

Is There a National Strategy Emerging for Patient Matching in the US?

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Abstract

Patient record matching has been a key area of emphasis for healthcare in the US, with several major efforts to identify best practices in the past decade. Because of a lack of a national patient identifier, several distinct approaches to patient matching in both the public and private sectors have emerged, which do not appear to be converging. One major focus of a number of patient matching initiatives is the identification of a core set of data elements found in most patient records, regardless of setting, to facilitate matching. These initiatives have also not yet converged. Some organizations participate in master patient index (MPI) deployments within their agency or jurisdiction. But participation in a shared MPI can also be challenging, and policies and processes for synchronizing record changes, among other issues, must be carefully considered. “Promising practices” should be identified from those jurisdictions that have lived through a migration to an enterprise MPI. While the healthcare ecosystem has learned a great deal, this is an area where constant quality improvement must be applied. The healthcare community must monitor the disparate public and private initiatives to solve the patient matching challenge, and adjust as needed to accommodate approaches intended to be universally implemented.

Key words: Master Patient Index, MPI, patient matching

1. Background

Accurate patient matching is an ongoing issue in healthcare informatics; in fact, given the growing emphasis on interoperability to facilitate improved continuity and quality of health care, patient matching has been receiving increased attention. “One of the largest unresolved issues in the safe and secure electronic exchange of health information is the need for a *nationwide patient data matching strategy* ensuring the accurate, timely, and efficient matching of patients with their healthcare data across different systems and settings of care.”¹ Unfortunately, the U.S. has not yet addressed patient matching in a comprehensive way by defining either a national strategy or best practice guidance and tools.

Issues of patient record *matching* are closely tied to issues of patient *identification*, since to match two records together (or determine they are *not* matches) rests largely on the confidence one has that a particular record in fact belongs to an individual who can be clearly identified, and that the matching record can be identified with the same individual. In many settings, this is more easily achieved by assigning a unique identifier to each individual to be used with impunity wherever that individual’s record is sent or referenced. While some countries have implemented solutions such as this, Congress banned the federal government in the U.S. from promulgating or adopting such a strategy in 1998.²

The Office of the National Coordinator for Health Information Technology (ONC) and many others have interpreted this somewhat narrow prohibition as preventing even the discussion of such a strategy within federal agencies, essentially shifting the conversation to the private sector, when it happens at all. More recently, however,

Congress clarified its position by stating that, “...this limitation does not prohibit HHS from examining the issues around patient matching. Accordingly, the Committee encourages the Secretary, acting through the Office of the National Coordinator for Health Information Technology and CMS, to provide technical assistance to private-sector led initiatives to develop a coordinated national strategy that will promote patient safety by accurately identifying patients to their health information.”³ In addition, the 21st Century Cures Act authorizes within a year of its passing a study, “to ensure appropriate patient matching to protect patient privacy and security with respect to electronic health records and the exchange of electronic health information.”⁴

Among the key questions for the healthcare community are:

- Which of the nationwide initiatives discussed below most warrant watching or active participation?
- Are there unique aspects of health record matching that would justify not aligning to national models and standards, when and if one emerges as a national standard?
- What are the potential costs of not aligning with national standards? Of doing so?
- Where do we look for the most appropriate metrics on matching to inform system assessment and potentially certification?
- What benefits and risks may need to be considered in linking a health system which participates in a broader Master Patient Index (MPI) or similar data set?

2. Approaches to a Nationwide Strategy

Because of this lack of a national patient identifier, several distinct approaches to patient matching have emerged, which do not appear to be converging:

2.1. Traditional approach:

In the absence of anything better or more practical, the traditional approach is to use matching algorithms—both deterministic and probabilistic—to examine patient data at a granular level, with the goal of avoiding both false positive and false negative matches. Such algorithms are often customized to meet local demographic trends related to in-migration and other factors. A major hurdle for this approach is the lack of standardized formatting of data elements, the variation in which elements are used, and what data are entered when information is unknown.⁵ This approach may also rely on a manual review component for records that are difficult to resolve; even a small proportion of records needing manual review may become challenging as volume increases. Various organizations have different tolerance levels for error, some advocating little or no tolerance at all. Healthcare organizations have been working successfully with these algorithms for many years, and there are a number of open source and commercial products in this space.⁶

2.2. Unique identifier:

Many people believe that only through the adoption of single, national patient identifier will we be able to consistently and longitudinally match our distributed patient records across provider sites and settings. They do not seem deterred by the current congressional ban on the federal government from promulgating or adopting such a strategy mentioned above. In some cases,

proponents of this strategy are advocating for a voluntary unique identifier assigned by a neutral organization.⁷ But even a unique identifier will not be sufficient by itself for matching; both because an identifier can be mistyped and for security reasons, other demographic data must be included.

