Technological and Organizational Context around Immunization Reporting and Interoperability in Minnesota

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Abstract

Background: Immunization information systems (IIS) operate in an evolving health care landscape with technology changes driven by initiatives such as the Centers for Medicare and Medicaid Services EHR incentive program, promoting adoption and use of electronic health record (EHR) systems, including standards-based public health reporting. There is flux in organizational affiliations to support models such as accountable care organizations (ACO). These impact institutional structure of how reporting of immunizations occurs and the methods adopted.

Objectives: To evaluate the technical and organizational characteristics of healthcare provider reporting of immunizations to public health in Minnesota and to assess the adoption of standardized codes, formats and transport.

Methods: Data on organizations and reporting status was obtained from Minnesota IIS (Minnesota Immunization Information Connection: MIIC) by collating information from existing lists, specialized queries and review of annual reports. EHR adoption data of clinics was obtained in collaboration with informatics office supporting the Minnesota e-Health Initiative. These data from various sources were merged, checked for quality to create a current state assessment of immunization reporting and results validated with subject matter experts.

Results: Standards-based reporting of immunizations to MIIC increased to 708 sites over the last 3 years. A growth in automated real-time reporting occurred in 2013 with 143 new sites adopting the method. Though the uptake of message standards (HL7) has increased, the adoption of current version of HL7 and web services transport remains low. The EHR landscape is dominated by a single vendor (used by 40% of clinics) in the state. There is trend towards centralized reporting of immunizations with an organizational unit reporting for many sites ranging from 4 to 140 sites.

Conclusion: High EHR adoption in Minnesota, predominance of a vendor in the market, and centralized reporting models present opportunities for better interoperability and also adaptation of strategies to fit this landscape. It is essential for IIS managers to have a good understanding of their constituent landscape for technical assistance and program planning purposes.

Keywords: immunization reporting, standards, interoperability, public health informatics, EHRs

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Introduction

Immunization information systems (IIS) are effective tools in achieving and maintaining adequate vaccination coverage levels to reduce or eliminate the burden of vaccine preventable diseases [1-3]. IIS offer related functionalities such as comprehensive vaccination history of a person given across multiple providers and over time, recommendations of vaccine needed through use of vaccine forecasting algorithms and reports of immunizations which are person-based or for a clinic or select population. The Minnesota Immunization Information Connection (MIIC) is Minnesota's statewide, web-based immunization information system, which has been operational since May 2002 [4]. MIIC is a population-based system with over 66 million immunizations on 6.9 million clients across the lifespan. MIIC operations are governed by the Minnesota Data Sharing Law [5]. Though immunizations are reported on voluntary basis, the provider participation in MIIC is high across health care sectors. Ninety-two percent of MnVFC (Minnesota Vaccines for Children) provider sites have submitted data regularly within the past six months.

The effectiveness of an IIS depends on the robust reporting of immunizations from healthcare providers and community vaccinators. Data on immunizations administered are reported to IIS by healthcare providers in various formats and mechanisms. Although reporting has largely been electronic since 2004, there has been a recent shift from electronic reporting using a proprietary flat file format to reporting using national data exchange standards. This recent change is driven by increased adoption of electronic health record systems (EHRs). The CMS EHR Incentive Program also referred to as "meaningful use" has been a significant driver for adoption of EHRs and effective use of the functionalities to enhance patient care and population health [6]. Minnesota has very high EHR adoption rates among hospitals (99%) and ambulatory clinics (94%) [7], reinforced by both meaningful use incentives and a state mandate for interoperable EHRs by January 2015 [8]. This momentum is supported by federal initiatives on standards to propel the use of standardized formats and codes for select public health reporting transactions which include immunizations [9]. In addition to the technology changes affecting the health care sector, reform initiatives are supporting coordinated models of care to support outcomes and payment reforms, including Patient-Centered Medical Homes (PCMHs) which are branded as Health Care Homes in Minnesota [10] and Accountable Care Organizations (ACOs). These influence organizational processes and affiliations and have a direct impact on tracking of immunizations at provider level and organizational reporting structures.

