TRANSITIONS BETWEEN ELECTRONIC HEALTH RECORD SYSTEMS: EXPERIENCES FROM DIVERSE HEALTH SYSTEMS

By

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A CAPSTONE

Presented to the Department of Medical Informatics & Clinical Epidemiology
and the Oregon Health & Science University
School of Medicine
in partial fulfillment of
the requirements for the degree of

Master of Biomedical Informatics

September 2017

School of Medicine

Oregon Health & Science University

CERTIFICATE OF APPROVAL

This is to certify that the Master's Capstone Project of

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"Transitions between Electronic Health Record Systems: Experiences from Informatics Leaders in Diverse Health Systems"

Has been approved

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Acknowledgements

I would like to thank my capstone advisor, Dr. Paul Gorman, Professor in the Department of Medical Informatics and Clinical Epidemiology (DMICE) at OHSU School of Medicine, for his guidance throughout this project. His insights on EHR implementation and qualitative research helped me develop the necessary inspiration and ideas for this project. He was a true mentor in that rather than giving me the right answers, he pushed me to develop my own ideas. I would also like to thank Dr. Rick McGee, Professor of Medical Education at Northwestern University Feinberg School of Medicine, for sharing his expertise in qualitative research and encouraging me as a qualitative researcher. I am grateful to Mark Berendsen, MLIS, Deputy Director, Galter Health Sciences Library, Northwestern University Feinberg School of Medicine, for assisting me in my literature search. I would like to thank Dr. Justin Starren, Professor of Preventive Medicine at Northwestern University Feinberg School of Medicine, for his support throughout this project. Our early discussions on types of EHR transitions and ways to study them sparked ideas that were the foundation of this study. I am indebted to the study participants, who took much time out of busy schedules to share their experiences. This study would not have been possible without their help.

Thanks to the DMICE faculty and staff, especially Dr. Bill Hersh, Department Chair, for his vision and support, Diane Doctor, Academic Advisor and Educational Programs Coordinator, for her guidance on course and degree requirements, and Andrea Ilg, Administrative Programs Administrator, for her encouragement throughout my graduate studies at OHSU. Thanks to my fellow students who walked this journey with me. Finally, I wish to thank my family for their patience and understanding, not only during this capstone project, but throughout my life.

Abstract

Introduction: Healthcare organizations are increasingly changing electronic health record (EHR) systems to improve quality and efficiency. Given their relative newness, there is scant literature on EHR transitions. Each institution must develop its own processes, without the benefit of learning health systems containing collective experiences, lessons learned, and guidelines. There is a need for research to identify issues and develop recommendations for EHR migrations. This study aims to characterize experiences and issues arising in EHR transitions.

Methods: Seven health informatics experts from diverse health systems with experience with EHR transitions participated in semi-structured interviews in which they discussed EHR transitions. Interviews were recorded, transcribed and analyzed for key concepts and themes.

Results: In this diverse sample, there were many common themes. Drivers of EHR transitions include organizational change, standardization, efficiency, functionality, and regulatory changes. EHR-to-EHR and paper-to-EHR transitions share issues such as leadership, governance, planning, workflow, implementation approaches, change management, training, support, and iterative improvements. Issues that are unique to EHR-to-EHR transitions include the lack of standard guidelines, need for decisions about keeping or consolidating multiple systems, and transitioning between different types of systems. Migrating legacy data is a major challenge, along with concerns about workflow, interoperability, and access to legacy systems and data.

Conclusion: Organizational, quality, and regulatory issues drive EHR transitions. As with paper-to-EHR conversions, leadership and change management are essential. Although

transitions between EHRs are more challenging, organizations that follow guidelines for paper-to-EHR conversions and address the unique issues in EHR-to-EHR transitions report positive outcomes. These findings serve as a basis for developing guidelines for EHR transitions.

Introduction

As hospitals and practices increasingly join and consolidate operations, they frequently elect to migrate or merge electronic health record (EHR) systems and patient data for ease of use, access, and integration of patient care processes (1-3). They may migrate to improve quality, fulfill regulatory requirements, and qualify for incentive payments. As EHR systems are complex, involving modules from multiple vendors and thousands of captured data elements, transitions to new systems may be costly (4-10). Each implementation is unique and may involve customizations, use of disparate systems, quality measures, and regulatory pressures (7, 9, 11-15). EHR mergers and migrations must minimize downtime and disruptions in patient care while maintaining data integrity and patient safety (2, 5, 7, 8, 12-14, 16-20). As healthcare organizations have only recently begun widespread adoption of EHR systems and these migrations have not been thoroughly studied or described, there is a lack of studies and standards on EHR-to-EHR transitions and their associated issues (7, 10, 12-14, 16, 21, 22). Thus, organizations that are merging systems have limited access to collective experiences or authoritative guidelines. Each transition must be customized and may result in greater expense, system disruption, and adverse impact on patient care, clinician workload, and system performance (15).

There is much more literature on paper-to-EHR transitions. Key issues include governance, planning, change management, implementation approach, workflow, training, and support. There is a need for more research on experiences of health organizations to identify issues and recommendations for EHR transitions.

Background

As federal incentive programs have driven EHR adoption, the majority of health care organizations have adopted EHRs. As of 2015, 96% of non-federal, acute-care hospitals and 87% of office-based physicians had adopted electronic health records (23, 24). Most EHR implementations are now transitions from one EHR to another rather than from paper to an EHR (7, 12). There are many factors driving EHR transitions. Hospitals and medical practices are involved in mergers and acquisitions to improve economies of scale (1-3). Up to half of all healthcare organizations report dissatisfaction with their current EHR systems and are considering replacing them (1, 2, 25). Organizations are also transitioning to new EHR systems to add new functionality, increase interoperability, meet regulatory requirements, and improve vendor support (1, 3, 7, 8, 25). They must weigh the benefits and risks of different approaches to transitioning their systems (2). Maintaining legacy systems causes the least short-term disruption to operations and productivity (2, 8, 9, 12, 14, 21, 26, 27). If the different systems can be integrated seamlessly, then a reasonable approach is to run parallel systems. Transitioning to an enterprise-wide EHR system may cause greater short-term difficulty but result in more seamless exchange of information and reduce the need for interfaces between systems (11). A major challenge in EHR transitions is data migration (2, 7, 12, 16, 17).

Using legacy systems may minimize disruption to users and IT staff and avoid costly data migrations, but there are significant costs of legacy systems. They may lack advanced functionalities and technologies that support patient safety and clinical workflow, such as quality metrics, interoperability, and decision support. Older systems may not meet

regulatory requirements, including quality-based programs such as the Medicare Access and CHIP Reauthorization Act of 2015 (MACRA), Merit-based Incentive Payment System (MIPS), and Advanced Alternative Payment Models (APMs), resulting in decreased revenue, loss of incentives, and financial penalties (9, 12, 28, 29). Each system requires separate vendor licensing and support fees. Old systems may have poor interoperability (9, 30). Maintaining old systems may be costly and require internal clinical and technical support teams to maintain different applications, workflows, and interfaces between systems (9, 11, 30). If information is documented or easily accessible in some systems but not others, users may miss important patient information (12). If similar workflows and information exist in multiple EHRs, information may be inconsistent across different systems.

