Transitioning from a Legacy EHR to a Commercial, Vendor-supplied, EHR

One Academic Health System's Experience

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Electronic Health Record (EHR); enterprise conversion; legacy systems; CCOW; medical record conversion

Summary
Objective: Describe the planning, decisions, and implementation results experienced during the large-scale transition from one EHR to another throughout a large academic health system, which occurred simultaneously throughout both in-patient and all ambulatory settings
Methods: Review of internal decision-making documents, interviews with key participants, and data from conversion software
Results: Over 7,000 unique users caring for a population of more than 1.2 million patients in both inpatient and outpatient venues and distributed across two states were successfully transitioned to a new EHR simultaneously. Challenges in data conversion were encountered resulting in more work for end-users than desired or anticipated. Users continued to access older information (principally schedules) in the legacy EHR one year later
Conclusion: Data conversion from one EHR to another can be unsuccessful due to differences in how EHR's structure data obtained from underlying feeder applications or databases. Abstraction of only the pertinent clinical content is difficult in the context of transitioning to a new EHR. Clinicians require facile access to legacy content that can be achieved by implanting CCOW compliant solutions.

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1. Background

The challenges of implementing an electronic health record (EHR) in organizations using paper-based medical records are well documented [1–3]. Less is known about the complex challenges of transitioning from one EHR to another. Clinical data migration between different EHR products, resistance toward implementation of new EHR systems, and the security of protected health information (PHI) are some challenges organizations must address when transitioning from a legacy EHR to a new system [4].

Some internally developed non-commercial EHR systems have been shown to increase the quality and safety of patient care, reduce medication errors, and decrease redundant or inappropriate care. However, most internally developed systems have achieved these improvements through resource intensive development and modification over many years. A recent survey documented that many of the capabilities that these systems cite as contributing to improved care are now available in commercial EHR's [5] . Organizations may find that the resources required for long-term investment in an internal health information technology project are prohibitive. Despite uniquely customized features, internally developed EHR systems may also lack the required software functionality to participate in federal HITECH stimulus funding [6, 7], whereas commercially available EHR systems are capable of providing the technical features compliant with "meaningful use" criteria [8]. After a lengthy review process Dartmouth-Hitchcock determined that a commercial system could replace it's internally developed EHR, named CIS.

One long-term goal of implementing EHR software is to share clinical content between systems. However, data exchange between EHR systems and access to previously recorded historical clinical data remains a major challenge [9]. This report documents the background, methods, and initial experience that a large academic health system (Dartmouth-Hitchcock) encountered as it transitioned from its legacy, self-developed EHR to a well-regarded and commercially successful EHR.

2. Objectives

Dartmouth-Hitchcock has a history of leadership in the development of clinical applications, having relied upon electronic clinical systems for more than 20 years. In 1996, Dartmouth-Hitchcock implemented the internally developed application, CIS, to display and enter documentation of clinical and demographic information across the spectrum of care including both inpatient and outpatient care. Embedded software from a number of commercial vendors (GE/IDX, First Data-Bank, Cerner, and PeopleSoft) was used to support both CIS and the underlying business operations. An internal study of the Dartmouth-Hitchcock information technology infrastructure in 2007 determined that a significant investment in information systems was necessary to support the organization. The pace of CIS development was insufficient to keep pace with the organization's increase in size, complexity, and sophistication. CIS lacked a number of desirable features such as computerized provider order entry (CPOE), analytic report writing capabilities, integrated clinical information across the care continuum, and inpatient nursing documentation. As a result, Dartmouth-Hitchcock contracted with a vendor to license and implement a commercially successful EHR to replace CIS in 2008.

As of the conversion date (which was timed to occur in the weeks prior to Go-Live to avoid missing more recent data), CIS was in use by over 7,000 unique users to access data on more than 33,000 patients per day across the system. All users (both clinical and administrative) were required to use the new system immediately on Go-Live day (the only exceptions were residents and medical students away on rotation who were required to use the new system on their return). CIS was built with a GUI "fat" client, middle-tier, and database layer. The database was programmed in Intersystems MUMPS (subsequently Cache) with a limited amount of additional Oracle data sets. CIS was developed incrementally from the early 1990's through 2010 and was characterized by emphasizing the clinician's perspectives relative to workflow and features. CIS used a patient-centric information display as shown in ▶Figure 1. The system featured free-text progress notes with inserts from field-defined content, field defined allergies and ambulatory medications, problem lists, operative procedure notes, immunization histories, family and social histories, reports of imaging and the actual images, laboratory results viewing, advanced directives, diagnostic reports, ambulatory flow sheets, and ad-

ministrative documents. The majority of prescriptions were managed by e-faxing with scheduled prescriptions printed on tamper-proof prescription paper in accordance with federal regulations. CIS medications and allergies were built on a vendor-supplied drug database. Free-text was permitted for the intended purpose of entering research medications prior to their commercial availability. In practice, the feature allowed users to enter misspelled medications as free-text entries.