Recognizing the changing health information technology landscape, the IIS functional standards were revised and include receipt of submissions by IIS and response to queries, based on

recommended standards [11]. Progress made by IIS across the country in meeting functional standards and in pediatric and adult participation rates has been described [12]. The need to utilize the momentum around meaningful use to improve interoperability between EHR and IIS has been elaborated [13]. Recent studies analyzed the impact on provider reporting of immunizations by comparing the batch and real-time methods [14] and the effects of automated registry reporting from EHRs [15]. Access to IIS decision support within EHR [16] has been studied and bi-directional communications between clinical sector and public health has been reviewed [17]. White papers on this topic include describing the overlap between EHRs and IIS [18] and the developing HIE landscape [19] to outline potential strategies and collaborations for IIS to consider in this exchange and use of immunization information across clinical sectors and public health.

This study attempts to distill the impact of various initiatives on Minnesota's healthcare landscape and to understand the operational context of MIIC. The objectives of this study are to evaluate the technical and organizational characteristics of healthcare provider reporting of immunizations in Minnesota and to assess the uptake and use of standards, including codes, data formats and transport methods. The research seeks to understand the evolution of electronic public health reporting of immunizations to MIIC from 2010 to 2014, the period of rapid adoption of health information technology by providers in Minnesota.

Methods

Data were obtained from different programs within the Minnesota Department of Health: MIIC, the state immunization information system and the MDH Office of Health Information Technology. The various data was assimilated and analyzed to understand the changes in adoption of electronic exchange of health information, impact of organizational changes and regulatory requirements and use of various standards over time. This process was used to compile an assessment of immunization reporting and interoperability, as depicted in Figure 1.

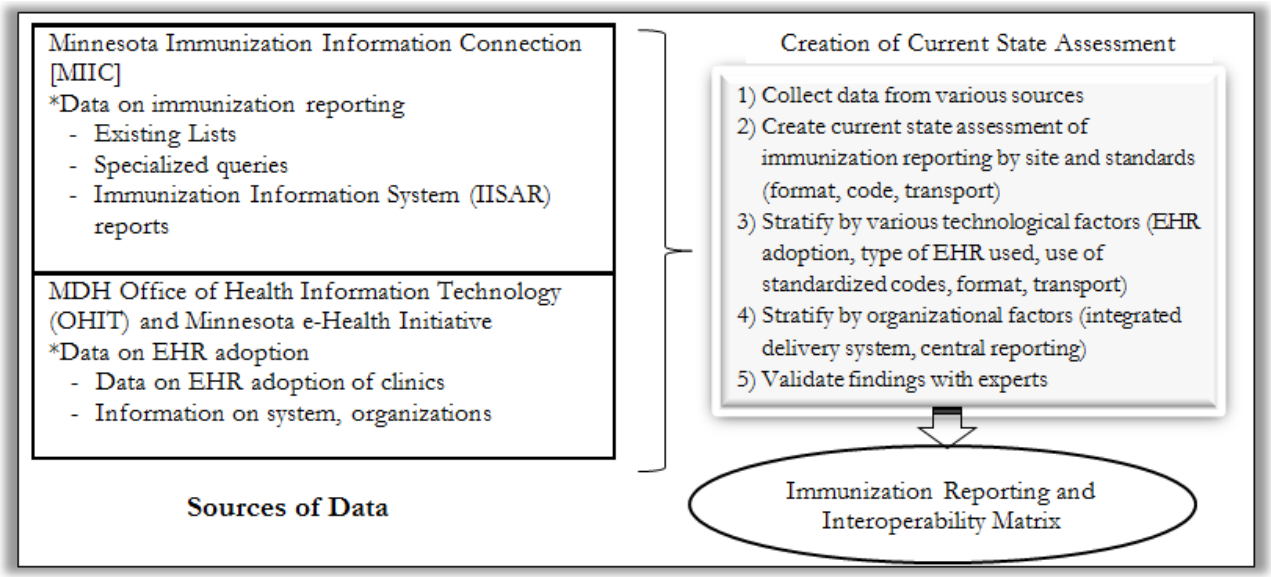

Figure 1: Conceptual Framework of Research Study

MIIC currently has 4,200 active organizations, some of whom send data as part of public health reporting (e.g. clinics) and some largely have read-only access (e.g. schools). Existing lists from MIIC were collected, organized and updated to reflect current reporting status. Queries were run on MIIC data to get reporting information on some organizations. Immunization Information System Annual Report (IISAR) for last 3 years was reviewed to gain an understanding of evolution of technical capabilities of MIIC. The synthesis of reporting status was limited to main healthcare systems as they account for majority of reporting and also to constraint the scope of this study.