EHR transitions and data migrations in particular are costly and challenging (4-10). Time and cost overruns are common, there are major concerns, and there have been well-publicized major failures involving EHR transitions (4, 5). Patient safety is the primary concern (2, 5, 7, 8, 12-14, 16-20). Clinical users may be accustomed to legacy systems and resist changing to a new system (10, 11, 13, 14, 27, 28). Users require training in the new system, and adoption of unfamiliar workflows and resulting stress may decrease efficiency and compromise patient safety (11, 12, 14, 21, 27, 28, 30, 31). A poor data migration results in loss of integrity of patient data and can adversely affect quality and patient safety. A new EHR system requires more internal and external support staff during planning and implementation (8, 11, 12, 14, 21, 27, 28). Benefits of migration include

upgrading to systems with advanced features, improved quality, regulatory compliance, interoperability, and consistency across the organization (7, 9, 12, 14).

Once the decision is made to proceed with transition to a different EHR system, a major goal of planning is to identify key issues and develop a plan to maximize the chances of successful implementation (32). The priority of issues and concerns will vary with each institution. Given the lack of guidelines and learning health systems with collective experiences, it can be difficult to navigate an EHR transition. Organizations must make important decisions based on limited information, and each EHR transition is a custom project (2).

There are many possible approaches to EHR integration. Separate systems can be maintained in parallel long-term, with old systems accessed separately or through links in current systems (12, 16, 17, 30). Another approach is to run systems concurrently as a bridge to total migration. An important question with this approach is the optimal time period for running multiple systems concurrently. Organizations may use a new EHR system for clinical care and operations but maintain all or part of legacy systems, read-only, for lookup purposes only (12, 28). Organizations may also retire legacy systems altogether and provide access to historical data through vendor-neutral databases, such as enterprise data warehouses (EDW). The other extreme is the “cold turkey” approach, in which the new EHR system goes live while legacy systems are completely retired. In the “big-bang” approach, all systems in an organization begin using the new system simultaneously (8, 12, 31). The opposite extreme is a phased approach, in which different

units or functions migrate to a new system sequentially. While phased implementations were common for paper-to-EHR transitions, the big-bang approach will likely become the norm for EHR-to-EHR transitions (12). It is helpful during the planning phase to review guidelines, weigh the relative benefits and risks of these different approaches, and mitigate known risks.

Experts have identified factors that affect the success of EHR transitions. The literature on conversions from paper to EHR and limited experience with EHR-to-EHR transitions can serve as a starting point for optimizing EHR transitions (11, 33). Clinicians using paper documentation have cited hardware concerns, physician champions, workflow education, and overall comfort with information technology as major concerns for initial EHR adoption. In contrast, prior EHR users have cited training, technical support, patient privacy, and change management as important factors (28). Causes of delays include concerns about time and cost overruns, cutover process issues, systems that do not meet requirements, and harm to the organization's reputation. Lack of business engagement has been cited as the major cause of cost overruns (8). People and organizational issues, such as leadership, training, support, user input, buy-in, and managing expectations, are critical for success in implementation of any health information system (34), including EHR transitions (8, 9, 13, 14, 21, 22, 27, 32, 35). Key recommendations include separating the data migration into a separate project with its own budget, active business engagement throughout the entire project, using data integration tools, and having dedicated internal experts (8, 12, 36). It is important to assess all data sources to increase the accuracy of scoping and to address issues with data governance, data quality, and

testing early in the project (8). Data validation and quality assurance during migration can be accomplished efficiently using automated and statistical methods (16). To provide further empirical basis for recommendations on EHR-to-EHR transitions, this study sought to learn from the experiences of six healthcare organizations that transitioned to new EHR systems.

Methods

Literature Review

A literature review, summarized above, was performed to explore previous research on EHR transitions. The review consisted of electronic searches of MEDLINE. Key MEDINE search terms are shown in Figure 1. Articles were included in the review if they describe EHR transitions. As EHR transitions are an instance of broader information systems transitions and data migrations, the search was broadened to include Engineering Village. These searches did not specify health or medical applications. A reference librarian suggested additional resources, and search terms, and constraints to improve recall and precision. Additional resources were identified through conversations with colleagues in health informatics, such as members of the American Medical Informatics

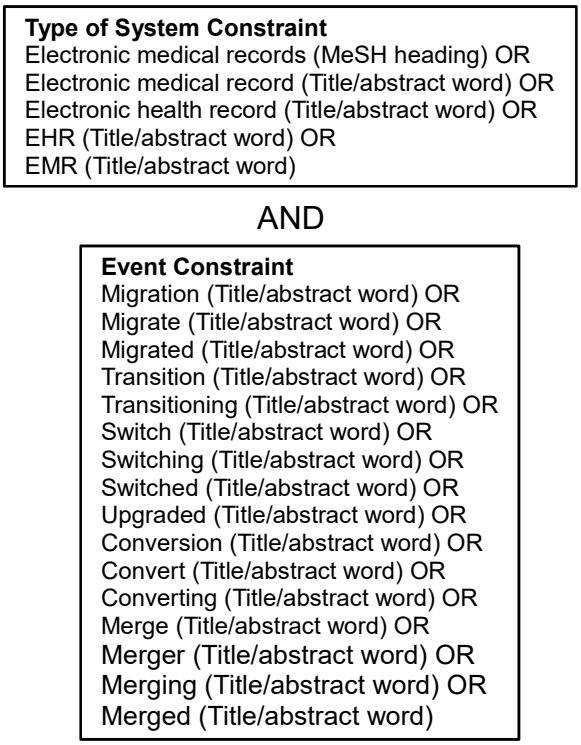

Figure 1. MEDLINE Search Terms

Association (AMIA). References within papers in the initial search were also examined for relevance. Searches using the same terms were also performed through general search engines such as Google.

Study Design

To explore the subject of EHR transitions, a qualitative study was performed using semi-structured interviews. The qualitative approach can capture the full story, encompassing all aspects during all phases of a situation or event. A quantitative survey can be used to study the same events, but the information collected is limited to respondent answers to pre-determined questions with a defined set or range of responses. The qualitative approach can capture richer data, including subtle nuances and unanticipated concepts. Themes formulated from exploratory qualitative studies can form the basis of research questions that are more amenable to quantitative research.

Within qualitative methods, there are many approaches for exploring experiences. Ethnographic research focuses on the culture of a particular group and would be useful for studying experiences of a group of individuals using a particular information system or workflow. However, it would not be as useful for studying the overall experiences of a large, complex organization with interactions between hundreds or thousands of individuals in multiple teams. Focus groups are useful for studying opinions or experiences of multiple individuals, but require participants to be in a single geographic location. Each respondent cannot tell a full story from start to finish, and group dynamics affect responses. A case study or series of case studies can provide stories about

experiences with EHR transitions, and several case studies describing EHR transitions in organizations of varying sizes and practice settings have been published. By contrast, examining multiple sites can identify patterns and compare experiences in different organizations. Semi-structured interviews beginning with open-ended questions allow respondents to thoroughly explore and describe their experiences. Information gathered from interviews can generate research questions more amenable to other methods, such as qualitative or quantitative surveys.

