

Immunization Information System and Informatics to Promote Immunizations: Perspective From Minnesota Immunization Information Connection

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ABSTRACT: The vision for management of immunization information is availability of real-time consolidated data and services for all ages, to clinical, public health, and other stakeholders. This is being executed through Immunization Information Systems (IISs), which are population-based and confidential computerized systems present in most US states and territories. Immunization Information Systems offer many functionalities, such as immunization assessment reports, client follow-up, reminder/recall feature, vaccine management tools, state-supplied vaccine ordering, comprehensive immunization history, clinical decision support/vaccine forecasting and recommendations, data processing, and data exchange. This perspective article will present various informatics tools in an IIS, in the context of the Minnesota Immunization Information Connection.

KEYWORDS: immunization information system, biomedical informatics, immunization, Minnesota

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Immunization Information Systems

The vision for management of immunization information is availability of real-time consolidated data and services for all ages, to clinical, public health, and other stakeholders. This is being executed through Immunization Information Systems (IISs), which are population-based and confidential computerized systems present in most US states and territories.¹ The IIS Support Branch at the Centers for Disease Control and Prevention (CDC) assists in the advancement of IISs to support the public health goal of protection against vaccine-preventable diseases. A total of 64 immunization program awardees (50 states, 5 cities, the District of Columbia [DC], and 8 territories) receive funding under section 317b of the Public Health Service Act to support IIS operations.¹ Figure 1 presents the percentage of children aged <6 years participating in an IIS across the United States, and IIS in Minnesota has $\geq 95\%$ participation rate.²

Among the many strategies to improve immunization compliance, adoption of IISs is increasingly recognized by various studies and taskforce reports as a key and effective tactic.^{3,4} Immunization Information Systems have the unique advantage of holding immunization data across various providers over time, thereby offering comprehensive vaccination histories. Immunization Information Systems serve as a powerful informatics strategy to support vaccinations at both individual and population levels by offering various tools. These range from immunization assessment reports, client follow-up with

reminder/recall, state-supplied vaccine ordering capability, and clinical decision support for immunizations (CDSi) with vaccine forecasting algorithms based on recommendations from Advisory Committee on Immunization Practices (ACIP).⁵

Minnesota Immunization Information Connection *Development and Evolution of MIIC*

Minnesota's IIS, the Minnesota Immunization Information Connection (MIIC),⁶ has been operational since 2002. It existed as a series of regional registries before merging together as a statewide system. MIIC was adopted from the Wisconsin Immunization Registry (WIR) in 2002 with Minnesota-specific modifications. The registry was designed as a scalable multitier application to support the entry of client demographic and immunization data via the internet and through the batch loading of legacy immunization information. Currently, 18 states or municipalities have adopted the WIR, which is a public domain system.⁷

MIIC⁸ is a well-established and robust registry with an increasing number of immunizations each year (refer Figure 2). MIIC provides the most comprehensive source of immunization records in the state. MIIC is one of the 6 IIS "sentinel sites," a recognition for achieving high data quality standards to use their IISs for program evaluation and vaccine use assessments. There is a regional and state partnership in the management and execution of day-to-day MIIC user training, promotion, and enhancements.



