, 2018*

Population

	2016 Census	MCIR	Diff.	% Diff.
Total	261,654	277,658	-16,004	-6
Adults (20yrs+)	195,664	206,653	-10,989	-5
Children (0-19yrs)	65,990	71,005	-5,015	-7

Immunization Sites

	Count	%
Active MCIR Immunization Sites	142	
Reported in the last 6 months	101	71
Active Vaccines for Children (VFC) Sites	22	
Reported in the last 6 months	21	95
Reg. Reporting Flu Sentinels (% of Total Sites)	2	67

Michigan is ranked 29th for 4313314 coverage (2016 NIS data)

Your County Immunization Rank n = 84 counties	
43133142 Coverage: (19-35mos)	**7**
1323213 Coverage: (13-17 years)	**2**
Waivers: (kindergarten, 7th grade & others)	**20**
Flu Coverage : (6 months through 8 years, complete)	**6**

Immunization Coverage Levels, Rankings and Goals by Select Vaccines and Age Groups

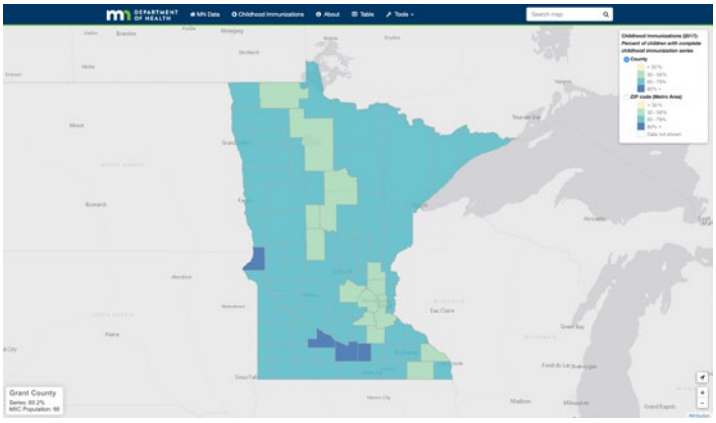
Measure	Kalamazoo (MCIR)	% Diff.*	MI Avg (MCIR)	US Average 2016 NIS	Your County Rank (n=84)	HP 2020 Goal
19 through 35 months	**%**	**%**	**%**	**%**	**No.**	
Birth Dose Hep B coverage	79.6	0.4	79.6	71.1	53	85%
4313314 coverage†	79.3	-1.1	74.2	70.7	13	80%
43133142 coverage†	66.4	-1.0	56.9	–	7	-
2+ Hep A	67.5	-0.9	58.5	60.6	8	85%
4+ DTaP	80.9	-1.1	77.4	83.4	21	90%
PCV Complete††	86.8	-0.5	83.4	81.8	18	90%
Rota. Complete†† (8-24 months)	80.6	0.3	71.3	–	4	–
WIC coverage (4313314)	79.3	0.3	79.5	67.7	59	-
Medicaid coverage (4313314)	77.0	-1.2	74.4	–	41	-
13 through 17 years				2016 NIS Teen		
132321 coverage‡	82.8	-0.1	76.5	–	30	-
1323213 coverage‡	51.9	0.2	39.1	–	2	-
1+ Tdap	85.4	-0.4	79.9	88.0	34	80%**
1+ MenACWY	84.9	-0.4	79.8	82.2	36	80%**
HPV Complete (Females)	54.4	-0.2	42.1	49.5	8	80%**
HPV Complete (Males)	50.7	0.3	37.8	37.5	5	-
MenACWY Complete†† (17 yrs)	57.3	-0.8	45.9	–	5	-
Adults (Census Denominators)				2016 NHIS		
1+ Tdap (19-64yrs)	62.6	1.2	52.6	24.7	16	-
1+ PPSV23 (65+ yrs)	54.8	0.9	42.5	42.2^	17	
1+ PCV13 (65+ yrs)	64.2	1.1	47.3	32.6^	16	
1+ PCV13 & 1+ PPSV23 (65+ yrs)	39.8	1.3	26.4	18.6^	16	-
1+ Zostavax (60+ yrs)	33.3	-0.2	26.3	30.6	14	30%
2017-18 Flu Season	**Kalamazoo**		**MI Avg**	**US Flu Avg**	**Rank**	**HP2020**
Flu Complete†† (6mos-8yrs)	40.1	0.2	29.8	–	6	–
1+ Flu (6mos through 17yrs)	39.1	0.6	28.6	59.3	4	70%
1+ Flu (18yrs+)	33.9	3.9	27.9	41.7	28	70%
School/Childcare (Feb'18)	**Kalamazoo**		**MI Avg**	**Kalamazoo**	**Kalamazoo**	**Rank**
School Completion	94.0	-0.7	93.8	–	–	32
Percent Waived (K+7+O)	2.8	0.4	3.6	Kindgtn : 3.1	7 grd : 2.1	20
Child Care Completion	86.6	-1.0	87.1	–	–	56
Percent Waived	1.3	-0.2	2.5	–	–	23