Background and Subjects

The aim of the study was to obtain detailed experiences about EHR-to-EHR transitions from informatics leaders and experts from diverse organizations and settings throughout the United States. Inclusion criteria for interviewees included: expertise in health informatics, experience with EHR-to-EHR transitions and data migrations, and fluency in spoken and written English. The intent was to represent different types of organizations, practice settings, patient populations, and specific EHR systems. A convenience sample of interviewees was drawn initially from informatics colleagues, and additional subjects were identified through the snowball technique and recruited by email. Each subject provided a curriculum vitae or résumé. The institutional review boards of two academic institutions approved this study for human subject research, without the need for formal committee review.[1]

[1] Consent for research on human subjects was granted under Northwestern University IRB ID STU00202767 and Oregon Health & Science University (OHSU) IRB ID STUDY00015969.

Topic	Introductory Questions
Personal Background	Would you please describe your educational training, informatics background, and current role in the organization?
Experience with EHR Transitions	Would you please tell me about your experiences and roles in prior EHR implementations and transitions, including paper-to-EHR and EHR-to-EHR?
Facilitators and Barriers	Please describe major issues, drivers and barriers to EHR transitions.
Implementation Recommendations	For EHR transitions, what are your recommendations for implementation?
Data Migration Recommendations	What are your experiences and recommendations for the EHR data?
Different Situations	Please describe any differences in EHR transitions in different settings and situations.
Paper-to-EHR vs. EHR-to-EHR	Please describe differences between paper-to-EHR implementations and EHR-to-EHR transitions.
Lessons Learned	Please describe potential issues and lessons learned.
Future	Describe the ideal scenario for an EHR-to-EHR transition.

Table 1. General guide for semi-structured interviews.

Data Collection and Analysis

The existing literature pointed to key issues that formed the basis of areas of focus for an initial set of interview questions. Based on a pilot interview with an informatics colleague, the interview questions were revised. The result was a semi-structured interview instrument having initial prompts about professional background, experience with EHR transitions, issues, lessons learned, and recommendations. Table 1 presents the general topics and broad questions for starting the semi-structured interviews. More detailed prompts are shown in Appendix B. Interviewees' responses served as the basis for more probing questions during interviews.

The author, a family physician and clinical informatician, explained the purpose and details of the study, obtained verbal consent, and conducted semi-structured telephone interviews lasting approximately one hour. Seven informatics leaders were interviewed

(two from one site were interviewed together) during a six-week period in April and May 2017. Interviews lasted 57 minutes on average, ranging between 50 to 80 minutes. Using a semi-structured review instrument allowed subjects to provide rich stories using their own words while ensuring consistent coverage of essential subjects. Interviews began with open-ended questions about participants' professional backgrounds, current roles and organizations, and experiences with EHR transitions. If necessary, prompting questions elicited more detail and ensured coverage of key topics. The interviews ultimately progressed to specific experiences, issues and recommendations surrounding EHR transitions. Interviews ended either when interviewees reported having no additional comments or due to interviewees' time constraints. As all participants consented to recording, all interviews were audio-recorded digitally. Participants received a $10 gift card for their time.

The author transcribed the interview recordings and presented transcripts to respondents to ensure accuracy, serving as a final opportunity for subjects to provide additions, clarifications, and corrections. Transcripts were revised as necessary based on respondent feedback. The transcripts were read and coded iteratively by the author using NVivo qualitative software (Doncaster, Australia) (38). Statements from subjects in transcripts served as the unit of analysis for coding. Statements were analyzed for key themes, and themes were organized into meaningful groupings. After the first interview was coded, initial patterns and themes emerged and formed the basis of the codebook. The remaining transcripts were coded to corroborate these patterns and themes, identify new concepts, and ensure data saturation, when no new themes or concepts emerged. Reports grouped

codes by themes and provided frequencies of responses, allowing concepts to be weighted.

Results

Participants

A total of seven health informatics experts with experience with EHR transitions who met inclusion criteria were identified through snowball sampling and recruited by email. All candidates demonstrated expertise in informatics and experience with EHR transitions and thus met inclusion criteria for this exploratory study. Six interviews were conducted with the seven participants.

Interviewees represented a diverse range of backgrounds, years of experience, types of institutions, patient populations, and practice settings (Table 2). Five participants were men and two were women. All had a health care background, including six physicians of varying specialties and one medical-surgical nurse. Interviewees' informatics experience ranged between 6 and 18 years. All participants held executive leadership roles in their organizations when they were interviewed and had prior experience leading paper-to-EHR and EHR-to-EHR transitions. Most had led multiple EHR-to-EHR transitions. Their organizations included two academic health systems, a multi-state health system, a public health system, a community hospital, a critical access hospital, and a volunteer health clinic. Although most organizations were based in major metropolitan areas, the health systems included hospitals and practices located in small and medium-sized cities, and there was an academic-affiliated critical access hospital. In some cases, leaders of a large health system as well as leaders of individual facilities within the same systems served as participants. These interviews with leaders from different levels within a single organization provided overall system and individual facility perspectives from the same

Professional Background and Role	**Gender**	5 men (71.4%), 2 women (28.6%)
	Clinical Discipline and Specialty	6 physicians representing: • Internal medicine • Pediatrics • Emergency medicine • Obstetrics and gynecology • Clinical informatics 1 nurse (Medical-Surgical)
	Time Since Graduation	18–43 years (mean 26.1 years, SD 10.4)
	Informatics Experience	5–18 years (mean 9.3 years, SD 4.8)
	Title	• Chief Medical Officer • Chief Medical Information Officer • Chief Health Information Executive • Director of Nursing • Medical Director • Director of Physician Operations
	Years at Organization	1–16 years (mean 8.1 years, SD 6.1)
	Prior Experience	• Most with paper-to-EHR, EHR-to-EHR • All with multiple EHR-to-EHR transitions
Current Organization	**Type and Size of Organization**	• Integrated health systems (academic, public, and community) • Medical group in multi-state health system • Regional health system • Community hospital • Academic-affiliated critical access hospital • Volunteer free clinic
	Number of Facilities	1–120+ facilities, 1–50 hospitals
	Settings and Population	• Nationwide and U.S. regional • Major metropolitan areas (urban, suburban) • Medium and small cities • Systems throughout the U.S.
	Acute or Ambulatory	• Health systems including acute, ambulatory • Home health and hospice care • Ambulatory-only sites
Old and New EHR Systems	**Type of Original EHR System(s)**	• Enterprise commercial vendor system • Multiple (2-5) commercial vendor systems • Best-of-breed system • Locally developed (homegrown) system
	Type of New EHR System(s)	• Enterprise commercial vendor system • Two systems (one inpatient, one outpatient)
	Type of Transition(s)	• Transition of entire organization to new • Multiple mergers or acquisitions
	Status of Current Transition	• Planning and decision-making phases • 80% complete • Completed

Table 2. Characteristics of participants, organizations, and types of EHRs.

