Direct and Electronic Health Record Access to the Clinical Decision Support for Immunizations in the Minnesota Immunization Information System

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Supplementary Issue: Use of Biomedical Informatics for Improving Vaccine Uptake and Adherence

ABSTRACT: Immunization information systems (IIS) are population-based and confidential computerized systems maintained by public health agencies containing individual data on immunizations from participating health care providers. IIS hold comprehensive vaccination histories given across providers and over time. An important aspect to IIS is the clinical decision support for immunizations (CDSi), consisting of vaccine forecasting algorithms to determine needed immunizations. The study objective was to analyze the CDSi presentation by IIS in Minnesota (Minnesota Immunization Information Connection [MIIC]) through direct access by IIS interface and by access through electronic health records (EHRs) to outline similarities and differences. The immunization data presented were similar across the three systems examined, but with varying ability to integrate data across MIIC and EHR, which impacts immunization data reconciliation. Study findings will lead to better understanding of immunization data display, clinical decision support, and user functionalities with the ultimate goal of promoting IIS CDSi to improve vaccination rates.

KEYWORDS: immunization, immunization information system, biomedical informatics, clinical decision support, electronic health record, Minnesota

SUPPLEMENT: Use of Biomedical Informatics for Improving Vaccine Uptake and Adherence

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Introduction

Immunization information systems. Immunization information systems (IIS) are population-based and confidential computerized systems maintained by public health agencies containing individual data on immunizations from participating health care providers.[1] Individual providers, health care systems, and public health stakeholders in a given jurisdiction access these systems to provide appropriate immunizations and to improve individual- and population-based vaccination rates. IIS offer numerous functionalities such as comprehensive history of vaccinations given across multiple providers and over time, vaccine forecasting algorithms to predict immunizations/clinical decision support for immunizations (CDSi), immunization assessment reports, client follow-up with reminder/recall, vaccine management tools, and state-supplied vaccine ordering capability.

IIS currently operate in a health care ecosystem empowered by electronic health records (EHRs) and other health information technology (HIT). Adoption of these different electronic infrastructures is supported by incentives from the Centers for Medicare and Medicaid Services (CMS)[2] through the federal Meaningful Use (MU) program. MU includes recommendations on standards to represent and exchange needed patient data and facilitate interoperability guided by Office of the National Coordinator for Health Information Technology (ONC).[3] The three-stage MU program recognized the role of IIS in improving vaccination rates and requires standards-based reporting of immunizations to IIS in Stages 1 and 2 and recommendations to access IIS CDSi in Stage 3.[4] The emerging health care reform under Medicare Access and CHIP Reauthorization Act (MACRA),[5] which comprises Merit-Based Incentive Payment System (MIPS), does incorporate immunization registry reporting and receipt of immunization forecasts and histories from the public health IIS.

CDSi in IIS. The recommendations issued by the Advisory Committee on Immunization Practices (ACIP)[6] serve

as the gold standard for guidelines related to immunizations. These ACIP recommendations are disseminated through various modalities including IIS. An important aspect to IIS is CDSi, which contains computable logic/vaccine forecasting algorithms based on ACIP recommendations that recognize gaps in immunizations and predict needed immunizations. This CDSi evaluation is complex, including factors such as age for vaccine administration, sex, the number of doses, their intervals, precautions, and contraindications.

With increase in use of EHRs, some of these complex immunization CDSi rules have been built directly into EHRs as CDS modules and/or accessed from IIS (through EHRs or directly via IIS interface). Due to immunization schedule complexity and need for a comprehensive vaccination history for accurate predictions, current recommendation is to access CDSi from IIS instead of locally in the EHR as types of CDS vary across provider groups and across EHR implementations.

Minnesota context. IIS in Minnesota (Minnesota Immunization Information Connection [MIIC])[7] has been operational since 2002 and currently holds 75 million immunizations for 7.6 million individuals with 4,852 organizations as registered users. Minnesota has a strong e-Health environment with a state-wide eHealth Initiative[8] led by an Advisory Committee and various laws related to e-Health.[9] Minnesota also has high EHR adoption rate in clinics and hospitals (97% clinics and 100% hospitals),[10] which presents a need and opportunity to better understand the access and use of IIS functions, including CDSi access through EHRs.

MIIC currently offers an option branded as "Alternate Access" to query and access MIIC and the CDSi from within the provider EHR.[7] This solution offers the ability to generate a query to MIIC for vaccination history and forecasting based on demographics of the EHR record. The display of query results and capability for reconciliation of immunization data vary across EHR platforms and implementation of this functionality.