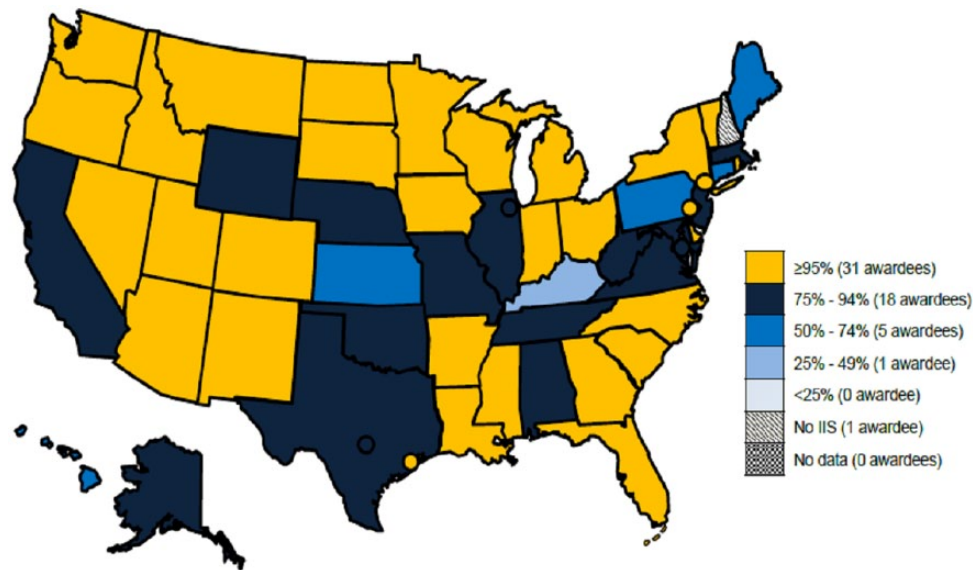


Figure 1. Participation in an Immunization Information System for children aged <6 years.

Source: 2015 Immunization Information Systems Annual Report (IISAR).

Data include 50 states, the District of Columbia (DC), and 5 cities (Chicago, IL; Houston, TX; New York City, NY; Philadelphia, PA; San Antonio, TX); national participation of 92% (excluding territories).

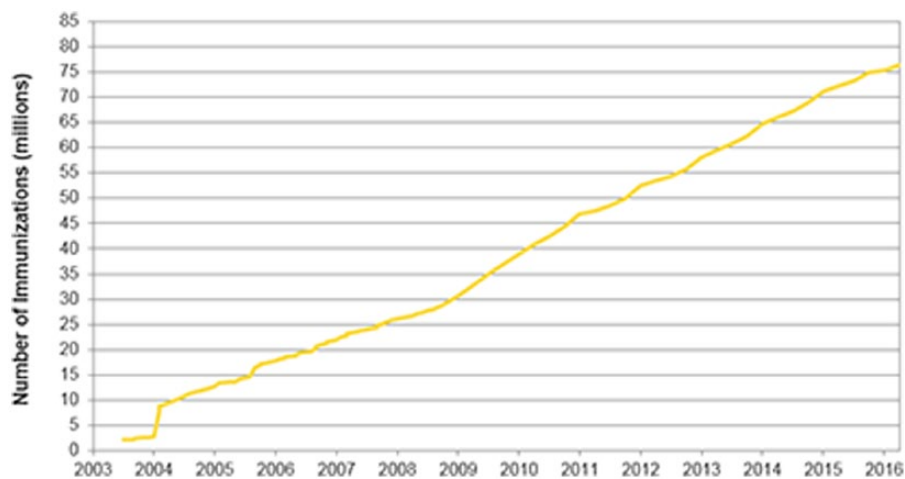


Figure 2. Number of immunizations in MIIC, July 2003 to April 2016.

Source: MIIC.

Data and Tools in MIIC

MIIC is a population-based system for the state of Minnesota that contains data on individuals across all age groups and their immunizations. Currently, MIIC⁸ holds more than 78 million immunizations for 7.8 million individuals over their lifespan (data current as of April 2016). Nearly all (99%) children under 6 years of age have 2 or more immunizations on their MIIC⁸ record, 80% of adolescents have 2 or more adolescent immunizations, and 90% of adults have at least 1 adult immunization in the application. MIIC⁹ is a multifeatured immunization information system with numerous data connections for data input and exchange ranging from the state vital records system, electronic health records, and IIS in neighboring states. MIIC⁹

provides numerous outputs in the form of reports and offers functionalities that support the delivery and tracking of immunizations. The various informatics tools offered by MIIC and its operations in context of health systems are presented in Figure 3, and some of the MIIC features are highlighted in the following sections.