2.3. Health Record Bank (HRB):⁸

For some, the optimal way to solve the patient matching issue is by putting the patient in charge. Advocates for this approach argue that medical records should be aggregated by the patient in a central repository or bank, much as financial assets are accumulated there and made available by the patient for authorized transactions or uses. Though this is an intriguing notion, HRBs have failed to generate any traction in the marketplace beyond some very limited experiments.

2.4. Biometrics:

For proponents of this approach, the best way to identify someone is by including a personal attribute in a patient's data that can't be easily faked—a biometric such as retinal scan, fingerprint or facial analysis—to identify a patient consistently across care settings. In addition, certain behavior (frequent use of latex gloves) and medical conditions and treatments (some cancer treatments) can obscure fingerprints. Anything short of that opens up the process to unacceptable error. In many settings today, however, the hardware and software is not in place to support biometric identification, making it hard to leverage in a patient matching strategy.

2.5. Innovative Approaches:

Several new, innovative approaches are beginning to emerge. This includes, for example, “referential matching” where two records are not compared against each other

but rather are each compared to a national database of identity data and if each records matches the *same* exemplar in the database they are considered to match each other.⁹

3. Recent Public and Private Sector Efforts

Despite the lack of consensus, a number of efforts are underway in both the public and private sectors to try to develop a nationwide strategy. They include:

3.1. ONC Nationwide Inter-operability Roadmap (2015):¹⁰

Section L of the *Roadmap* addresses Accurate Individual Data Matching and references the work reported in an earlier ONC *Patient Identification and Matching Final Report*.¹¹ The *Roadmap* provides some brief background as well as suggested data elements for matching (the appendix to this report includes a crosswalk of data elements proposed by the various initiatives discussed here). Milestones for the next ten years focus on lowering the patient duplication rate across the board for all health care organizations. Table 12 at the end of the document identified additional calls to action for the healthcare community, and the supplemental materials published with the *Roadmap* provide some additional background.¹²

3.2. ONC Patient Matching Community of Practice (2015):

This relatively small group of interested parties met regularly from December 2014 until the summer of 2015 under the leadership of an ONC fellow. Its major focus was developing a five-level data quality maturity model to try to characterize an organization's sophistication in using different common data elements to perform patient matching functions, as well as articulating value propositions for improved

matching for different stakeholder types. The project released two documents, *Developing and Testing a Data Management Model and Maturity Scale Tailored to Improving Patient Matching Accuracy*¹³ and *Guidelines for Pilot Testing of Data Management MaturitySM Model for Individual Data Matching*¹⁴ describing its work. The Data Quality Maturity Scale, included as Appendix B, highlights how systems across the healthcare community, at least as reflected in the core data elements, are at the high levels of maturity. In practice, however, the data elements needed for levels 4 and 5 are precisely the ones that are least consistently captured.

3.3. ONC Patient Matching Aggregation and Linking (PMAL) initiative (ongoing):

Influenced by the Patient Matching Community of Practice, ONC released a federal procurement through the Patient Centered Outcome Research Network (PCORnet) to develop and describe best practices in patient matching strategies as well as test different strategies with research data. The procurement was awarded to the Kaiser Foundation Hospitals (Oakland, CA) in September 2015 and work is ongoing.

3.4. Various HIMSS work groups, task forces and activities (ongoing):

Over the past several years, the Healthcare Information and Management Systems Society (HIMSS) has had no fewer than three distinct standing groups dedicated to patient matching and identity issues (Identity Management Task Force, Patient Identity Integrity Workgroup, HIE inPractice Task Force Patient Matching Subgroup), as well as an Innovator-in-Residence engaged full-time in matching algorithm testing activities. In August 2015, HIMSS held its first-ever Patient Matching Testing Event.¹⁵

More significantly, HIMSS government relations staff are working on development of a strategy to begin to lobby Capitol Hill on patient matching issues. More recently, however, these efforts have been consolidated and fewer distinct activities appear to be ongoing.