EHRs and IIS. To date, EHR-IIS research includes concept papers,[11,12] single clinical setting reports,[13,14] assessment of automated reporting from EHR to IIS,[15,16] creation of computable CDSi logic,[17] impact of IIS-supplemented EHR reminders on flu vaccination,[18] responses to regulations,[19,20] and refinement of relevant standards.[21,22] Literature review reveals limited studies on exchange of data across public health systems and clinical care and these have focused primarily on clinician alerts for diseases.[23,24] Studies with emphasis on data interchange between IIS and EHRs have been limited with a paucity of research on CDSi offered by IIS. Prior research by the authors has focused on understanding the technological context around reporting of immunization from EHRs to IIS[25] and in characterizing the access to CDSi in IIS based on volume of queries to the IIS.[26]

The objective of this study was to analyze the CDSi presentation by MIIC IIS through direct access by IIS interface and by access through EHRs to outline similarities and differences. This will lead to better understanding of the display of immunization-related information, clinical decision support, and available user functionalities, with the ultimate goal of promoting IIS CDSi to improve vaccination rates.

Methods

The study was conducted in Minnesota using its IIS, the MIIC. Review of CDSi representation was completed through two modes: interviews of subject matter experts and by review of CDSi-related system functionalities in MIIC and EHRs. The experts for the study were chosen based on their knowledge of CDSi in MIIC and in selected EHR systems. Staff members from the following four organizations were included: the MIIC program, a large non-profit health care system, a local public health department, and an EHR vendor. The interviews were conducted during the time period of March–May 2015 in semi-structured format. The objective was to solicit information on access to MIIC CDSi, fit within the workflow, display of immunization data in user interface of MIIC and EHRs, representation of immunization data elements (including vaccine forecasting) from query of MIIC CDSi, and functional capability of EHRs to incorporate MIIC CDSi data and to understand the process of reconciliation of immunizations across the two systems. Topics included in the semi-structured interview are displayed in Table 1.

The EHR systems (Epic©, PH-Doc©) examined in this process were selected based on high adoption in Minnesota with Epic© being used by 49% of clinics[27] in the state and PH-Doc© used by 56% of local public health departments.[28] Apart from being the dominant market product in private and public health care, these products also had varying functionality with Epic© offering a static (read-only) view of MIIC CDSi and PH-Doc© offering an interactive option for movement of data across MIIC and EHR. Screenshots of the various user interfaces relevant to CDSi were collected from MIIC and from the two EHR systems as part of this

Table 1. Semi-structured interview topics.

Participants and their role	Demonstration of access to CDSi and its fit within workflow
Representation of immunization data elements (including vaccine forecasting) from query of MIIC CDSi	Display and presentation of immunization data in user interface of IIS and EHRs
Functional capability of EHRs to incorporate MIIC CDSi data and the Immunization Reconciliation Process	Other relevant information

process. Analysis focused on the data elements presented, categories of information, presentation of data and ability for reconciliation of immunization data with capabilities for data comparison, data edits, and data input into EHR from MIIC.

Results

Both the EHR products examined (Epic©, PH-Doc©) had access to MIIC positioned within the immunization workflow. Both EHRs offered 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. Data displayed from MIIC and the two EHR systems are presented in Table 2. There is overlap of displayed immunization history and vaccine forecasting data elements between MIIC and the EHR systems, as the EHR system draws in response data from MIIC and displays it for the user. The MIIC CDSi through its user interface presented immunization information composed of data elements in three distinct categories: individual demographic data (19), vaccination history (7), and vaccine forecasting recommendations (5). Figure 1 presents the 31 data elements presented by MIIC in the direct interface access. Figures 2 and 3 highlight the vaccination history and vaccine forecasting display provided by MIIC.

Table 2. Immunization data elements displayed.