The second data source is the Minnesota ambulatory clinic health information technology survey (clinic survey), an annual online survey designed to uniformly collect and share the progress of Minnesota's providers in adopting and implementing EHR systems, and exchanging electronic health information. The clinic survey is managed by MDH's Office of Health Information Technology and has been conducted annually since 2010. The 2014 survey includes responses from 1,206 of 1,404 clinics that have registered with the Statewide Quality Reporting and Measurement System (SQRMS), for a response rate of 86%. Clinics in Minnesota are required by law to register with SQRMS and respond to the clinic survey.

A matrix was created to depict the current state assessment: (a) healthcare provider entities reporting and their technological characteristics such as EHR adoption, type of EHR used, format used for reporting (standards vs. not, type of standards: format, codes, transport), (b) healthcare provider entities reporting, their organizational characteristics such as integrated delivery network and number of sites reported, (c) changing trends around electronic exchange.

An organization can be along a spectrum on standards adoption ranging from use of no standards to some set of standards to all recommended standards. If an organization reports using recommended standards for immunization reporting which include HL7 2.3.1/HL7 2.5.1 exchange standard, CVX vaccination codes, MVX manufacturer codes and transport method which supports real-time reporting (e.g. web services), the entity has achieved a high level of interoperability with MIIC. The study findings were validated with subject matter experts to gain understanding of the context and other factors which facilitate or hinder adoption of standards and hence movement towards interoperability.

Results

Reporting of immunizations to MIIC has evolved over the years since 2004 (refer Figure 2). Currently, more than ninety percent (91%) of incoming immunizations are reported through electronic modalities (both batch and real-time transfers). This is in contrast to a decade ago when majority of reported immunizations (88.4%) were entered through direct data entry in 2004. Of the incoming electronic reporting, two-thirds (60%) of immunizations are reported to MIIC through batch modes. Real-time reporting did not exist during inception of MIIC, but currently about one third (31%) of immunizations are reported through this automated and instantaneous modality. This transport option had good adoption rate over the last two years, with real-time reporting increasing from 8.9% in 2011 to 31% in 2014.