"family." Interviewees led implementations from and to various EHR systems and configurations, including enterprise commercial, best-of-breed, and homegrown systems.

Key themes

Table 3 contains a summary of the issues described by respondents about EHR transitions. Themes include the importance of past experience in leaders managing EHR transitions, drivers of EHR transitions, and issues that are common to EHR-to-EHR and paper-to-EHR transitions. Interviewees also discussed issues that are unique to EHR-to-EHR transitions. Finally, respondents discussed the their most recent EHR transitions.

Importance of Past Experience

Prior experience with EHR implementations and transitions was cited as valuable for subsequent transitions:

> "Now, here with the conversion at [our free clinic] …I utilized all that experience, and our conversion here went way better than I ever expected…. the conversion at [a hospital in a metropolitan health system] was down the road a bit, so we had had a lot of experience…. We would help, because we've been through the history of it. So… [the health system] got pretty good at it at the end." (Free clinic and metropolitan health system)

Importance of Prior Experience

- Prior experience contributes to successful EHR transitions

Drivers of EHR Transitions

- Organizational change (e.g., mergers and acquisitions)
- Standardization
- Efficiency
- Functionality and performance
- Regulatory change
- Need for repeat transitions

How are EHR-to-EHR and Paper-to-EHR Transitions Similar?

- Leadership and governance
- Planning and project management
- Workflow considerations
- Infrastructure improvements
- Overall approach to implementation
- Change management
- Training
- Support
- Learning and iteration

How Are EHR-to-EHR and Paper-to-EHR Transitions Different?

- Information, guidelines, and recommendations
- Single enterprise versus multiple systems
- Transitions between related versus different EHR systems
- Transition from locally developed to vendor systems
- Migration of legacy data
- Access to legacy systems
- Overall challenges in EHR transitions
- EHR-to-EHR versus paper-to-EHR: which is more difficult?

Outcomes

- With good change management, users will accept new system
- Key metrics return to baseline in weeks to months

Table 3. Summary of key themes.

Drivers of EHR Transitions

There were many reasons for EHR transitions, and most organizations cited similar reasons. These drivers could be grouped into organizational changes, interoperability, functionality, quality, and efficiency.

Organizational Factors

Participants from large health systems cited mergers and acquisitions of health systems and facilities and the need to integrate information systems as major drivers of EHR transitions:

> "We…merged…. And they decided to move all of their employed providers…onto [one] platform, to have an integrated ambulatory and inpatient platform." (Multi-state health system)

Merging facilities and EHR systems provides smaller facilities, such as community hospitals and critical access hospitals, with greater access to technology and support:

> "…one of the huge benefits of that critical access hospital being part of a large system is that a standalone critical access [hospital]...would not have been afforded the ability to even have [the enterprise vendor system] had it not been...part of a big system…. you'll find it extremely unusual that a [standalone] critical access hospital has an…EHR of the caliber of [the new system]. Because as a standalone, they would have never been able to do that." (Outlying community and critical access hospitals and practices in academic health system)

Standardization

Interviewees reported that a key reason for transitioning to an all-in-one system was to standardize information and workflow and improve the ability to access and exchange information across the entire system. This was especially true for systems with patients that visit multiple health professionals and facilities:

> "…our outpatient setting and our physician groups that are employed within the system are on the same [EHR] system …., the outpatient and the inpatient. It makes it a lot easier for…the continuity of care to continue to flow as they treat those patients." (Outlying community and critical access hospitals and practices in academic health system)

> "These EHRs are not always built with standards.... If they're using…a vendor that is only for urology, perhaps those problems aren't SNOMED encoded…. Under procedures, they're using SNOMED, not CPT, or they're using CPT, not SNOMED." (Multi-state health system)

> "So, we did the whole thing at each facility with the idea of trying to standardize." (Metropolitan health system)

Having a limited number of EHR systems promotes consistency for health professionals across the system, which is especially important for professionals who practice in multiple facilities:

"It is the same system…, looks the same…and we have doctors that go to different offices.…When they open up…for the office…[on] Street A versus Street B…and they can see across all of them…, it's one system." (Multi-state health system)

When EHR systems are unified, practice guidelines can be standardized and incorporated centrally, improving the quality of care:

"…having one system in place would help us to, from an operational standpoint…to standardize…. Physicians don't always like that…. so that everyone knows…they're following best practices, using evidence-based guidelines, those types of things. So, getting them all on the same system helps." (Multi-state health system)

"…we're trying to…[have] one homologous group of order sets that is shared…across the health system…. if you're treating congestive failure with a congestive heart failure set in [one] region, it's the same as if someone walked into [any of our hospitals] .... increase quality outcome by decreasing clinical variation. Where it's not [that] everybody's doing their little nuance of how they treat patients. We're trying to come up with standardized order sets that give the base for everybody to have the same basic treatment." (Outlying community and critical access hospitals and practices in academic health system)

"There was a lot of free texting… that [the hospital] was doing into their system. [The EHR vendor] had developed many more flowsheet types of documentation for the routine nurse. And for all of our specialties, we used a lot of discrete box-checking versus free text…. you could always free-text, but we tried to make it so

that you could retrieve that data in a report and see how your patients were doing with whatever were your important indicators." (Metropolitan health system)

Using a single system improves the patient experience by providing consistency for patients throughout a facility or system:

"…what we're trying to do as an organization is to really create a…standardized and similar experience for patients. So, when patients go to one of our…practices…we want them to…expect the same level of service, the same quality of care." (Multi-state health system)

With a single EHR system, patients can use a single patient portal to access information from throughout the system rather than a different portal for each EHR system:

"A single [patient portal] could be another tool on the patient side. We [would] all have one, no matter where they go in the organization. Right now, before we're getting together, we basically have three patient portals, four. We don't use one of them, because we have so many different EMRs, but…it's a disjointed way to the patient." (Academic health system)

Efficiency

Many participants cited the need for greater efficiency as a major reason for transitioning to an enterprise system:

"…the most efficient way to take care of patients is to all be on the same EMR…." (Outlying community and critical access hospitals and practices in academic health system)

Multiple mergers and acquisitions resulted in up to five EHR systems in use across an integrated delivery system. Interviewees reported that it was increasingly difficult to maintain IT support and training staff with adequate expertise in all systems. Using one or two systems reduces the need for specialized expertise and allows support and training to be centralized, increasing efficiency:

> "From an economics standpoint as well as the support standpoint, we do a lot of central support. We have a corporate IT center…and we support all of our end-users…. 'If you know one EHR,' the joke is, 'you know one EHR' …. if somebody…asks me a question about the [current EHR system] …I can pretty quickly…drill down with them and try and talk about it and understand. If they were to call me about [a legacy system], I wouldn't have a clue how to help them…. you can't maintain the support. You can't maintain the training; the costs are too high…. So that's the reason why we try to put everyone on a single platform…. the maintenance is just almost impossible if you try and maintain multiple EHRs." (Multi-state health system)