Even though CIS was used as the EHR for the Dartmouth-Hitchcock system, including two large community-based practices in Manchester and Nashua, it was managed with two distinct instantiations to accommodate differences in the use of the underlying IDX/GE business systems and operational practices. Clinically, the two instantiations were linked with a toggle enabling users to efficiently change regions within CIS. One goal of implementing the new enterprise EHR was to merge and consolidate all clinical data in a single instantiation.

Dartmouth-Hitchcock leaders worked with the new vendor to choose an implementation strategy. Two options emerged: an incremental replacement of CIS with the new system, or a "big bang" replacement of CIS all at once. It was felt that the most urgent need for the new EHR was nursing documentation on the Inpatient units and CPOE across the system. The challenge of operating two EHRs concurrently during a staged implementation was thought to create more risks to patient safety, clinician efficiency, and ambiguity relative to the legal medical record. Accordingly, Dartmouth-Hitchcock leaders decided to replace CIS using an "all at once" implementation strategy.

As Dartmouth-Hitchcock began to develop and customize the vendor software in preparation for the transition to the new system, the organization strategized how to manage patient data stored in the legacy system. Based on data conversions at other client sites, the vendor advised against converting data from the legacy system to the new system principally due to technical difficulties in institutions that tried data conversion. Instead, the vendor recommended a process of manual data abstraction. The project team perceived that abstraction and manual data entry would require a disproportionate amount of effort. Given the similarities between the legacy system and the new vendor EHR, the project team was confident that additional efforts to develop a clinical data conversion strategy were warranted. Both the legacy system and the vendor system were built on Cache databases and utilized the same drug database.

3. Methods

Dartmouth-Hitchcock project leaders were eager to provide access to meaningful historical data within the new system while limiting provider reliance on the legacy system to access historical data. The intent was to convert the maximum amount of legacy clinical information from CIS to the new system prior to the scheduled Go-Live in early 2011, and to eliminate ongoing data entry into CIS except for completing unfinished work. Dartmouth-Hitchcock followed the following guiding principles throughout the data conversion project:

- Efficiency: the conversion would support clinicians by readily providing legacy clinical information from CIS in the new system. Anticipated negative impacts on clinician workflows would be minimized.
- Consistency: converted clinical information would have a functional equivalent in the new system.
- Accuracy: accuracy was prioritized over completeness since complete clinical data was available in the legacy system.
- Safety: converted clinical information would not cause potential harm to patient care.

Patient data, advanced directives, allergies, ambulatory medications, problem lists, operative procedures, and immunization histories were included in the scope of the conversion project.

Clinical information explicitly excluded from the scope of the initial implementation included personal preference lists, the retail pharmacy dictionary, preventive care, order requisitions, patient surveys, administrative documents, external documents, family history, social history, laboratory results, scanned documents, diagnostic reports, clinical flow-sheets, and patient messages. In circumstances where a one-to-one conversion of legacy clinical information was impossible, the converted data was formatted to enable a member of the clinical team to identify and correct the partially converted clinical information in the new system.

3.1. Scanned Documents

The legacy system contained 5,160,057 scanned documents. By intent, only a small fraction of them were converted from the legacy Oracle database to the new system using an HL7 interface. This included 74,002 Advance Directive, Living Will, Advanced Beneficiary Notice, Out-Of-Hospital DNR, and Durable Power of Attorney (POA) documents.

3.2. Immunizations

The legacy system contained 2,063,546 immunization entries. The majority of immunization entries were successfully converted from the legacy system to the new system using an HL7 interface. Legacy immunization entries included source and series information, but the new system did not use similar logic or functionality. Consequently, the vaccine source and manufacturer's series were not converted to the new system but were maintained in the legacy system. Immunizations, routes, and manufacturers found in the legacy system but absent in the new system were built in the new system and mapped for conversion.