* % difference in the county since the last report card; Flu data shows difference between seasons; School and CC difference between annual reports
† 4313314(2): 4 DTaP, 3 Polio, 1 MMR, 3 Hib, 3 HepB, 1 Varicella, 4 PCV, (2 HepA)
†† Complete = no additional doses of this vaccine are needed.
‡ 132321(3): 1 Tdap, 3 Polio, 2 MMR, 3 HepB, 2 Var, 1 MenACWY, (2 or 3 HPV doses-Males & Females)
** The adolescent Healthy People 2020 age group is 13 through 15 years
^Data from the 2017 Morbidity and Mortality Weekly Report on Adult Pneumococcal Coverage
Reference the FAQs for additional definitions including information on 1+, 2+ and 3+

MDHHS

[32]Michigan Department of Health and Human Services County Immunization Report Card. Retrieved from http://www.michigan.gov/mdhhs/0,5885,7-339-73971_4911_4914_68361-321114--,00.html.

Figure 12 | *Minnesota Department of Health MN Public Health Data Access*[33]



Blue Earth County

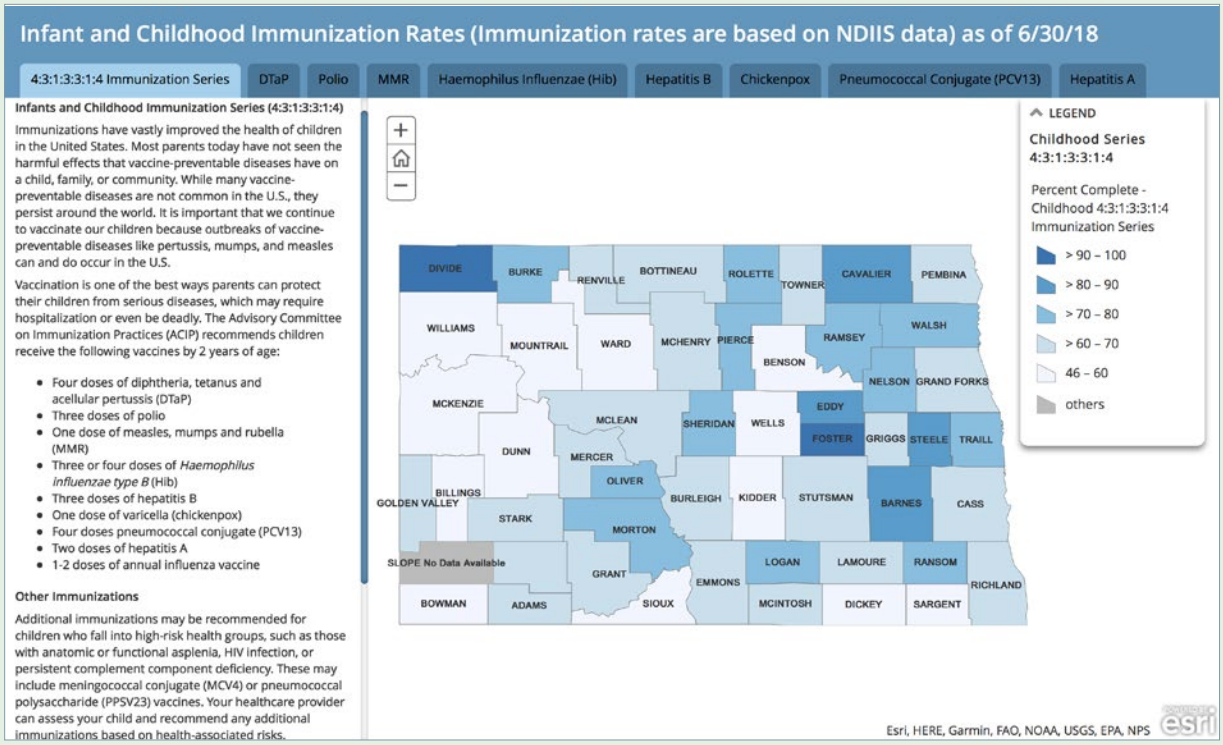
Series*	82.0%
DTaP	86.3%
Polio	94.1%
MMR	90.1%
Hib	89.7%
Hep B	92.9%
Varicella	94.2%
PCV	91.5%
Rotavirus	80.8%
Hep A	66.9%
MIIC Population	746

Series (*)
Data not shown (**)

Open Full Table | Close

[33]Minnesota Department of Health MN Public Health Data Access. Retrieved from https://apps.health.state.mn.us/mndata/webmap/immunizations.html.