Functionality and Performance

Concerns with functionality and performance were also cited as important reasons for EHR transitions. Newer EHRs have desired functionality that may not be present in older systems. Some legacy systems were only designed for limited numbers of patients or users, which resulted in problems with growth, such as through mergers or acquisitions involving new sites:

> "We also found that…some of the applications do not support…large numbers of users…. Some of the applications are great if it's just going to be a three- or four-doc office, but that's truly different than an office of…30 physicians who also have…40 [medical assistants] … and 10 front desk people and their own radiology suite." (Multi-state health system)

Other desired functionality reported included alignment with core business and workflow needs:

> "...providers…decided they really wanted to focus on ambulatory. And that's where [the new vendor system] has been successful…. they've focused on the ambulatory market…. They've really focused on the office physician." (Multi-state health system)

> "We got lucky with [the new system] …. visually, it is relatively easy to navigate versus [legacy vendor system 1] …, and [legacy vendor system 2] … was terrible. So, it's, it's a lot more intuitive to navigate than those other systems. And when [the new system] …was designed, it really was designed for an outpatient setting, versus… [vendor system 1] and [vendor system 3] …, [vendor system 4]. Those were designed for inpatient settings, and I think they [vendors] had a harder time adjusting to the outpatient setting." (Metropolitan health system)

Regulatory Change

New EHR systems may help organization promote interoperability through the use of standards and achieve compliance with regulatory requirements and incentives such as

Meaningful Use (MU) and Medicare Access and CHIP Reauthorization Act of 2015 (MACRA):

> "…if they're on a small vendor, some of them…can't keep up with the standards that are going to be required for MACRA and MIPS [Merit-Based Incentive Payment System] or that were required for MU or Stage III MU…." (Multi-state health system)

It was not unusual to transition to one system and then transition again, usually to an enterprise system, within as little as two years. Reasons for these transitions included a changing regulatory landscape and a need for greater interoperability. In this context, it would be challenging to support best-of-breed systems. Although these concerns favored transitions to enterprise, vendor systems, there were concerns within individual departments:

> "And the…[prior] system was put into place…. [We] decided… [about two years later] that that wasn't currently meeting our needs and goals and ultimately pursued changing.... The intention was for [the second system] to be our future state platform…. due to a lot of the changing landscape…. Meaningful Use was a large driver of that…. Being able to [meet] the government's requirements, show interoperability...and communication of our systems, ultimately proved very challenging.... we reevaluated…and realized that we were better off actually redirecting and going toward a large vendor EHR…, best-of-breed to a monolithic system…." (Public health system)

How Are EHR-to-EHR and Paper-to-EHR Transitions Similar?

Many issues identified by research subjects for their EHR-to-EHR transitions also apply to paper-to-EHR conversions. These topics include leadership, governance, planning, resources, change management, training, support, and the overall approach to implementation. Issues common to both types of transitions are shown in Table 4.

Leadership and Governance

Nearly all respondents discussed the importance of high-level leadership that includes executive leaders, clinicians, and IT professionals.

> "The high-level… [decisions], about 10%, are those organizational decision points…. Then you got about 25% at the advisory level…on the top tier of the workgroups, those clinicians that are part of the leadership, and then you have about, probably 10%...the executive sponsors of the project or…the CEO, the CFO, that's saying, 'We just have to do this for the organization.' Those top things that front-line users can't decide, and that clear delineation between who is doing what and deciding what helps build the project along. Because it's not all top-down, and it's not all bottom-up, because the bottom can't make all those decisions. They don't know all the ramifications of some of, revenue cycle, and billing functions, and other things." (Academic health system)

EHR implementations should be primarily clinical projects with IT involvement rather than vice versa:

Issue	Detail
Leadership and Governance	• Administrative, clinical, and information technology • Clinician-led, with IT collaboration • Engage clinicians • Representation from different fields, specialties, groups
Workflow Considerations	• Opportunity to improve overall workflow • Importance of appreciating workflows • Changing established workflows is challenging
Infrastructure Improvements	• Opportunities for improving related infrastructure
Planning and Project Management	• Clinical project management for clinical workflows • IT project management for technical aspects • Logistics are challenging • Time for transition can vary from 6 months to 2 years • Adjust workload and schedules for lost productivity
Overall Approach to Implementation	• Phases or "waves" for different sites or groups of sites • Prioritize sites based on size, readiness, current functionality • Big-bang approach for each site to maximize support • Consider phased approach for specialized workflows
Change Management	• Good change management is essential • Communication • Managing expectations • Ongoing enhancements
Training	• Allow time for training • Make training required • More training needed • Focus on workflow • Expectations higher for EHR-to-EHR transitions
Support	• More support needed in the beginning • "At-the-elbow" support in the beginning • Develop local expertise • Address and track issues
Success Metrics	• User acceptance and satisfaction • Patient satisfaction • Completion of documentation • Reimbursement • Resolution of tickets • Return to baseline
Learning and Iteration	• Implementations improve with time and experience

Table 4. Issues affecting both EHR-to-EHR and paper-to-EHR transitions.

"We'd try and operate under…dyad structure…. If you look in the industry, it's pretty standard now with large…[integrated delivery networks]…. We get a physician lead and an administrative lead from a group, and they sit on our…transformation leadership committee." (Multi-state health system)

"And it became much more of a clinical project as opposed to an IT project. That involvement of the clinical leaders was years ago…, was fairly different for IT to kind of go along with it, because it used to be, IT picked the software, IT implemented software, and everybody else kind of dealt with it. And this was a little bit different…." (Academic health system)

"So, the structural process, having both IT [and] clinical operations work together in…organizing the how, we get a lot better buy-in. And IT knows exactly what to build based on the needs of those users." (Academic health system)

"…a big informatics mantra is, these projects are not IS [information services] projects, they're clinical projects with IS support, and I think approaching these big implementations like that is also critically important, and having as much clinical knowledge…in teams or internally…has been invaluable in…terms of a clinical focused product from the get-go, as opposed to…starting with what IS or IT thinks it should look like and then adding, getting back-and-forth feedback…. we were able to get to a more clinically applicable product or build sooner because of our active IS, our informatics, clinical involvement." (Public health system)

Clinical users have the best understanding of clinical workflow and should lead the EHR implementation and provide input, together with operations and executive leadership:

> "…there were physicians on the project that said, 'This is what we need to do.' The rest of the physicians listen to them. If was just run by IT, they would push back…. we're going to use clinical people to lead, to help gain support…. We're going to have physicians come across and be the project leadership team to work with IT…. The model worked really well. They were actually involved. They made decisions on behalf of the medical staff and communicated back…. An informatics group of nursing with physicians to come up with the organizational structure of governance…. You have operations, which sits in like a dyad with the clinicians to help run this." (Academic health system)

> "We had kept our clinical end-users engaged…to fully understand what the legacy workflows and needs looked like, so that we could accommodate them into the new… [EHR] workflows…. [We had] …ongoing meetings with our operational areas to validate that the build…was meeting what they were anticipating and their goals were…. We hired a higher proportion than average of clinical end-users to become… [EHR] analysts, and so, a large portion of our analyst build team came from clinical backgrounds so themselves could act as…subject matter experts and clinical advisors…. We had to find the fine line between our internal group making those decisions versus reaching out truly to the operational areas to get answers…. we found…a happy medium… and then it led to…higher satisfaction...." (Public health system)