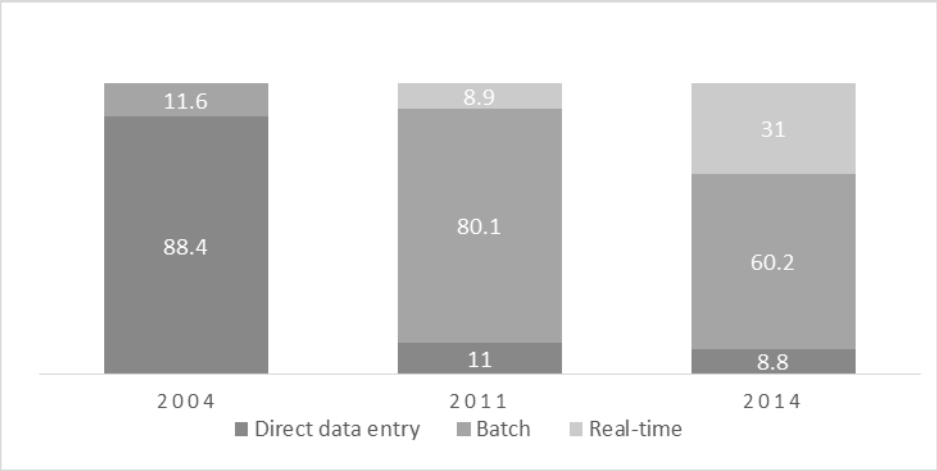

Figure 2: Trends in Immunization Reporting to MIIC: 2004 – 2014

The provider landscape in which MIIC is operating has undergone dramatic changes as well with more than 90% of clinics having adopted electronic health records in 2014. Based on data from Minnesota Statewide Quality Reporting and Measurement System, as of 2014, about 1,404 clinics representing 235 entities (health systems/medical groups) are operating in Minnesota. Ninety-three percent of clinics (1,118) had an EHR installed and in use, and another 6% are planning to adopt (see Figure 3). These data also present insights into the EHR system used by the clinics and highlight the dominance of a single vendor in the market, which is used by 40% of the clinics. Table 1 presents the percent and count of Minnesota clinics using each of the common electronic health record systems.

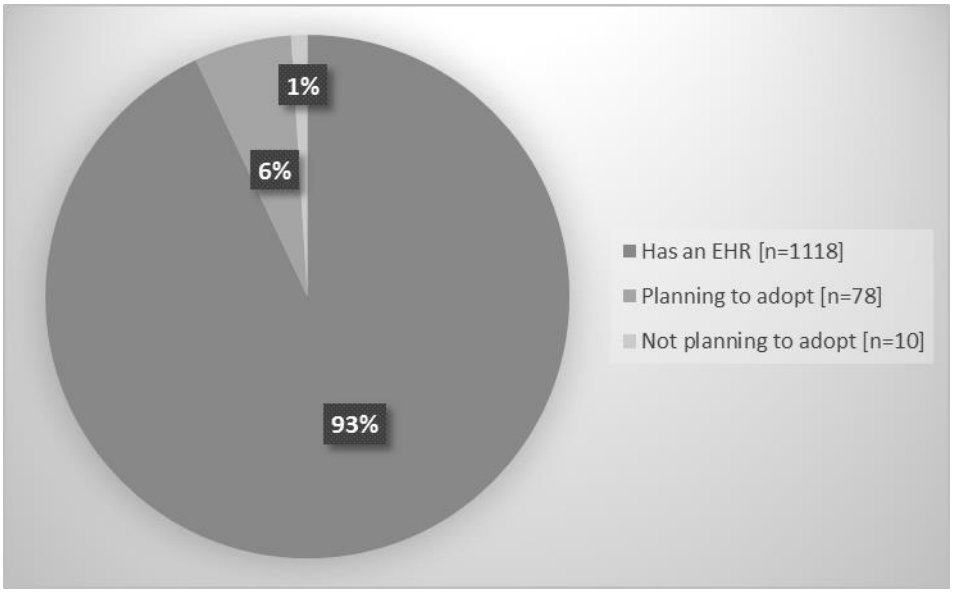

Figure 3: EHR Adoption Rate in Minnesota Clinics, 2014

Table 1: EHR Systems used by Adopting Clinics, 2014

EHR Vendor	Percent	Count
Epic	40%	449
Allscripts (Medinotes)	9%	100
eClinicalWorks	9%	98
Greenway (PrimeSuite)	8%	94
NextGen	6%	67
Cerner	5%	53
Centricity (GE Healthcare)	4%	46
Other	18%	205
Total		1,118

The format (exchange standard) of immunization reporting to MIIC has evolved over the years with an increasing reporting based on recommended exchange standards (HL7). From the MIIC data, the sites reporting using HL7 standards increased from 109 in mid-2011 to 708 sites as of July 2014. Current version of HL7 standards (HL7 2.5.1) is being adopted and used by 151 sites. Real-time reporting to MIIC also expanded over the corresponding time period (2011-2014) with a growth from 11 sites in 2011 to 326 sites using real-time methods as of July 2014. A growth in automated reporting occurred in 2013 due to adoption by many providers (143 sites adopted the existing real-time technology) and introduction of new transport option (adopted by one site in that year). Figures 4 and 5 depict the adoption of HL7 exchange standard and real-time transport method respectively over the years 2011- 2014.