3.3. Allergies

The legacy system contained 771, 975 active allergy entries. The majority of allergy entries were successfully converted from the legacy system to the new system using an HL7 interface. Both the allergen and the reaction were converted. The legacy system included both coded allergy entries and free text allergy entries. Legacy free text allergy entries were converted and displayed in the new system as "CIS Free Text Allergy" with the accompanying reaction and severity contained in the comments section. In the new system, end-users who encountered a converted free text allergy entry were presented with a Best-Practice Alert (BPA) prompting them to code the allergy in the new system. More than 500 legacy free text allergy entries were manually mapped and converted to the new system by the project team. For example, separate entries for almond, walnut, and pecan allergies in the legacy system were mapped to a single codified "Tree Nut" allergy in the new system.

3.4 Ambulatory Medications

The legacy system contained more than 2,200,000 active medication entries. Despite attempts to convert the legacy entries to the new system, significant discrepancies between the legacy data and the converted data required end-users to reconcile and update all medication lists in the new system. Good practice and regulatory standards call for medication reconciliation to occur at each clinical encounter. The initial medication reconciliation post transition was especially challenging due to the reasons cited below.

Legacy medication entries included both codified and free text entries. 94% of legacy medication name entries were codified using the same vendor-supplied drug database as the new system, and successfully converted to the new system. Free text medication entries in the legacy system were converted to the new system with the prefix, "CIS Free Text Med".

Medication sigs (dose, frequency, route, instructions) were entered as free text in the legacy system. Fifty-five percent of legacy sig entries successfully mapped and converted to the new system. After a successful conversion, the sig fields in the new system are automatically populated with legacy information upon medication reorder.

Forty-five percent of legacy sig entries did not map or convert to the new system. Free text sigs from the legacy system without a match in the new system still appear in the new system's "Previous Sig" field; however the sig fields remain blank and not automatically populate with legacy information upon medication reorder. End-users were advised to delete these medications and reorder.

It was expected that clinicians would be required to concurrently access legacy medication lists through the "CIS Viewer" to verify and correct converted data in the new system. This was challenging as the medications on each list were presented in a different order and the two instantiations of CIS contained many duplicates (▶Figure 2).

3.5. Problem List

CIS allowed clinicians to document problems as free text, ICD-9 codes, SNOMED CT classifications, or a combination of the above. The new system utilized embedded software from IMO (Intelligent Medical Objects) for the problem list. Each of the approximately 234,000 active problems from the legacy system required manipulation by an end-user to select the appropriate IMO code within the new system.

3.6. CCOW-mediated Access to Unconverted Data

Two methods were developed for accessing CIS legacy clinical information from:

1. Conversion of clinical information from CIS into the new system and displayed as if entered into the new system natively which was described previously
2. The ability to run the new system and CIS in tandem showing clinical information in native CIS screens in context with the new system's screens.

The latter utilized the HL7 standard CCOW, which stands for clinical context object workgroup. The project team discovered that CCOW communication between CIS and the new system was feasible. This CCOW component of the new EHR and the CIS Viewer keeps patient and user context synchronized between the two systems. A "CIS Viewer" was created to display legacy data aggregated in chart sections well-known to CIS users. The CIS Viewer appears only if legacy information exists. This visual cue to the presence of historical data appears as a floating toolbar within the new system and points to a read-only version of CIS. Navigating from one patient to another is limited to the new EHR.

Additionally, the CIS Viewer provided access to the two distinct instantiations of CIS (that of the academic medical center and that of the community practices). If a patient has clinical information in both cases, a drop-down menu is included in the CIS Viewer to toggle between the two distinct CIS records.

The CIS Viewer attempts to bridge the new system and CIS seamlessly by providing immediate visual cues when data is present in CIS chart sections. Additionally, when a user clicks on a button in the floating toolbar, content from the relevant CIS section pop-ups and permits the user to view CIS and clinical information in the new system side-by-side. The toolbar buttons are intended to provide access to the most frequently accessed clinical information that was not converted into the new system.

The development effort to produce this software component required approximately 4 programmers working for five months. In the time period since implementation of the new EHR, the development team has tracked the ongoing use of the Patient Agent CCOW-mediated legacy software as seen in ▶Figure 3.