"…we've learned [that] without having physicians involved, you don't get a good output…. They're the users of the thing, nurses are the users...Physicians had built the [legacy system's inpatient] side of it…. They liked what they had, the parts they were able to modify. We had lack of physician…involvement for the… [legacy system] side for the ambulatory…. we said [that] we're going to change that going forward as we…do [the] enterprise [system]…. And it was a great thing, because if physicians get involved, they stay involved, and they actually help champion the process…. have clinical involvement and be part of the project, that's number one." (Local community and academic health systems)

Clinical leaders make key decisions and assign tasks to workgroups that work out the details:

"…. you have workgroups below that are focusing on…what we actually do. So…65, 70% of all the decisions are coming from people who do the work…. [Clinicians] know how to take care of patients, and they should make those decisions. And so, delegating into those groups and giving them the power to decide helps facilitate…the decision-making process…." (Academic health system)

There should be clinical representation from different facilities, groups, disciplines, and specialties:

"So, we had a…steering committee that was made up of physicians, nurses, administrators, pharmacy, quality…. It's an enterprise function, so we had to have enterprise representation." (Local community health system)

> "Let's grant someone from each campus, as a representative, so that they can help be champions for their campus for change." (Academic health system)

> "…. we had the physician lead for ambulatory be a physician lead for the enterprise product. We had a physician lead for ED....We had…specialists and a family practice doc be leads." (Academic health system)

> "We included all our stakeholders. We had nurses, we had physicians, we had pharmacy…. We had everybody looking, even at…the RFP and…the demonstration, and so they…were very happy and excited." (Multi-state health system)

It is also valuable for information services professionals to spend time learning about clinical workflows, although they cannot replace clinicians:

> "…as negative as it sounds…I personally found that it's a lot easier, at least…in terms of… [EHR] builds, to have someone with a clinical background get trained in… [the EHR build] than it is for someone with an IS background to get trained in clinical knowledge, to truly understand that workflow. They should, and we've encouraged that…our people…coming out of IS go and shadow and spend time in the clinical areas to understand what's going on. But [with] the…complexity or involvement of clinical workflows…I found that taking someone from a clinical background and giving them an [EHR] build knowledge was more successful than the other way around." (Public health system)

If available, resident physicians and other trainees should be involved with the transition:

> "It was pretty easy for residents…to catch on, because they'd been used to it…. the residents probably drove the medical staff conversions." (Metropolitan health system).

Workflow Considerations

EHR transitions presented workflow challenges and opportunities. Organizations need to understand and consider operational and quality improvements when planning their EHR transitions:

> "Workflow, document changes, everything that's needed to support that new system, needs to be appreciated and given to those end-users prior to go-live. That's the biggest challenge and biggest learning [lesson]…" (Outlying community and critical access hospitals and practices in academic health system)

> "…we took the EHR migration as an opportunity to…transform our whole physician enterprise…. We're trying to look at our processes…to optimize how…we're doing other things. To look at our billing processes…, swim lane diagrams of how patients are seen in different offices, and even…lean and six sigma methodologies. Why is the printer all the way in the back? Why is the nurse doing the triage in the back of the office…?" (Multi-state health system)

Changing long-established workflows to improve efficiency is important but challenging:

> "I'm a huge proponent of documenting real-time. One of the big things…that still happens in hospitals, especially nursing…, everybody goes and does their care, and it used to be…you would wait until the end of the shift and do all your documentation,

and that was horribly inefficient. So, our preaching was always to do real-time documentation, but it was very hard to get to happen." (Free clinic)

Infrastructure Improvements

An EHR transition is an opportune time to consider upgrading related infrastructure:

> "[Our critical access hospital] is unique in that they are getting new email, new HR [human resources] system, new blood bank, new lab, and a new EHR. All at the same time. So, this is multiple projects to bring about the EHR change.... There's a supply chain functionality that goes in there…. You have to have the correct HR system that goes through with provisioning each of the job codes to the security points. So, they're all contingent on each other." (Academic health system)

> "The one thing that we did get was some great advice…, we should convert…our wireless carrier…. That made all the difference in the world in our wireless support. Our network was really bad. If we had to rely on our network and our networked computers, we would not be able to do this." (Free clinic)

Planning and Project Management

Good planning and project management are essential, and time spent in the beginning improves the chance of success later.

Clinical and technical project management. Transition projects need adequate and dedicated project management resources, with high priority given to both clinical and technical workflow considerations:

> "…the project management…has to be twofold. There has to be IT project management that deals with the technical aspects…, and there needs to be a clinical project manager that deals with the workflows of substance…, understanding, and …making the end-users understand how those workflows need to change…." (Outlying community and critical access hospitals and practices in academic health system)

Logistics. The planning, infrastructure, and logistics of communication involving teams scattered across multiple campuses becomes its own challenge, especially with mergers and acquisitions:

> "The logistics around organizing it, from room availability, scheduling across campuses…. When you're merging and acquiring different hospitals, you have multiple email systems. You've got multiple distribution lists…and how do you communicate to everybody? …You need your own…project management crew to do all the logistics.... Every single time you take someone out of their regular work to plan something or do something, that affects the entire project.…it's like added work to them. So, it's projects within projects…. every team is integral…from the admin staff that are planning and placing…appointments …. throw in marketing to make sure that the message is consistent and the channels.... It's full-scale, like building a community… from a plot of land with nothing on it to putting in the entire

infrastructure of sewer, water, and lighting, and all the roads…and make sure that we got…a government put in and town hall and everything.... You've got to go through every single aspect to plan it out." (Academic health system)

Time needed for transition. Organizations varied greatly in the time taken for EHR transitions, from planning to go-live. Large organizations spent up to two years planning their transitions. Other sites may implement in a shorter timeframe.

"We did it very fast. We did it six months [for each site], which is really unusual. Usually, people take much longer, but we did start at six months" (Multi-state health system)

"We brought up two hospitals in eleven months." (Local community health system)

"And so that whole [implementation] process took…approximately twelve months to complete." (Public health system)

Clinical workload and scheduling. Respondents reported that schedules, workloads, and productivity expectations need to be adjusted before, during, and after go-live. These adjustments provide room for time needed for supporting the implementation, training sessions, learning the new system, dealing with IT issues, and adjusting to the new system:

"…we tried to schedule our patients to about half the number that the clinicians normally had, because we knew it would take them twice as long. And so that's what

they did as well. They tried to up-staff if they could. That wasn't always possible." (Metropolitan health system)

One interviewee emphasized the importance of providing voice recognition software and medical scribes to help physicians:

> "The physicians obviously are in charge of their notes, but typing skills are not their cup of tea…. if we would have done more of that…early on, we might have had a lot easier adoption.…When we did the…emergency department conversion, we utilized voice recognition technology, and that also assisted in the conversion because the process for the physicians was essentially the same as, as the dictations. They just did their dictation into a microphone. That's the same as the scribe situation…basically just a dictation, which they're used to…. As long as they have scribes, they're all fine with it." (Metropolitan health system and free clinic)