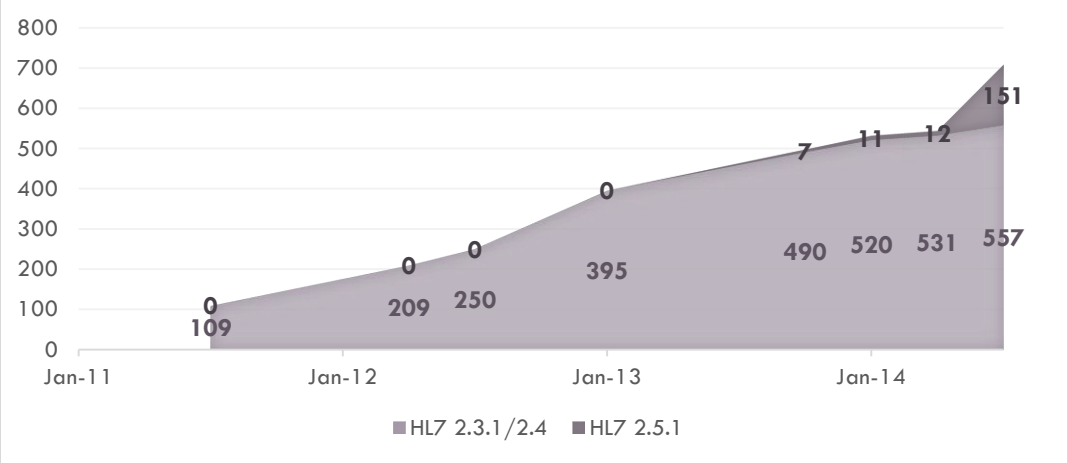

Figure 4: Standards-based Immunizations Reporting Using HL7 to MIIC: 2011 – 2014

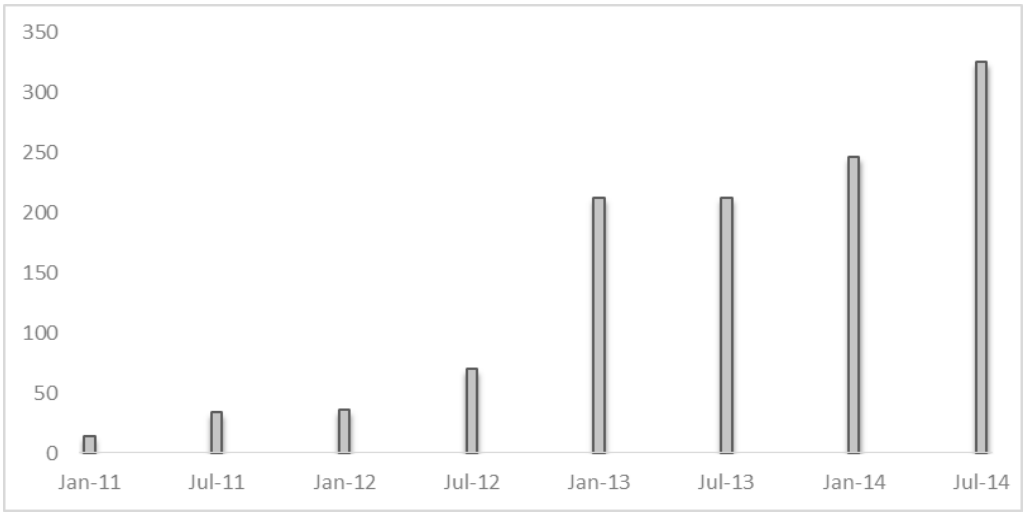

Figure 5: Facilities with Real-time Data Submissions to MIIC: 2011 – 2014

The next step in the study was to create a current state assessment of reporting. Results of compiling of data across programs on EHRs and reporting information (including format, codes and methods) are shown in Table 2. With high EHR adoption rates in Minnesota, all the main integrated healthcare delivery systems and medical groups reporting to MIIC are on various EHR platforms. Twenty integrated healthcare delivery systems were studied in detail as they report for 874 sites and account for more than two thirds of volume of immunizations submitted to MIIC. Of these, 80% (700 sites) report using HL7 exchange standards. Six hundred and ninety sites (79%) report using recommended vocabulary standards for immunizations (CVX) and some of these sites report both CPT and CVX codes. Currently, 326 sites submit through real-time reporting and PHIN-MS is utilized more (241 sites), whereas the newly introduced technology to support real-time reporting via web services/SOAP has been adopted by 85 sites. To maintain these, 6 interfaces support the PHIN-MS reporting by main organizational units and 2 interfaces support the web services based reporting. Figure 6 depicts the context and centralized reporting in organizations, wherein immunizations given across 874 sites are reported from 20 centralized units in corresponding organizations. This impacts the interfaces required to be maintained by MIIC and lesser numbers are needed to manage reporting by multiple sites.