4. Results

Dartmouth-Hitchcock implemented the new EHR throughout the system in both in-patient and ambulatory settings at a single moment on April 2, 2011. The gradual phasing-out, or "sun-setting", of CIS began immediately afterwards.

- Phase One – Immediately after Go-Live, CIS transitioned to "CIS Lite". CIS Lite is distinguished from the CCOW viewer version of CIS in that it allowed users to continue entry of data as noted subsequently. Providers had the ability to look up patients in CIS, and were allowed limited "write" access to CIS Lite for the purpose of completing unfinished or pending documentation but not initiate new documentation. This was accomplished by changes to the CIS manager software that controls provisioning within CIS. The security modification restricted end user ability to initiate new notes but permitted users to amend, addend, take action, complete tasks and attest. Providers were still able to share and route their notes from CIS with other providers. All of the notes remained in CIS Lite as they had in full CIS after sharing or routing. Advanced Directives, Medications, Allergies, Problem Lists, Operative Procedures, Immunizations, and Flowsheets

could not be altered. Dictation was also removed from CIS Lite, and there was no longer any display of patient demographics other than the patient banner. The Doctor/Staff directory, On-Call schedules, iLinks, Dashboard, Notes, and Orders Sets were all replaced by the new system and not available in CIS Lite.

- Phase Two – A few weeks after Go-Live, CIS Lite was transitioned to be strictly view-only with no further data entry or editing.
- Phase Three – Despite an original estimated timeline of six months post Go-Live, Dartmouth-Hitchcock has not moved to the third and final phase of the CIS transition during which CIS Lite will only be available to Health Information Services (Medical Records) staff. Use of the legacy EHR persists due to subtle advantages in the presentation of the underlying scheduling system not for clinical content. It is expected that with the completion of conversion to the business systems of the new EHR that this access can be discontinued. During phase three the CIS Viewer toolbar will be available until such time that the legacy system is no longer maintained. Recommendations by legal counsel and suggestions by AHIMA (the professional organization of health information management) suggest that will be a minimum of ten years.

The clinical transformation project team was particularly attentive to monitoring the transition for potential patient safety issues attributable to the deployment of the EHR. The Chief Officer responsible for patient safety and quality was present in our command center and an active participant in the Go-Live process. His staff conducted a concurrent review of all the feedback provided about the new system as well as the existing incident reporting structures. We did not identify any substantial negative outcomes to patients as a result of the transition.

5. Conclusions

In this report we document the rationale, planning, and implementation of the change from a self-developed, legacy EHR to a commercially developed EHR. Our experience documents a myriad of challenges, many of which were anticipated and addressed prior to the cutover. Fundamental differences exist between an original deployment of an EHR versus a transition from one EHR to another. Paramount is the desire by clinicians to have the pertinent and relevant data from the legacy EHR transferred to the new EHR. Our experience suggests that an abundance of caution is required to avoid the consequences of minor data differences that can lead to failure of conversion. Partially converted or inconsistently converted clinical information can result in persistent inefficiencies in the new EHR and even the potential for clinical errors, although despite careful review we did not identify any.

Assumptions that similarities between the underlying database structure and embedded content would create an effortless method for data conversion were not borne out in the meta-data and configuration. Clear and expeditious access to the legacy clinical data is required. Utilizing CCOW as an essential part of the conversion, provided the framework for this to occur.

One unexpected finding from our review is the persistent dependence on the legacy EHR (both the CIS viewer for individual patient data and the CIS Lite application for administration data as documented by usage data. This use of CIS Lite has plateaued but is still occurring a year post conversion. (▶Figure 3) Institutions contemplating similar transitions would be well served not to underestimate the complexity of these issues.

Conflict of Interest

The authors declare that they have no conflicts of interest in the research.

Human Subjects Protections

Human and/or animal subjects were not included in the project. The institutional review board approved the project without requiring formal committee review.