3.5. The Sequoia Project and Care Connectivity Consortium:

These two organizations—the Sequoia Project, which operates the eHealth Exchange, and the Care Connectivity Consortium (CCC), whose members are major health systems with strong informatics capabilities—have embarked on a joint project which culminated in their *Framework for Cross-Organizational Patient Identity Management*.¹⁶ This document is really three documents in one: first, it provides some detailed empirical discussion of matching strategies, successes and limitations from Intermountain Health, a CCC member. Second, it describes in some detail a five-level organizational maturity model for data quality relevant to cross-organizational patient matching. This model is much more rigorous than the maturity model developed by the ONC Patient Matching Community of Practice, based as it is on Carnegie-Mellon's original Capability Maturity Model work, and goes well beyond the Community of Practice's examination of data elements used for matching. Third, it proposes a set of minimal acceptable principles for organizations aspiring to Level 1 of the maturity model (which is the basic level, Level 0 being reserved for organizations whose capabilities are unknown). This material, while still in draft form as of January 2016, is notable for its rigor and comprehensiveness, and is a resource for the healthcare community to monitor and perhaps participate in creating. The project should be forming a workgroup in 2017 to assess comments received about

the original framework and determine next steps.¹⁷

3.6. CHIME National Patient ID Challenge (ongoing):

Launched in January 2016, this innovative collaboration between the College of Healthcare Information Management Executives (CHIME) and HeroX is challenging anyone in the marketplace to identify the best plan, strategies and methodologies that will easily and quickly identify patients and achieve 100% accuracy."¹⁸ Two Concept Blitz winners were announced in June 2016 and the final Innovation Round winner is expected to be announced in the summer of 2017. This project has generated a lot of "buzz" in the health care community, and will be worth monitoring.

3.7. Pew Charitable Trust Research Funding:

In September 2016 Pew announced a funded research program and began seeking proposals for research in three areas related to patient matching: patient matching safety implications, patient matching cost implications, and EHR usability safety implications.¹⁹ Proposals were due at the end of October 2016 with awards anticipated early in 2017.

There is some overlap in these efforts, yet there is little coordination and leverage of their work products and activities. There certainly does not appear to be any convergence around a particular strategy or approach.

4. Data Sets for Matching and Data Quality

One major focus of a number of patient matching initiatives—including ONC—is the identification of a core set of

data elements found in most patient records that could serve as a core set of data to facilitate matching. Appendix A contains a table with all the demographic data elements identified by a number of the initiatives discussed above, supplemented by the corresponding data elements from a sample public health data standard. Some liberties were taken in grouping data elements with slightly different names but similar intent on the same line of the table. Many believe that if record holders focused on improving the quality and completeness of a clearly-identified set of (typically) structured data elements that the accuracy of matching, particularly across organizations, could be greatly enhanced. Note that very few data elements are in common across all the data sets identified (these are indicated in bold in the tables).

Generally speaking, the patient's name, date of birth, gender and address are in common. In its case study from Intermountain Health, the Sequoia Project does a very nice job of describing how the addition of different combinations of data elements (they call them traits) improves the uniqueness of the record set they examined. All the combinations of traits began with first name, last name and date of birth. Gender added little to the equation. Postal ZIP code, phone, middle initial and last four digits of the Social Security Number (SSN) had a significant impact. This kind of analysis has also been done in NYC, where researchers examined the impact of the presence of different data elements in patient searches through their HL7 query/response Web service. In their study, they found a significant impact when mother's maiden name or the internal CIR ID number were provided in a query.²⁰ The 2012 Immunization Information System (IIS) Patient De-duplication study found similar results when optional data, such as SSN and Medical Record Number, were used.²¹

Unfortunately, SSN is sometimes discouraged as a data element due to security concerns, and is even prohibited from being sent or received in one jurisdiction, according to New York State Public Health Law.²²

While there is much discussion about the quality and completeness of data used for matching, and a desire to reduce the level of duplication in healthcare-related databases, there is little agreement on *how* the level of duplication should be calculated and how accurate its measurement actually is. While the ONC *Interoperability Roadmap* has set goals in this area, it, too, has not defined how individual systems can be consistently assessed to determine their status. HIMSS is attempting to put some time and effort toward developing and testing metrics as well as test data sets, but does not appear to have resourced this activity sufficiently.²³

5. Impact of Participation in a Shared Master Patient Index

Some organizations participate in master patient index (MPI, also sometimes referenced as a master person index) deployments within their region. These MPIs may involve integration within a larger health system, across loosely-coupled components of a health system, or participation in a broader health information exchange (HIE) MPI initiative. Records entering the agency are processed *first* by the MPI, which may be coupled with additional interoperability services (like message routing or cleansing). Regardless of scope, the intention is usually for participating systems to use the MPI's cross-system database and tools to attempt to more accurately match records from across the programs leveraging the MPI. But in other cases, the intention may only be to leverage an intermediary (like an HIE) and what it knows about a patient to ensure a more

accurate match when a record moves to the health system.