MIIC Users

MIIC activities are governed by the Minnesota Immunization Data Sharing Law (§144.3351).¹⁰ The state statute allows for immunization data sharing without consent of the patient across a broad group of organizations, including child care facilities, schools, local public health, as well as

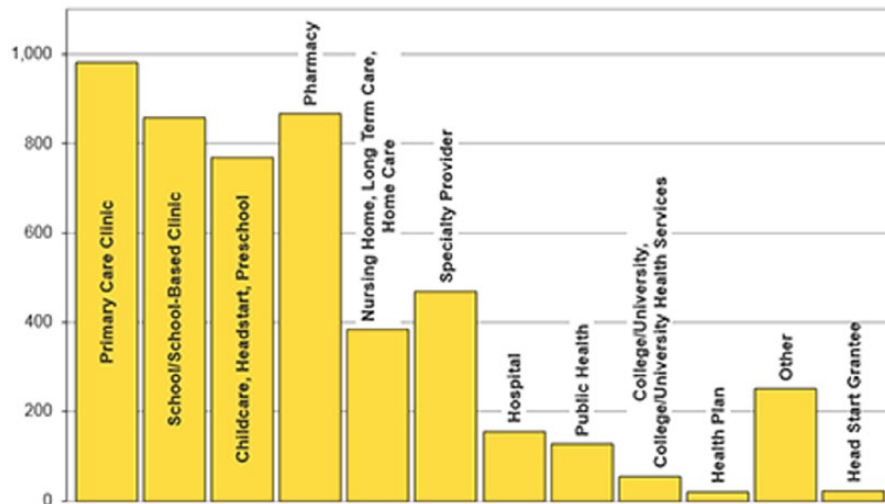


Figure 4. Conceptual model of informatics tools in MIIC.

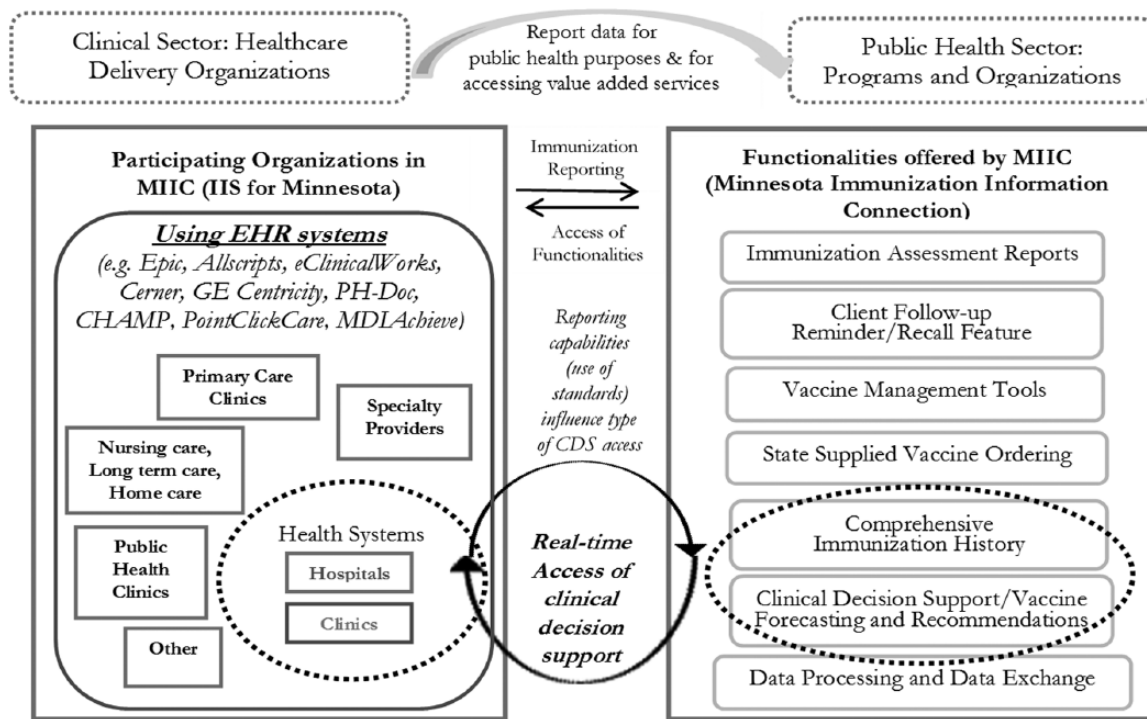


Figure 3. Number of active organizations in MIIC. CDS indicates clinical decision support; EHR, electronic health record; IIS, Immunization Information System. Source: MIIC, April 2016.