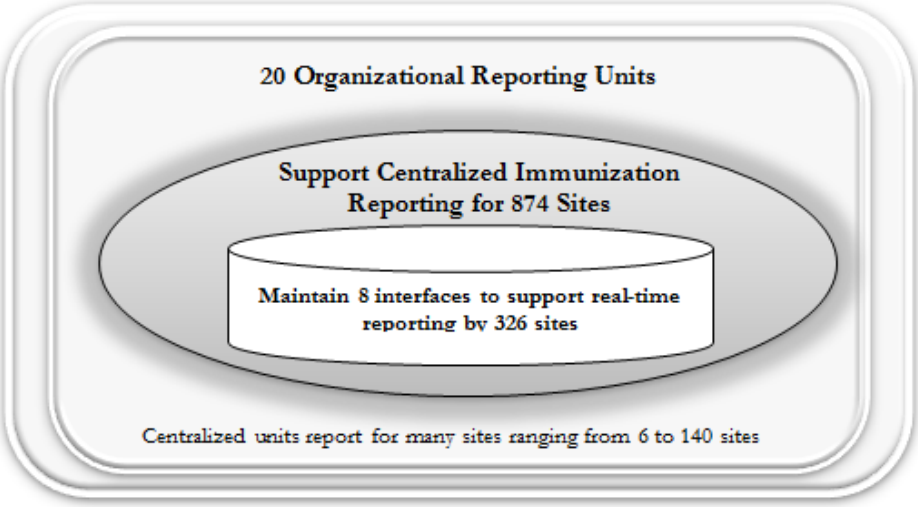

Figure 6: Organizational Context and Reporting through Centralized Structures

Table 2: Current State Assessment of Immunization Reporting for Select Systems

Health System	Sites / Clinics Represented	EHR System in Use	Adoption of Standards/Recommendations*		
			Exchange format and standard	Vocabulary / Codes	Transport Method
Health System 1	80	EPIC	HL7 2.4	CVX	SFTP
Health System 2	87	EPIC	Flat file	CPT	SFTP
Health System 3	33	EPIC	HL7 2.4	CVX	PHINMS
Health System 4	39	EPIC	HL7 2.4	CVX and CPT	PHINMS
Health System 5	105	EPIC	HL7 2.4	CVX	SFTP
Health System 6	75	EPIC	HL7 2.3.1	CVX	SFTP
Health System 7	81	GE Centricity	HL7 2.4	CVX	PHINMS
Health System 8	12	Cerner	HL7 2.4	CVX and CPT	SFTP
Health System 9	15	GE Centricity	Flat file	CPT	SFTP
Health System 10	140	EPIC	HL7 2.5.1	CVX	SOAP
Health System 11	27	EPIC	Flat file	CPT	SFTP
Health System 12	22	EPIC	HL7 2.5.1	CVX and CPT	SOAP
Health System 13	13	AllScripts	HL7 2.4	CPT	PHINMS
Health System 14	12	AllScripts	HL7 2.3.1	CPT	UI
Health System 15	73	EPIC	HL7 2.5.1	CVX and CPT	PHINMS
Health System 16	4	eClinical Works	Data entry in UI	CPT	User Interface (UI)
Health System 17	15	AllScripts	HL7 2.4	CVX and CPT	PHINMS
Health System 18	23	Integreat EHR	Flat	CPT	SFTP
Health System 19	6	GE Centricity	Flat	CPT	SFTP
Health System 20	12	eClinical Works	Flat	CPT	SFTP

** Details on recommended standards for immunization submission are available at http://www.health.state.mn.us/divs/idepc/immunize/registry/hp/data.html.*

Discussion

Minnesota has high level of EHR adoption with a confluence of integrated healthcare delivery systems and this presents an interesting context in terms of immunizations reporting. Incentives, significant e-Health policy and programmatic efforts, organizational shifts such as mergers and business affiliate agreements to provide access to EHRs have facilitated EHR adoption. The dominance of a single vendor in the market presents some unique opportunities for collaboration and expansion of technical capabilities and interoperability.