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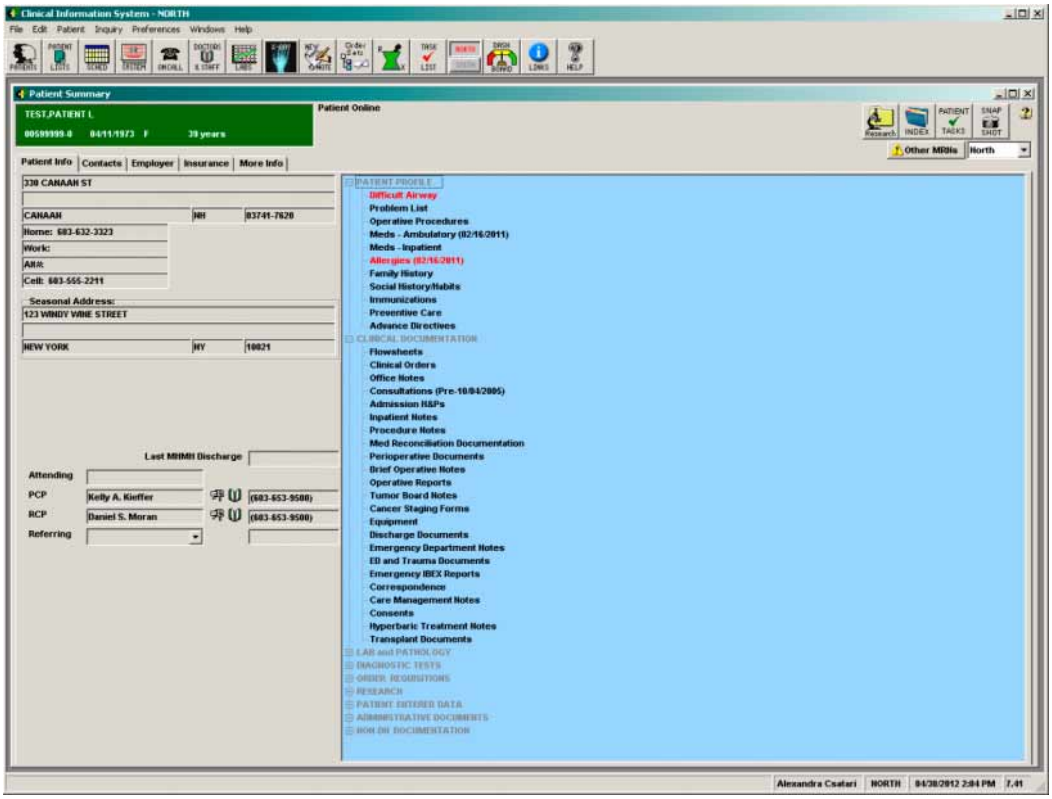
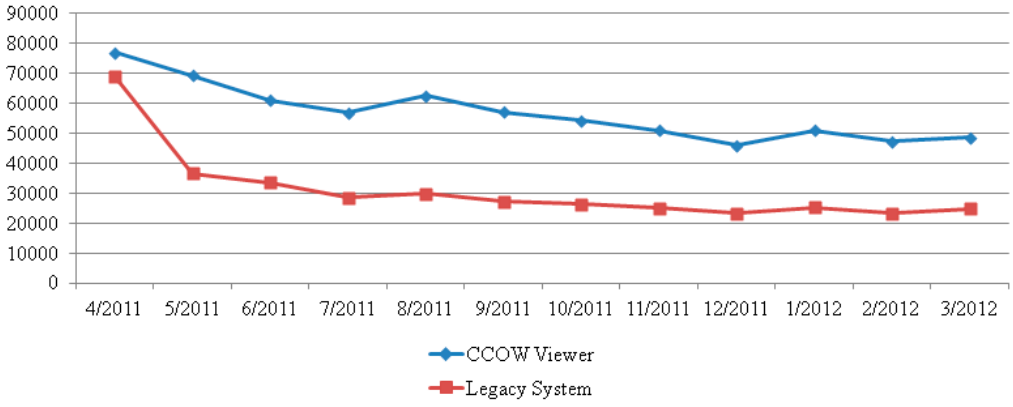


Fig. 1 Legacy System Patient-Centric Information Display

Fig. 2 CIS Legacy Medication Lists and New System Medication List



Month	CCOW Viewer	Legacy System
4/2011	76939	68904
5/2011	69193	36639
6/2011	61086	33569
7/2011	56803	28432
8/2011	62556	29846
9/2011	57048	27224
10/2011	54183	26379
11/2011	50948	24971
12/2011	45866	23233
1/2012	50976	25272
2/2012	47202	23262
3/2012	48541	24714

Fig. 3 Ongoing Use of the CCOW-mediated Legacy Software

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