Minnesota-licensed providers such as physicians, nurses, and social workers. Provider participation in MIIC is high, with all local public health agencies and nearly all primary care providers and hospitals in the state participating. In recent years, there have been marked increases in participation among pharmacies and specialty clinics. Overall, there are approximately 4972 active organizations in MIIC ranging from primary care clinics, specialty providers, hospitals, pharmacy, and public health (refer Figure 4) and approximately 8000 active MIIC users.⁸ Users have role-based access to consolidated immunization

records for their clients, client-specific immunization clinical decision support, tools for immunization assessment and outreach, as well as functionality for ordering and managing state-supplied vaccine.

Immunization Assessment Reports

The assessment reports¹¹ are popular among providers and local public health, especially because almost all MIIC user types have access to run these reports for their own organizations

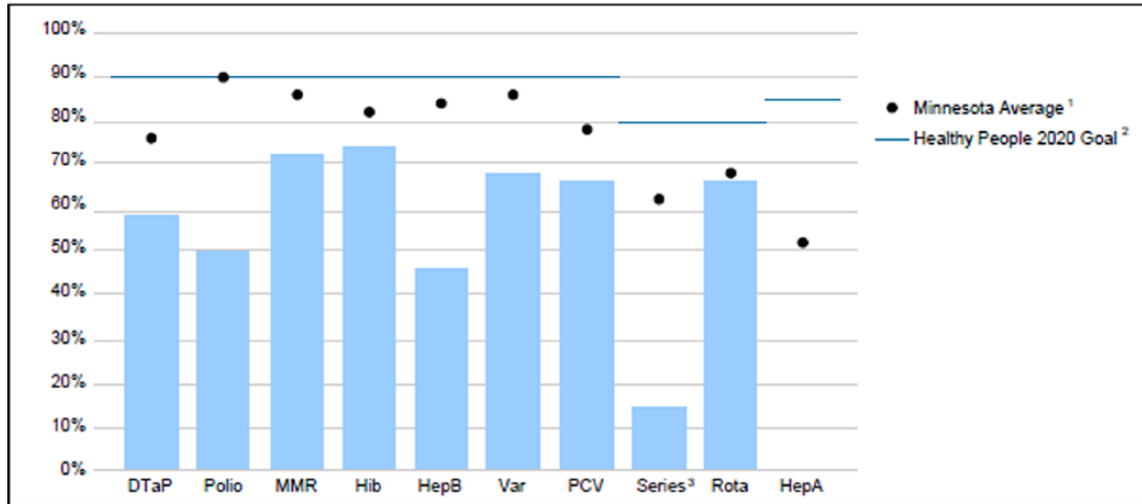


Childhood Immunization Summary

Assessment Test
 Report Type: Child Standard
 Birth Date Range: 08/17/2010 - 08/16/2011
 Report Run Date: 08/16/2013 Assessment Date: 08/16/2013
 Report Generated by: MIIC

Assessment of Immunization Rates by 24 Months

38 Client Records Assessed



	UTD #	UTD %	MN Average ¹	
DTaP	22	58%	77%	4 or more doses of diphtheria, tetanus, and pertussis vaccine
Polio	19	50%	90%	3 or more doses of poliovirus vaccine
MMR	27	71%	87%	1 or more doses of measles, mumps, and rubella vaccine
Hib	28	74%	82%	2, 3, or 4 or more doses of <i>Haemophilus influenzae</i> type b vaccine, depending on product and age at first dose
HepB	17	45%	85%	3 or more doses of hepatitis B vaccine
Var	26	68%	86%	1 or more doses of varicella vaccine
PCV	25	66%	79%	2, 3, or 4 or more doses of pneumococcal conjugate vaccine, depending on age at first dose
Series	5	13%	62%	Receipt of all doses for antigens listed above (DTaP, polio, MMR, Hib, Hep B, Var, and PCV)
Rota	25	66%	68%	2 or 3 or more doses of rotavirus vaccine, depending on product type received
HepA	0	0%	52%	2 or more doses of hepatitis A vaccine

Figure 5. Vaccination assessment reports in MIIC.
 Source: MIIC.