An MPI and a health system can be either tightly coupled or loosely coupled. In a tightly coupled scenario, a health system will typically undergo an initial process of “registering” its patient in the shared MPI. Two outcomes usually result. First, each record is associated with an existing MPI record or, if not found, triggers the creation of a new MPI record. In some cases, a record may in fact match *multiple* MPI records and spur record consolidation. Similarly, multiple records may match a single MPI record, indicating that records need to be linked or combined. Second, the MPI stores the unique health system ID associated with each matched record, and in some cases the unique MPI ID flows back down to the health system and is stored there in the corresponding record. As changes are made to either system the two systems need to continue to be synchronized. In some cases, the MPI becomes the dominant system and *all* changes to demographic data occur there, only to be shared with the participating systems later.

In a more loosely coupled scenario, there may be no pre-registration of the health system records in the MPI, but rather the association of health system and MPI records may occur over time. For instance, if an MPI is put into place to facilitate interoperability between the organization and external data partners, a record may only be associated with an MPI record when the first interoperability transaction for that patient is processed (and not before). Still an even more loosely coupled scenario may only support the MPI and health system storing each other’s record IDs. In this scenario—which is becoming more common as HIEs and health system interoperate—the association of a health system record with an HIE record is done carefully the first time an

interoperability transaction is processed for the patient with the goal of then enabling more accurate and speedy processing for subsequent transactions.

Participation in an MPI by a health system can improve its ability to match patient records, as the MPI likely has a broader set of records and more complete records than the health system, depending on how widely it is deployed and with what types of other systems it interoperates. Some organizations have fully integrated systems which combine and/or relate data from disparate programs into a single database.²⁴ On the other hand, agencies may choose more loosely coupled solutions because it allows systems to operate more independently, though this may be at the expense of consistent patient matching.

However, participation in a shared MPI can also be challenging for a health system. When data updates or merges between patient records are performed in the MPI, the updates may not flow down transparently to the health system, either because the automated processes are not that sophisticated or because the health system is reluctant to make changes to its data that come from an external source that is only indirectly associated with the clinical community. Similarly, a merge of patient data in a health system may not flow transparently up to the MPI, resulting in a loss of synchronization. Finally, a health system may choose to consider what record cleansing activities it should (or should not) continue to perform in a shared MPI environment.

In an HIE environment, these challenges can be even more pronounced. Data ownership is distributed. Though it is a matter of policy which can vary, usually data is owned by the organizations that contribute it (or sometimes the patients themselves) rather than the HIE which has stewardship

over data it receives. HIEs usually place high priority on maintaining the integrity of the source data in its original form, though some HIEs consolidate data together for presentation or transport. HIEs rarely have access to the patient or even the source systems. For the purposes of matching, the HIE can only work with the data that is provided unless there is provision for follow-up with the organization that submitted the data. Explicit HIE policy incorporated (even if only by reference) into a data sharing agreement must identify the responsibilities and limitations of the HIE and downstream recipients of data.

Even more so, source data in an HIE-like environment is inconsistent and often conflicting: data comes from multiple, simultaneous sources. It is not always possible to discern which data is correct—even data that appears to be more recent may not be more current. HIEs need to keep in mind that the purpose of the Master Patient Index (MPI) is both to enable accurate matching of patients, as well as to be the authoritative source of demographic (or other) information. Multiple, seemingly conflicting sets of demographic data may help build a more powerful record—determining which is the correct/current data is not relevant to the task. HIEs can develop and institute shared, distributed responsibility for resolving ambiguous patient matches with policies and tools that allow participating organizations to review ambiguous matches based on data they submitted.²⁵

Finally, in an HIE-like environment false positives may have much deeper ramifications: Any false positive (i.e., information for two *different* people which appears to be a match representing the same individual) is bad, but when the match occurs some distance from the patient and the (often multiple, distributed) systems

where the data originated, there is often little opportunity to notice let alone correct the error. This is especially true when the recipient of the information has no prior relationship with the patient for whom data is now being presented. HIE-like systems need to be very careful when matching and merging/linking records together and need to err on the side of caution. HIE-like systems need to establish governance and stewardship principles and procedures that can both identify false positives and can address what happens if a false positive linkage is created.