MIIC is a successful immunization information system with over 4,000 registered organizations and this offers venues for collaboration to promote better reporting and IIS use. Immunization reporting using standards need to comply with all recommendations: HL7 messages for exchange, CVX and MVX for coding immunizations and using appropriate transport protocols (web services recommended). Automated standards-based real-time reporting has grown over last couple of years with one third of immunizations being reported through this modality. Currently, the HL7 v2.3.1 exchange standard and PHIN-MS transport are utilized more, but are superseded with new exchange version and transport recommendations. Stage 1 meaningful use requirements promoted HL7 v2.3.1 and with grandfathering clause of this format standard in Stage 2, there is less interest in upgrades to next version of exchange standard (HL7 v2.5.1). Technical assistance to support web services transport and HL7 2.5.1 should be considered to promote adoption.

This research has some limitations as well, with current state assessment of interoperability focused on only the clinics. Community vaccinators and pharmacies have an expanding role and are an important part of immunization service delivery and their reporting status impacts the overall interoperability and quality of data in IIS. Similarly, role of HIE entities in this space has been evolving. Currently, no reporting to MIIC occurs through HIE entities. Their clientele needs to be understood to identify opportunities for collaboration [19]. There is variability amongst providers using same EHR vendor in their mode of immunization reporting. Understanding its context will help MIIC to devise strategies in promoting uniformity and recommended standards-based reporting. The role of emerging models such as ACOs and PCMHs and impact of those organizational structures on immunization reporting and access to IIS services need to be studied.

Minnesota is a unique position with other drivers in place such as 2015 interoperable electronic health record mandate [8] and certification of health information exchange (HIE) entities [20]. The impact of these regulations needs to be evaluated. Potential future studies/projects include outreach to large integrated health delivery systems in the state to better understand future EHR-IIS exchange needs. With overlap between some EHR and IIS functionalities [18], there is a need for provider education to highlight the IIS functions to support improvements in clinical care, population health management and public health assurance. With both technological capabilities and organizational affiliations in flux, there is a need for continued assessment and understanding of trends in healthcare organizations across the state. While suggested format standards exist for exchange, there is a big gap in best practices for data integration and semantic representation. This has implications for clinical decision support, quality measures and use of IIS functionality by healthcare providers. These have a significant impact on bi-directional interoperability between clinical sector and public health.

Conclusion

Immunization information systems (IIS) operate in an evolving health care landscape with technological changes supported through the use of EHR systems by providers, standards-based reporting driven by meaningful use incentive program, presence of HIE entities, and emerging models of health care delivery and payment such as PCMHs and ACOs. This research shows that, even with high EHR adoption rates, utilization of recommended standards for codes, data format and transport methods is not consistent across providers nor EHR vendor systems. It also

points to emerging organizational structures which impact reporting of immunizations to public health.

Additional research is required to understand the factors which lead to adoption and use of standards and the context around variability in technological capacity across providers using same EHRs. Further studies are also warranted to know more of the utilization of IIS functionality by health care organizations which may influence their decisions regarding reporting of immunizations. It is essential for IIS managers to understand the technical capabilities and organizational structures of their constituent landscape to support optimal immunization reporting, access and use of IIS services and for technical assistance and program planning.