(refer Figure 5). The pediatric reports present vaccine coverage data for 24- to 35-month-old children associated with the organization. The reports include up-to-date (UTD) percent by individual vaccine by the age of 24 months, as well as the primary childhood series (4:3:1:3:4:1:4). A separate report produces a list of children not UTD by 24 months. Current assessment functionality also includes an adolescent immunization report, which displays coverage rates for the adolescent suite of vaccines: Tdap, MCV4, MCV4 booster, +1 human papillomavirus (HPV), and +3 HPV for 13- to 17-year-olds. This report also includes a missed opportunities calculation, which is based on a visit where an immunization was administered in the last 12 months for a patient in the assessment group and Tdap, MCV4, and/or HPV

vaccines could have been given but were not. The adolescent and childhood reports were further enhanced by adding the Healthy People 2020 goals for each vaccine (if the vaccine had a HP 2020 goal) and included an annually updated statewide average coverage rate for each vaccine. These additions were meant to help providers contextualize their coverage rates and incentivize improvement planning.

Client Follow-Up Feature and Reminder/Recall for Vaccinations

The client follow-up tool¹² in MIIC assists in identifying clients who are recommended and/or overdue for selected

MnVFC Pediatric	MnVFC Pediatric Varicella	Adult MHCP	Adult Un & Underinsured	Permission Needed	Influenza	Other
Instructions						
Use this form to order vaccine for pediatric patients younger than 19 years.						
DT, Td and PPSV23 should only be used in certain circumstances. To order call the MnVFC Program at 651-201-5522.						
Vaccine	Brand	Doses on Hand	Doses Ordered	Unit Size and Packaging		
DTaP	Daptacel - SP	<input type="text"/>	<input type="text"/>	10 single-dose vials		
DTaP	Infanrix - GSK	<input type="text"/>	<input type="text"/>	10 single-dose vials		
DTaP-Hep B-IPV	Pediarix - GSK	<input type="text"/>	<input type="text"/>	10 pre-filled syringes		
DTaP-IPV	Kinrix - GSK	<input type="text"/>	<input type="text"/>	10 single-dose vials		
DTaP-IPV	Kinrix - GSK	<input type="text"/>	<input type="text"/>	10 pre-filled syringes		
DTaP-IPV-Hib	Pentacel - SP	<input type="text"/>	<input type="text"/>	5 single-dose vials		
Hep B-Hib	Comvax - MRK	<input type="text"/>	<input type="text"/>	10 single-dose vials		
Hepatitis A Pediatric/adolescent	Vaqa - MRK	<input type="text"/>	<input type="text"/>	6 pre-filled syringes		
Hepatitis A Pediatric/adolescent	Vaqa - MRK	<input type="text"/>	<input type="text"/>	10 single-dose vials		

Figure 6. Ordering of state-supplied vaccine in MIIC. DTaP indicates diphtheria and tetanus toxoids and acellular pertussis; Hib, *Haemophilus influenzae* type b; IPV, inactivated polio vaccine; MHCP, Minnesota Health Care Program; MnVFC, Minnesota Vaccines for Children.

vaccinations and conducting follow-up with those individuals. Also known as reminder/recall, providers can use client follow-up to send messages to those due or past due for immunizations. This initiative can be population based or clinic based to improve vaccination rates. In the event of a vaccine-preventable disease outbreak, this feature will assist in identifying individuals who are not vaccinated and in need of follow-up. The client follow-up list can be customized based on age, vaccine status (due or overdue), and vaccines of interest. The outputs of this tool are client report, mailing labels, mail merge, and contact list. This is a great tool to support immunization quality initiatives.

Immunization Quality Improvement: Assessment, Feedback, Incentives, and eXchange

Assessment, Feedback, Incentives, and eXchange (AFIX) is a continuous quality improvement process used for improving immunization rates and practices at the provider level.¹³ Assessment, Feedback, Incentives, and eXchange involves an interactive discussion, face-to-face sharing of immunization rates, and educating providers on the use of MIIC to improve immunization rates and practice. The Minnesota Department of Health (MDH) Immunization Program has used MIIC for conducting the federal AFIX visits since 2008. Assessment, Feedback, Incentives, and eXchange site visitors take MIIC-generated Assessment Reports to Minnesota Vaccines for Children (MnVFC) participating clinics, review the rates with those providers, and support providers with resources to increase use of MIIC to improve immunization rates. The recent CDC-led AFIX/IIS integration effort

focuses on bringing all AFIX throughout the country to use IISs for quality improvement. Minnesota efforts have eliminated chart pulls and have increased MIIC use by users to drive their improvement activities.