DISPLAY ELEMENT	MIIC	PH-Doc©	EPIC©
Individual information			
Name	✓	✓	✓
Birthdate	✓	✓	✓
Gender	Stored elsewhere	Stored elsewhere	✓
Address	✓	✓	✓
Mother's maiden name	✓	✓	✓
Chart#/MIIC ID	✓	✓	✓
VFC eligible	✓	✓	✓
Schedule name	✓	✓	✓
Client comment	✓		
Vaccination history			
Date administered	✓	✓	✓
Series	✓	Stored elsewhere	✓
Vaccine group	✓	✓	✓
Vaccine/trade name	✓	✓	✓
Dose	✓	✓	✓
Owned?	✓	Stored elsewhere	✓
Reaction	Stored elsewhere	Stored elsewhere	✓
Historical?	✓	✓	✓

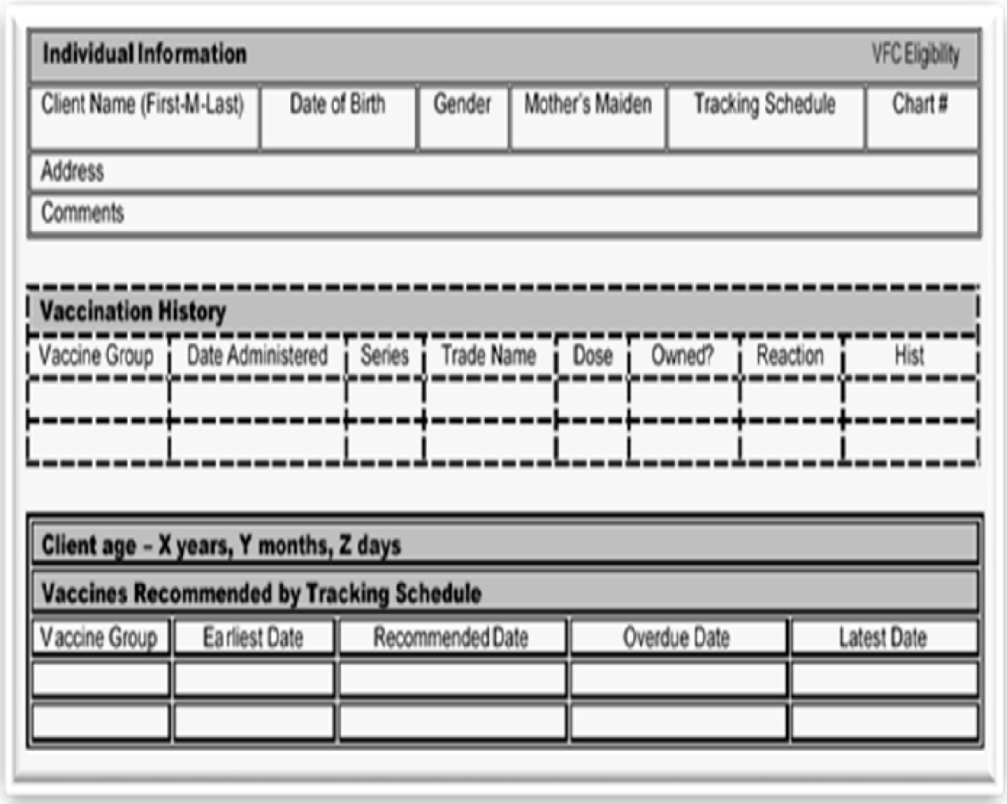

Figure 1. Clinical Decision Support for Immunizations (CDSi) presented by MIIC.

History

Add Immunization | Edit Client | Reports | Print | Print Confidential

Vaccine Group	Date Administered	Series	Vaccine [Trade Name]	Dose	Owned?	Hist?	Edit
DTP/aP	10/07/2002	1 of 5	DTaP	Full			
	12/09/2002	2 of 5	DTaP	Full			
	02/12/2003	3 of 5	DTaP	Full			
	11/03/2003	4 of 5	DTaP	Full			
	05/31/2007	5 of 5	DTaP	Full			
HepB	07/30/2002	1 of 3	HepB-Peds		No	Yes	
	02/12/2003	2 of 3	HepB-Peds		No	Yes	
	04/30/2003	3 of 3	HepB-Peds		No	Yes	
Hib	10/07/2002	1 of 4	Hib-OMP		No	Yes	
	12/09/2002	2 of 4	Hib-OMP		No	Yes	
	02/12/2003	3 of 4	Hib-OMP		No	Yes	
	07/30/2003	4 of 4	Hib-OMP		No	Yes	
Influenza	11/18/2006	1 of 2	FLU >= 3 Years [Fluzone >= 3 yrs ®]	Full			
	11/30/2007	2 of 2	FLU-Nasal [FluMist ®]	Full			

Figure 2. Vaccination history display in MIIC.
Screenshot: Courtesy of MIIC.