Figure 13 | *North Dakota Department of Health Infant and Childhood Immunization Rates*[34]



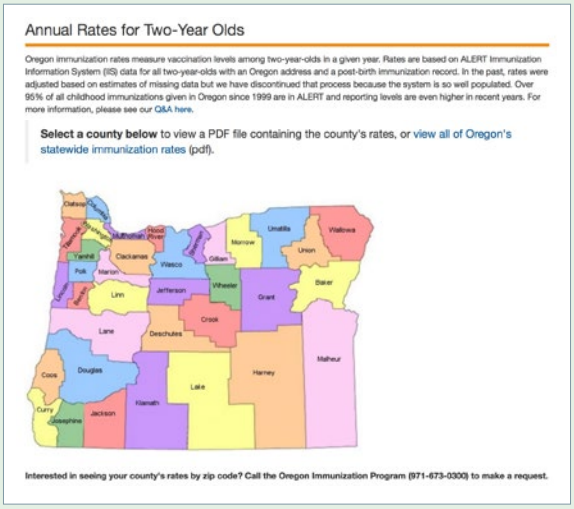
[34]North Dakota Department of Health Infant and Childhood Immunization Rates (immunization rates are based on NDIIS data) as of 12/31/17. Retrieved from: https://www.ndhealth.gov/immunize/rates/ChildHood.aspx.

Figure 14 | *Oregon Child Immunization Rates*[35]

Crook County Immunization Rates

	2014	2015	2016	2017
Two-Year-Olds Up-to-Date Rate (1)				
4:3:1:3:3:1:4 (a)	64%	65%	69%	70%
4:3:1:3:3:1 (b)	66%	73%	74%	76%
4 doses DTaP	75%	78%	78%	79%
3 doses IPV	91%	93%	93%	89%
1 dose MMR	85%	91%	91%	90%
3 doses Hib	84%	90%	91%	87%
3 doses HepB	88%	89%	92%	89%
1 dose Varicella	84%	88%	90%	90%
4 doses PCV	73%	73%	78%	77%
1 dose HepA	81%	86%	88%	87%
2-3 doses Rotavirus	66%	66%	70%	64%
1 dose Flu (in most recent season)	54%	48%	50%	47%
Women, Infants and Children (WIC) Clients (c)	63%	66%	70%	68%
Non-WIC Clients (c)	65%	61%	65%	76%
Enrolled in DMAP (c)	64%	66%	69%	72%
Not enrolled in DMAP (c)	63%	62%	68%	68%
One or more VFC vaccines (c)	66%	66%	70%	72%
No VFC vaccines (c)	57%	*	65%	*
Hispanic (c)	*	*	*	*
White (c)	65%	64%	67%	70%
African American (c)	*	*	*	*
Asian (c)	*	*	*	*
American Indian and Alaskan Native (c)	*	*	*	*
Hawaiian/Pacific Islander (c)	*	*	*	*
Multiple Race (c)	*	*	*	*
Other/Unknown (c)	*	*	*	*

* Rate not displayed for populations of fewer than 50 people in accordance with Oregon Public Health Division confidentiality policy.
(1) Source: ALERT Immunization Information System, Oregon Immunization Program
(a) Two year olds are children 24 to 35 months of age residing in the county. Fully immunized with 4 doses of DTaP, 3 doses IPV, 1 dose MMR, 3 doses Hib, 3 doses HepB, 1 dose Varicella, and 4 doses PCV. This is the official childhood vaccination series.
(b) Same as (a) minus PCV. Rate presented for historical tracking purposes.
(c) 4:3:1:3:3:1:4 series



[35]Oregon Child Immunization Rates. Retrieved from: http://www.oregon.gov/oha/PH/PREVENTIONWELLNESS/VACCINESIMMUNIZATION/Pages/researchchild.aspx.

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  - *President-Elect* • **Amanda (Mandy) Harris,** Nevada Department of Health
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    - **Baskar Krishnamoorthy,** Florida Department of Health IIS
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    - **Quan Le, RN,** Louisiana Immunization Program
- AIRA staff:
  - **Beth Parilla, MPH,** AIRA Senior Program Manager
  - **Ketti Turcato, MPH,** AIRA Program Manager
  - **Alison Chi, MPH,** AIRA Program Director
  - **Mary Beth Kurillo, MPH, MSW,** AIRA Policy & Planning Director
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