State-Supplied Vaccine Ordering

The MnVFC program is the Minnesota version of the federally funded Vaccines for Children (VFC) program. Its goal is to ensure affordable vaccines for all children within their medical home. Due to increasing federal requirements, enhancements are being made to make MIIC a “one stop shop” for ordering and managing MDH vaccine over the next few years¹⁴ (Figure 6). The ordering tool in MIIC offers several advanced features, such as email notifications, view pending or past orders, and the ability to track vaccine shipment information. The tool eventually will produce reports to help providers manage their state-supplied vaccine and allow them to track returned and wasted vaccine through MIIC instead of using a paper form. Currently, ordering in MIIC allows organizations with multiple facilities to order using only 1 sign-in. This cuts out the extra step of having to log in and out of the application to create an order for each facility.

Immunization data exchange and interoperability

Statewide efforts to promote interoperable electronic health records (EHRs),¹⁵ as well as the Centers for Medicare and Medicaid Services EHR incentive program (Meaningful Use),¹⁶ contributed to a shift in the method of immunization

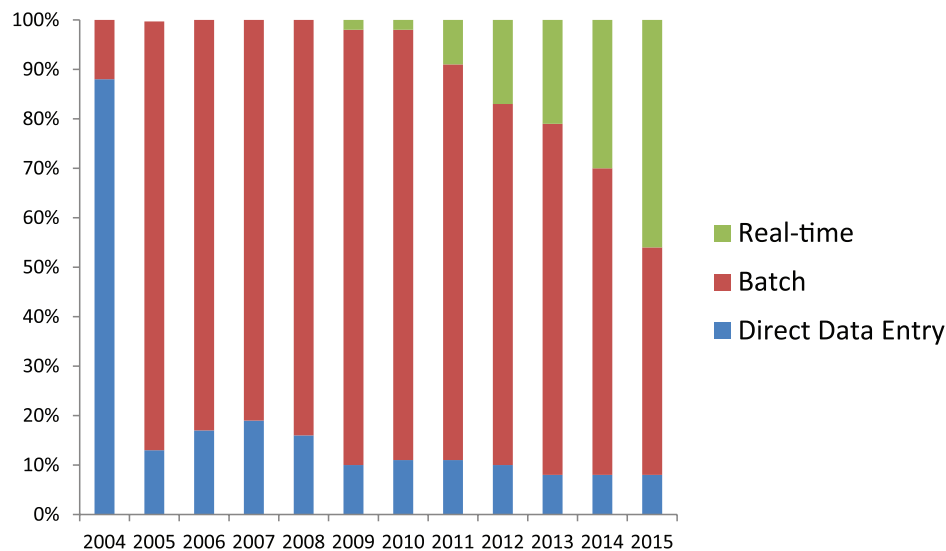


Figure 7. Trends in reporting to MIIC.

reporting to MIIC.¹⁷ In 2004, 90% of immunizations were directly entered into the IIS by a user. Today, 97% of immunizations are reported electronically, with half of those reported through batch method and the rest by real-time reporting (Figure 7). Standards-based reporting of immunizations (using HL7 exchange standard) to MIIC increased to 708 sites over the period of 3 years (2011–2014), along with growth in automated real-time reporting.¹⁸ In addition, clinical users increasingly want access to the MIIC history and forecasting within their EHR, so this valuable tool needs to be part of clinical workflow.

Clinical Decision Support for Immunizations

An important aspect of IISs is CDSi consisting of vaccine forecasting algorithms to predict needed immunizations and to recognize gaps in immunizations based on Advisory Committee on Immunization Practices (ACIP) recommendations.⁵ ACIP recommendations on vaccines are disseminated through various modalities, including IISs. CDSi comprises evaluation and forecasting which is complex, including factors such as age for vaccine administration, sex, number of doses, intervals between doses, precautions, and medical exemptions. MIIC currently offers an option branded as “Alternate Access” to access MIIC and CDSi from within the provider EHR.¹⁷ This solution offers the ability to generate a query to MIIC for vaccination history and forecasting based on demographics of the EHR record. This option addresses the issue of repeat data entry for the query and also does not require logging into the MIIC system separately. The history and forecast are displayed either as a read-only view within the provider EHR or with the capability for automatic data comparison across the 2 systems, ability to edit data and input into EHR.