Current Age: 11 years, 26 days

Vaccines Recommended by Selected Tracking Schedule

Add Selected

Select	Vaccine Group	Earliest Date	Recommended Date	Overdue Date	Latest Date
	DTP/aP		Complete		
☑	HepA	07/28/2003	07/28/2003	01/28/2004	
	HepB		Complete		
	Hib		Complete		
☑	HPV	07/28/2011	07/28/2013	07/28/2015	07/27/2029
☑	Influenza	10/16/2012	07/01/2013	09/18/2013	
☑	Meninge-conj	07/28/2013	07/28/2013	07/28/2015	07/27/2023
	MMR		Complete		
	Pneumo-conj		Complete		
	Polio		Complete		
☐	Td/Tdap	09/18/2017	09/18/2022	09/18/2023	
	Varicella		Complete		

Figure 3. Vaccine forecasting display in MIIC.
Screenshot: Courtesy of MIIC.

The variation was in presentation of the vaccination history and the ability to integrate data across the two EHR products examined. The MIIC CDSi data displayed by the PH-Doc© system (Fig. 4) holds much of the same data elements as the MIIC display. A key functionality of PH-Doc© is the dynamic data exchange between MIIC data from query of IIS and the EHR system. Data can be reconciled by incorporating data from the MIIC query directly into the EHR without the need for manual data entry. PH-Doc© provided the capability to compare immunization differences between MIIC and the EHR system in a side-by-side view of both systems. In addition, it highlighted differences in immunizations between the two

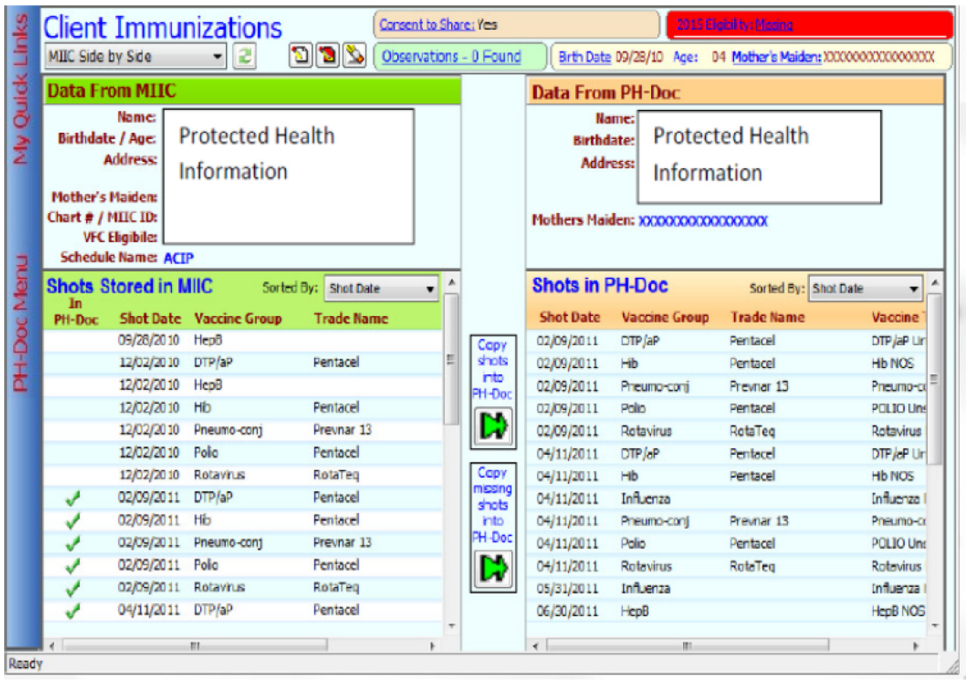

Figure 4. Dynamic data display provided by PH-Doc©.

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systems, which is essential for reconciliation of immunization data. Review of Epic© pointed to a read-only view of the MIIC data obtained from Alternate Access query (Fig. 5) and did not support side-by-side comparison of data from the two systems. The data display utilized the same formatting options as in MIIC with similar display of vaccination history and forecasting.