Overall Approach to Implementation

Phases for different sites. Participants who led large health systems reported that implementations proceeded sequentially through individual phases or "waves" of practices or facilities. As support and training resources were deployed to sites as needed, there would not have been adequate resources for large numbers of sites to go live simultaneously:

> "…we started our first…. we're still in process…. We've done waves. So, we've done four waves. We have our fifth wave, which involves our urgent care centers. So, I would say we're…4/5 done. So, we're pretty far down the road now." (Multi-state health system)

> "Because we're so large, I don't think we had the choice [to do all sites at once]. We couldn't support it from a training and from a technologic standpoint. So that really wasn't possible for us." (Multi-state health system)

> "There was no way to logistically support all the way at [the outlying and central sites] at the same time. There are not enough people. Because we're utilizing people from [central sites] to support out [outlying sites], because they've already lived it. Once… [outlying sites] are on, when we go with… [the remaining central sites], we'll have people…that can support them…. we couldn't support it all at once if we tried to do every hospital at the same time." (Academic health system)

Respondents reported a number of approaches to prioritizing transitions involving multiple facilities. With mergers, new sites can transition upon joining or be added to existing timelines:

> "At the same time, we were going through our merger with the second hospital…. when the merger was actually finalized, we rolled those providers into the project also." (Academic health system)

> "Also, we have smatterings of practices that, when we acquired them, they wanted to stay on …their EHR for a period of time, and usually we would allow that, knowing that we were going to come around as we had waves of implementation." (Multi-state health system)

Facility size was one factor for determining the order of transitions:

"So, we picked the big hospital to go first..." (Local community health system)

Others reported transitioning smaller sites or sites using smaller systems first. This approach optimized the use of resources, as smaller sites were migrated quickly while planning and design were in progress for the parent system:

"So, we did a bunch of… [smaller EHR system] groups, kind of smattering ones, before we got to the… [larger EHR] ones." (Multi-state health system)

"We're bringing up two hospitals first on the… [new EHR] system, and then we're going to bring up two larger hospitals about a year after that." (Academic health system)

Migrating the most eager groups or facilities first capitalized on these sites' enthusiasm, allowing them to weather difficulties inherent in being the first sites to go live:

"Believe it or not, a lot of them wanted to get on the new system. They had seen it. They were excited. So, we did it based on desire." (Multi-state health system)

Another reported approach was to migrate the sites having the most difficulty with existing EHR systems, either due to inadequate functionality or performance or relationship with the vendor:

"We were having issues with response time in one of our EHRs, the… [vendor] EHR, and that's no secret. Their EHR, the way they are, [how] the database is built, it only supports x number of users…. We were having response time issues, so we moved those groups first, just to try and ease some of the pain." (Multi-state health system)

> "And the first function that we went through was bringing up ambulatory on [the enterprise vendor system] because we did not have any very good functioning relationship with… [the legacy vendor]. So, we did ambulatory first, and then we did enterprise next." (Local community health system)

One reported strategy was to migrate sites prior to expected increases in patient volume due to seasonal variation. For example, one system migrated its facilities in Florida prior to the winter season, with its annual increase from patients who have winter homes in that state:

> "For example, Florida is busiest in the winter, because we have a lot of snowbirds…so we needed to get them up before…November, before December, January, and it got to be busy season." (Multi-state health system)

Big-bang versus phased approach for each site. For the most recent transitions, all respondents advocated for and reported using a big-bang rather than phased approach for implementation for individual groups or facilities:

> "We did a big bang.… At 11:59, we shut down our legacy systems and about 4 hours later, we brought up… [the new system]." (Public health system)

The consensus was that although the all-at-once approach may have been difficult for users initially, it allowed the transitions to occur quickly, avoided a lengthy transition, and maintained access to all information in the system:

> "You have to rip the Band-Aid off all at one time. It's not death by a thousand cuts. Everybody has…a couple weeks of uncomfortableness, and then things settle out. It's

not like you're constantly bombarding them with something new. So, everything got blown up at one time, the dust has relatively settled, and I think it was the right decision to make." (Outlying community and critical access hospitals and practices in academic health system)

"It just was probably the…least painful, easiest way for us to implement it. If we had gone down a phase-wise approach, we were then talking about how to, to interface… [our homegrown system] into [the vendor system] …and our, our legacy lab, rad [radiology], or pharmacy system into… [the vendor system]. And we had no interest in doing any of that, because it would be hundreds, thousands of hours of interface work for a temporary process. And…our legacy systems, despite them being piecemeal, were…integrated across care settings…. So, if we hadn't integrated… [the legacy system] into… [the vendor system] and only done inpatient first and then done ambulatory later, then they couldn't see each other…. It was obvious that we needed to do a big bang…." (Public health system)

Another major reason to go live all at once is the ability to take advantage of support personnel who may only be available for a limited time, such as vendor staff and consultants:

"We went live, all at once…. And that, that's kind of the best way to do it. I think it's painful, but, you know, you have to have everybody ready. We did do it all at once." (Multi-state health system)

> "…with the big-bang approach, we had more resources available. All at once versus trying to slowly transition over, you're having a go-live too regularly to maintain the adequate support for all that's needed, and so my perception was that you have more support, hands-on in the, the hospital setting, more 24-hour support than if you were to do a partial go-live with different sections." (Medical group within multi-state health system)

Whether a big-bang or phased approach is used overall, an organization may use a phased approach to transition departments or groups with specialized workflows and EHR systems:

> "There was something that they used to use...in the NICU. They had a program that was custom-developed.... After we had converted everybody, we would do the upgrades and do additional departments, and do those conversions of those custom-grown places. Mother-baby, ED. So, when we converted inpatient, we didn't do the specialty units. We went back and did the emergency department, OB [obstetrics] department…." (Metropolitan health system)

Change Management

All leaders emphasized the importance of change management:

> "Well, there's the change management side. It just, the biggest part of the whole thing because that's what everybody's worried about, right? There's a lot of times that people don't know if they feel that change is bad, it's just change.... I keep going back to change management…, the fact that you get to participate, and you get to help [develop] what we're actually going to use. And because of that, you're actually

going to use what we built as opposed to complaining about it." (Academic health system)

"So, for them to transition, going from what they didn't necessarily love, and we said, 'We're going to switch.' But, when we switch, it becomes, 'I love the old product, because it did all this stuff, and I don't want to move to the new one.' Which is just pretty much human nature…and it's a difficult thing…. It's really just change management…. It's got to be a win-win for them. They go kicking and screaming, no matter what, because, 'We're good at this now' …. It was a fear of change rather than the understanding…. they knew they had to change because it was a benefit. But at the same time, it's just extra work…. Retraining and relearning and getting into a rhythm again takes time, and so, once they invest in that and understand that they have to do it, it comes pretty smoothly." (Academic health system)

"…there's…that trough of disillusionment they talk about with technologies, that it's exactly what you'd expect. And it's just that change…." (Multi-state health system).