MIIC Data to Improve Vaccinations and Support Immunization Initiatives

A major, organization-wide objective of MDH is on Health Equity and targeting and eliminating health disparities. As part of this initiative, MIIC and the Office of Vital Records (OVR) are collaborating on projects related to immunizations. Immunization rates for specific subsets of the population were calculated by matching information (eg, race, ethnicity, mother’s country of birth) from OVR to MIIC. Some project examples include maternal vaccination study and study of Somali vaccination trends. The project which examined immunization rates of Minnesota’s Somali population using MIIC data found gaps in immunization coverage which were used for targeted outreach efforts and broad media interventions to address the vaccination gap.¹⁹

Increasing adult immunization rates was the objective of a project which used MIIC data for baseline rates and conducted outreach to provider sites serving adult population (eg, pharmacies, Ob/Gyn, sexual health providers).²⁰ FluSafe is an initiative which uses MIIC to increase the health care worker vaccination rates of influenza in Minnesota hospitals and nursing homes. FluSafe was proven to be effective with higher rates of influenza vaccination in participating sites.²¹ MIIC has been used to provide timely data and to improve process efficiency in assisting child care centers with their mandatory annual immunization report to MDH under Minnesota Statute (Section 121A.15).²²

The High-Risk ZIP Code Project used MIIC data to identify 12 ZIP codes with historic and currently low immunization rates relative to other areas of Minnesota. To increase immunization rates in these ZIP codes, reminder/recall activities targeted children aged 24 to 35 months who are not UTD on their 4:3:1:3:3:1:4 series. Parents of not UTD children were sent letters initially, with follow-up letters sent quarterly to parents of kids who remained not UTD. The overall UTD

percentage increased by more than 16.4% in the targeted ZIP codes compared with a 4.2% increase in the control ZIP codes. The reminder/recall efforts had a possible impact on immunization rates in these 12 ZIP codes.²³

MIIC data on county-level vaccinations since 2010 have been made available online.²⁴ This public access portal includes a map of series coverage by county and metro area zip codes and tables with county rates for single antigens and pediatric series and is on a mobile-friendly platform. The objective is to increase access to MIIC data and enhance its utility to improve immunization rates.

Positioning MIIC to Provide Value and Path Forward

Although MIIC is among the leading IISs in the nation, it does face challenges in terms of improving the access and utility of its data, ensuring good quality of data, and meeting the technical requirements driven by IIS functional standards and changing electronic landscape in health care. These were recognized in the MIIC²⁵ Strategic Plan and priority actions identified. In addition, MIIC operates in an organizational environment wherein technical and business operations reside in varying units adding a layer of complexity and coordination needs. MIIC relies mainly on federal funds that support IIS operations with additional competitive funding for special projects (eg, EHR-IIS interoperability). With the delivery of certain preventive services including immunizations being offered beyond the confines of traditional health care organizations, the spectrum of stakeholders and scattering of immunization record increase. This presents MIIC with both an opportunity to serve as a record hub for immunizations and also the challenge of maintaining comprehensive data that are accurate, timely, and complete. Currently, MIIC responds to nearly 200 consumer immunization requests per month. Increasing consumer demands may present a need for consumer access to MIIC.

It is essential for IIS in various states and jurisdictions to work together to combine efforts, share knowledge, and collaborate on standards development and policy positions. The American Immunization Registry Association,²⁶ a membership organization for IISs, supports the various IIS development and implementation efforts. The growing adoption of EHRs in provider offices and hospitals with electronic tracking of immunizations of their care population and in-built informatics decision support tools will affect the value proposition provided by IISs and influence their functionalities and outreach. The ultimate goal is to position MIIC to continue to be an effective tool to support improvement in clinical immunization practice, serve as a resource for population health management, and ensure that public health has the most accurate and complete data to support immunization outreach and vaccine-preventable disease response efforts. Immunization Information Systems such as

MIIC offer valuable informatics tools to increase immunization rates and decrease vaccine-preventable diseases.

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Author Contributions

MM worked in the conceptualization of project and providing resources for content. SR provided support in writing of the manuscript. All authors reviewed and approved the final manuscript.

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