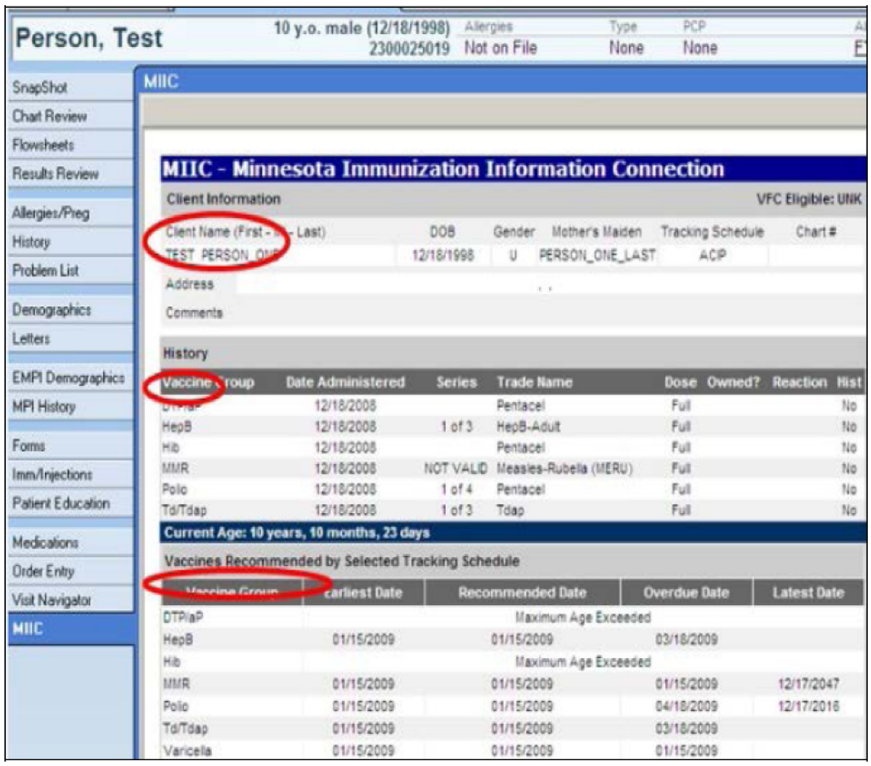

Figure 5. MIIC CDSi data display in Epic.

Notes: Copyright © Epic Systems Corporation. Screenshot: Courtesy of MIIC.

Discussion

As immunization guidelines are increasingly embedded into various electronic tools, including EHRs, there is a need to decrease the variability due to varying logic (CDSi rules) across the variety of clinical decision support options. IIS CDSi incorporates ACIP recommendations and presents a great opportunity to increase the uniformity in implementation of immunization guidelines. Both current efforts to promote EHR adoption/use (MU) and emerging[5] payment reform efforts ensure use of interoperable and certified EHRs. Given this EHR landscape, there is a growing need for research on access and use of CDSi at the point of care, specifically through EHRs.

This study contribution is to analyze and present information about the IIS CDSi through various access options, both directly through the IIS interface and by access through EHRs. Study limitations are that it presents functionality during early 2015 and does not describe current EHR product upgrades. Additionally, current Epic© and PH-Doc© installations do support dynamic data movement between MIIC and EHR, which is essential for reconciliation of the immunization data. Another limitation is that the study focuses on presentation of immunization data and does not validate the rules/decision logic in both MIIC and the two EHR systems.

Identifying how best to utilize decision support and immunization data available through IIS will be of high importance as bidirectional exchange across EHRs and IIS is implemented. Recent projects have evaluated the capability of select EHR products in their ability to submit data to the IIS and query the IIS[29] and in the process of developing usability guidance documents.[30] Vendors and users should participate in the usability review process and also utilize the guidance for product enhancements and EHR review/selection. It will be of great benefit if national organizations such as the American Immunization Registry Association[31] can work collaboratively with IIS and EHR communities to develop best practices around presentation of IIS data in the EHR and issue guidelines on reconciliation of immunization data across the two systems.

As delivery of certain preventive services including immunizations have spread beyond the confines of traditional health care organizations, IIS serve as a hub for immunization data by holding immunization information across providers and over time. In addition, they can serve as a central resource for decision support logic based on current ACIP recommendations. It is essential to understand the access and use of the IIS CDSi functionality, given the increasing adoption and use of EHRs. Findings will help to guide best practices in immunization data integration and data display and, ultimately, support clinical decisions on immunizations.

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Author Contributions

Conceived and designed the project: SR. Participated in project: SW, AB, DJ, TW, MM. Wrote the first draft of the manuscript: SR. Contributed to the writing of the manuscript: SW, MM. Provided content for manuscript: AB, DJ, TW. All authors reviewed and approved the final manuscript.

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