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References

1. Centers for Disease Control and Prevention. Immunization Information Systems (IIS). 2014. Available at: http://www.cdc.gov/vaccines/programs/iis/index.html. Accessed October 8, 2014.
2. Community Preventive Services Task Force. 2014. Recommendation for Use of Immunization Information Systems to Increase Vaccination Rates. *J Public Health Manag Pract*. 2014, 1-4.
3. Groom H, Hopkins DP, Pabst LJ, Morgan JM, Patel M, et al. 2014. Immunization Information Systems to Increase Vaccination Rates: A Community Guide Systematic Review. *J Public Health Manag Pract*. Epub 06 2014. PubMed http://dx.doi.org/10.1097/PHH.0000000000000069
4. Minnesota Immunization Information Connection (MIIC). Submitting and Exchanging Data with MIIC. 2009. Available at: http://www.health.state.mn.us/divs/idepc/immunize/registry/index.html. Accessed October 24, 2014.
5. Minnesota Statutes Immunization Data. 2014. Available at: https://www.revisor.mn.gov/statutes/?id=144.3351. Accessed November 4, 2014.
6. Centers for Medicare and Medicaid Services. EHR Incentive Programs. 2010. Available at: http://www.cms.gov/ehrincentiveprograms. Accessed 13 June, 2014.
7. MDH Office of Health IT. Minnesota e-Health Assessment Reports, Factsheets and Briefs. 2013. Available at: http://www.health.state.mn.us/e-health/assessment.html. Accessed October 13, 2014.
8. Minnesota eHealth Initiative. 2015 Interoperable Electronic Health Record Mandate. 2007. Available at: http://www.health.state.mn.us/e-health/abouthome.html. Accessed November 4, 2014.

9. Office of the National Coordinator for Health Information Technology. Standards and Interoperability. 2010 Available at: http://www.healthit.gov/policy-researchers-implementers/standards-interoperability. Accessed June 13, 2014.

10. Homes HC. Certified Health Care Homes in Minnesota. 2010. Available at: http://www.health.state.mn.us/healthreform/homes/documents/certhch.pdf. Accessed June 14, 2014.

11. Centers for Disease Control and Prevention. Immunization Information Systems Functional Standards, 2013-2017. 2012. Available at: http://www.cdc.gov/vaccines/programs/iis/func-stds.pdf. Accessed October 24, 2014.

12. Cardemil C, Ng T, Pabst L. 2013. Progress in Immunization Information Systems -- United States, 2012. *MMWR Recomm Rep*. 62(49), 1005-08. PubMed

13. Dombkowski KJC. 2012. S. J. Redefining meaningful use: achieving interoperability with immunization registries. *Am J Prev Med*. 42(4), e33-35. Epub 03 2012. PubMed http://dx.doi.org/10.1016/j.amepre.2012.01.009

14. Schauer SL, Maerz TR, Verdon MJ, Hopfensperger DJ, Davis JP. 2014. The Wisconsin Immunization Registry Experience: Comparing Real-time and Batched File Submissions From Health Care Providers. *WMJ*. 113(3), 102-06. Epub 06 2014. PubMed

15. Merrill J, Phillips A, Keeling J, Kaushall R, Senathirajah Y. 2013. Effects of automated immunization registry reporting via an electronic health record deployed in community practice settings. *Applied Clinical Informatics*. 4(2), 267-75. PubMed http://dx.doi.org/10.4338/ACI-2013-02-CR-0009

16. Stevens LA, Palma JP, Pandher KK, Longhurst CA. 2013. Immunization registries in the EMR Era. *Online J Public Health Inform*. 5(2), 211. PubMed http://dx.doi.org/10.5210/ojphi.v5i2.4696

17. Dixon BE, Gamache RE, Grannis SJ. 2013. Towards public health decision support: a systematic review of bidirectional communication approaches. *Journal of the American Medical Informatics Association: JAMIA*. 20(3), 577-83. Epub 03 2013. PubMed http://dx.doi.org/10.1136/amiajnl-2012-001514

18. HLN Consulting. IIS and EHR Feature Overlap. 2014. Available at: https://www.hln.com/assets/pdf/HLN-IIS-EHR-Overlap-White-Paper.pdf. Accessed October 8, 2014.

19. HLN Consulting. IIS and HIE: Is there a Future Together? 2013. Available at: https://www.hln.com/assets/pdf/HLN-IIS-HIE-White-Paper.pdf. Accessed October 24, 2014.

20. Minnesota Statutes Health Information Exchange Oversight. 2010. Available at: http://www.health.state.mn.us/divs/hpsc/ohit/hieoversight.html. Accessed November 4, 2014.