Like the public and private initiatives around patient matching, the use of MPIs within and between organizations is likely here to stay. The healthcare community will need to better understand how to work effectively with such initiatives in ways that augment and improve rather than detract from operations. To date, there are few enough experiences that it may not be possible to articulate best practices; however, some effort should be made to identify “promising practices” based on the experiences of those who have lived through the transition to using an enterprise MPI.

6. Conclusion

While the healthcare ecosystem has learned a great deal, this is an area where constant quality improvement needs to be applied. More needs to be done to develop test cases that reflect varying data elements, growing ethnic diversities, and other factors, as well as metrics and tools for determining success rates. Similarly, some matching algorithms were developed with a focus on specific subsets of the population (like children); the expansion to lifespan systems has brought significant increases in volume, as well as increases in demographic changes (new last names due to marriages, changes of address, etc.) that challenge accurate

merging. In the public sector, different data sharing methods with vital records (legal name updates) or the Department of Motor Vehicles (name or address changes) could potentially assist with improved matching and merging. Just as importantly, the

healthcare community must monitor the disparate public and private initiatives to solve the patient matching challenge, and adjust as needed to accommodate approaches intended to be universally applied.

Appendix A – Data Element Comparison

Elements in **bold rows** are common to all information sources.

	Interoperability Roadmap	ONC Matching CoP	Sequoia Intermountain Case Study	HL7 v2.5.1 Implementation Guide for Immunization Messages v1.5 (PID/NK1 Segments) ²⁶
First Name	✓	✓	✓	✓
Last Name	✓	✓	✓	✓
Previous Name	✓	✓		
Name Alias		✓		✓
Middle Name/Initial	✓	✓	✓	✓
Name Suffix	✓	✓	✓	
Date/time of Birth	✓	✓	✓	✓
Date/time of Death			✓	✓
Patient Death Indicator				✓
Administrative Gender/Sex	✓	✓	✓	✓
Address, current	✓	✓	✓	✓
Address, current (USPS cleaned)		✓		
Address, historical	✓	✓		
Telephone Number, Primary, current	✓	✓	✓	✓
Telephone Number, Work, current			✓	✓
Telephone Number, historical	✓	✓		
Race		✓	✓	✓
Ethnicity			✓	✓
Mother's Maiden Name		✓		✓
Mother's Current Name				✓
Father's Current Name				✓
Name Prefix		✓		
Marital Status		✓		
Medical Record Number			✓	✓*
Last 4 digits of Patient SSN		✓		
Patient Full SSN			✓	✓*
Mother's Full SSN				

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	Interoperability Roadmap	ONC Matching CoP	Sequoia Intermountain Case Study	HL7 v2.5.1 Implementation Guide for Immunization Messages v1.5 (PID/NK1 Segments) ²⁶
Father's Full SSN				
Driver's License Number		✓		✓*
Passport Number		✓		
Alien Registration Number		✓		✓*
Multiple Birth Indicator		✓		✓
Multiple Birth Order		✓		✓
Birth Location		✓		✓
Health Insurance Policy Identifier		✓		
Health Insurance Plan Name		✓		
Previous Health Insurance Plan Name		✓		
Medicaid ID		✓		✓*
Medicare ID		✓		✓*
Biometric ID		✓	✓	
Birth Facility				✓
Primary Language				✓
Birth Registration Number				✓*
Patient Active/inactive Status Indicator				✓
Patient Marital Status				✓
Patient Religion				✓
Patient Account Number				✓
Veteran's Military Status				✓
Nationality				✓
Tribal Citizenship				✓

* HL7 supports many types of identifiers within the PID segment

Appendix B – Data Quality Maturity Scale

From *Developing and Testing a Data Management Model and Maturity Scale Tailored to Improving Patient Matching Accuracy*, Office of the National Coordinator for Health IT, September 2015

Note that most of these data elements require structured data capture on the part of the data supplier.

Item	Level 1	Level 2	Level 3	Level 4	Level 5
Data	Given Name Last Name Date of Birth Gender Middle Initial Suffix Race Primary Phone # Address Street State Zip	Middle Name Mother's Maiden Name Prefix Marital Status	Alias or Previous Name USPS Address Identifier: Last 4 SSN Driver's license Passport Alien ID #	Multi Birth Birth Order Birth Place E-mail Previous Address Previous Cell Phone(s)	Insurance ID/policy Insurance Plan Name Medicaid ID Medicare ID Biometric ID
Supporting Process	-	-	Daily Reconciliation	Quality Assurance Process	-
Required Reporting	Confirm % capture	-	-	-	-

References:

¹ Lee Stevens, Office of the National Coordinator for Health Information Technology (ONC), Health IT Buzz Blog on the release of the *Patient Identification and Matching Final Report*, February, 2014. [emphasis added] See <http://www.healthit.gov/buzz-blog/electronic-health-and-medical-records/patient-matching-findings-released/>

² Public Law 105–277. 105th Congress. October 21, 1998. See <https://www.gpo.gov/fdsys/pkg/PLAW-105publ277/pdf/PLAW-105publ277.pdf>. It is interesting that, for many years, patient social security numbers have served as nationwide unique patient identifiers, despite their lack of suitability or legality for such a purpose.

³ US House of Representatives, Committee on Appropriations Report, Departments of Labor, Health and Human Services, and Related Agencies Appropriations Bill, 2017, p. 108. See <http://appropriations.house.gov/uploadedfiles/hrpt-114-hr-fy2017-laborhhsed.pdf>

⁴ 21st Century Cures Act, US Congress, passed November 25, 2016. <http://docs.house.gov/billsthisweek/20161128/CPRT-114-HPRT-RU00-SAHR34.pdf>

⁵ See https://www.healthit.gov/sites/default/files/patient_identification_matching_final_report.pdf

⁶ For example, the immunization information system (IIS) community has conducted at least two major efforts to study, understand and improve the patient matching capabilities and success of its registries. First, in 2006, the Connections Community of Practice convened a work group and developed the Unique Records Portfolio, an exhaustive practical guide to record matching and linking issues and strategies (see <http://phii.org/unique-records>). In 2011, CDC convened a Patient De-duplication Expert Panel which met for several years and also developed detailed recommendations and best practice guidance published in 2013 (See <http://www.cdc.gov/vaccines/programs/iis/interop-proj/ehr.html#patient>).

⁷ For example, see <https://www.gpii.info/>

⁸ See <http://healthbanking.org/>

⁹ For example, see <https://www.verato.com/>

¹⁰ See <https://www.healthit.gov/policy-researchers-implementers/interoperability>

¹¹ See https://www.healthit.gov/sites/default/files/patient_identification_matching_final_report.pdf

¹² See pages 26-27 at <https://www.healthit.gov/sites/default/files/hie-interoperability/Interoperability-Road-Map-Supplemental.pdf>

¹³ See <https://www.healthit.gov/sites/default/files/ptmatchwhitepaper.pdf>.

¹⁴ See <https://www.healthit.gov/sites/default/files/pilottestingpm.pdf>.

¹⁵ See <http://www.himss.org/News/NewsDetail.aspx?ItemNumber=43893&RDtoken=58380&userID>

¹⁶ See <http://sequoiaproject.org/framework-for-cross-organizational-patient-identity-matching/>

¹⁷ See Goedert, J, *Sequoia Project forming patient identity matching workgroup*, HealthData Management, December 15 2016. <<https://www.healthdatamanagement.com/news/sequoia-project-forming-patient-identity-matching-workgroup>>

¹⁸ See <https://herox.com/PatientIDChallenge>.

¹⁹ http://www.pewtrusts.org/~media/assets/2016/09/health-information-technology-rfp.pdf?utm_campaign=LM+-+GP+-+HIT+-+RFP+Notice+09+12+16&utm_medium=email&utm_source=Pew

²⁰ http://www.immregistries.org/resources/iis-meetings/4A_Hannah_Mandel.pdf

²¹ See https://www.google.com/url?q=http://www.immregistries.org/resources/iis-meetings/Fred_Grant_AIRA_De-Duplication_Presentation.pdf

²² See https://www.emedny.org/meipass/webinar/NYSIIS_HL7_251_SPECS.pdf

²³ As an example, CDC made available some normative test cases in 2004 and again in 2013, though no systematic testing of the later test cases was ever performed; see <http://www.cdc.gov/vaccines/programs/iis/interop-proj/ehr.html>.

²⁴ For example, see RI's KIDSNET Integrated Child Health System at <http://www.health.ri.gov/programs/kidsnet>.

²⁵ For examples, see Patient Data Matching at <http://www.clinical-innovation.com/topics/ehr-emr/patient-data-matching?page=0,0>

²⁶ See <http://www.cdc.gov/vaccines/programs/iis/technical-guidance/downloads/hl7guide-1-5-2014-11.pdf>