Ideally, leaders have experience leading change, even if the change is not related to EHRs:

"…it wasn't our first rodeo…in the sense that we had built a new hospital…so there was an aspect of building the new hospital and then moving patients one day from the old hospital to the new hospital, and turning the switch on making everything work …. people that had been here a while had lived through that and understood the

pain and gain …. Other than moving people physically, you're really doing a very similar thing." (Outlying community and critical access hospitals and practices in academic health system)

Ideally, users feel supported throughout the change:

"…that support from your peer and leadership and governance…helps with the change. It doesn't make the change easier. It just helps with the change, because, when it comes down to it, you've still got to change, right? You've still got to get out of the old thing that you're in and into the new way." (Academic health system)

Communication. Early and regular communication helps keep everyone informed, expresses support, and encourages participation:

"I think that started early on…messaging to the physicians and to the staff, how things were going to be changing.... We didn't know, how it was going to be changing? We just were…told that it would be changing." (Outlying community and critical access hospitals and practices in academic health system)

"[The main challenge] is just lack of awareness or information and feeling included…. The more that information gets out to the people that the change is affecting, or they have a representative that is managing the change for them and understands they got their back, those two things of awareness and participation lead to buy-in." (Academic health system)

> "And then throw in marketing to make sure that the message is consistent and the channels that we're using for the messaging goes out." (Academic health system)

In large health systems, helping distant sites feel more included requires more effort but increases buy-in:

> "…[with] the bigger organization…it gets a little bit more difficult..., just logistics. As you're driving from one campus to the other, it is getting buy-in to say, 'Look, we're all in this together. We've got to make an effort to do this.' Sometimes we rotate meetings around. We have some centrally located meetings to make it happen, but those things play a role to the success of the project…. We can't just…turn around and say this is the home base and this is what we're going to do, because the organization is bigger than that." (Academic health system)

Managing expectations. Transparency, realistic goals, and managing setting clear expectations help to ensure project success and minimize disappointment:

> "Be transparent. Allow people to understand what you can and cannot accomplish in the time frame of a project…. A project…it's got a beginning and a defined end and a scope, and everybody wants to do everything or make it perfect. Perfection is…the worst thing…because it's not perfect, and if we try and do perfect, we spend so much time doing perfect, we never get to use the damned thing. So, understand that it is a project, that it is a project in an enterprise, that it does have constraints, both in resources, time, and configurability…." (Academic health system)

As there is no perfect EHR system, any solution will require compromises between stakeholders:

> "There's no perfect EHR. There really isn't. And anyone who's used a lot of them…could tell you that…. There are some niche EHRs.…If you look at things like KLAS scores, or you talk to the physicians who've used different ones…there might be one that's more geared towards a cardiologist, and…there might be one that's more geared toward a neurologist…. So, physicians…may want their own individual EHR" (Multi-state health system)

Ongoing enhancements. Some users believe that they need to have all requested functionality implemented prior to go-live, or it will never be available. Leaders emphasized that they prioritize and plan timely implementations but needed to plan for ongoing improvements and refinements after go-live:

> "Then the other learning [point] is really supporting and letting everyone know that you don't have to try and put everything in this, because we are going to have ongoing, post-live enhancement, optimization cycles…. The biggest fear a lot of the clinicians come up with: 'If I don't put everything in that I want now, we'll never get a chance again.' That's a thought process. And you have to guide them through and have support from leadership to say, 'Don't worry about it. We are constantly going to support this, in optimization, enhancement, and hearing what needs to be done for the system.' Just saying that and seeing that there's a process to support that, allows clinicians to think of it in a way of, '…I know we can only do so many things. I can hold off on this idea that's going to take a ton of work until later.' Because the goal of this is to get everybody on one record in a consistent way, and then we can work on

further enhancements and optimizations…. that's a big thing." (Academic health system)

Training

All respondents spoke about the importance of training. Training should occur in advance, and it is ideal for organizations to have in-house trainers from the beginning.

> "We, from the get-go, implemented a very large training team, compromised of a number of people from multiple clinical backgrounds that were focused on building and developing curriculum and training for each of the specialty areas. And they spent months to well over a year…learning the previous workflows and what the new system…would look like, building curriculum and content around that and working to develop…training curriculums so that when we were ready to go live, we had a robust kind of training plan for each of our clinical areas." (Public health system)

Allow time for training. Organizations need to budget time for training into their project plans, as training is valuable, but can be time-consuming:

> "Another learning is, recognize the time constraint that's put on the organization as a whole to train, support, and get back to a steady state. And that's all real, and you have to build it into the project and understand you can't expect everyone to be perfect on day one, that it's going to take some time to kind of get used to the new system. And train, and give adequate training and time for training, because…the amount of time and effort you put into training at the front end, you reap the

improvement into understanding the system and getting to a steady state on the back end." (Academic health system)

Make training required. Although it may seem coercive, making training mandatory ensures that it will be completed:

"We made training required. You couldn't be on the medical staff unless you trained. Pretty much, everyone went through with it. We didn't really have anyone leave the medical staff or anything like that." (Academic health system)

More training. A common theme was that more training was needed than originally recommended or expected:

"So originally, the vendor said, you only need…an hour of training for that. But then, what we discovered after we went live is our providers were completely confused…how to do specific things within the inbox. How that they do that, how do they do this? So, we actually changed this to…three hours of inbox training." (Multi-state health system)

"I think the training that we had was adequate… there was just a little bit of hands-on support that could have been augmented, but…within the first week or two…, with the product that we chose, with the training that we had, everybody was up to speed." (Medical group within multi-state health system)

Offer different types of training. It is helpful to have different types of training, such as in-person courses, online programs, and sessions at the point of care:

> "There were a lot of physicians with big issues…older nurses, thinking you can't teach an old dog new tricks. I tried to help people understand that yes, you can, and we utilized every possible method of education…. We tried to have classes, we opened up for practice, we did one-on-one education with the physicians and residents." (Metropolitan health system)

Focus on workflow. The focus of training should be on helping clinicians adapt to new workflows and tasks:

> "Well, I've been chanting this for a long time…. [The CMIO] just laughs at me now because he's heard it from me for so long. But I think the biggest challenge in going forward…is that the [EHR] training in and of itself is great task training. So, I always liken it to...ordering a sweater on eBay with a different computer software program…. It's just a different way of doing. The thing that is everybody's nemesis is the appreciation of change in workflows in how adopting a new system changes that workflow." (Outlying community and critical access hospitals and practices in academic health system)

Support

Support is critical during implementation. Much support comes from vendors, which have an interest in promoting successful implementations:

> "…it's really a replacement, a migration or replacement marketplace. So, the vendor…worked with us to understand what we felt the requirements were to move data, how to move data, what data needs to be reviewed, what data can go in automatically. So, they were actually quite good, I would say, in the process, you know. Wasn't perfect, but they were interested in learning as well. So, we really appreciated that." (Multi-state health system)

More support needed in the beginning. Needs for support are most intense the first few weeks following go-live and taper soon after:

> "…the approach to the go-live and the go-live management…was 24/7. We started with a 2-week support time, 24/7.... And as time went on, usually after the first week, we were scaling down to more of a skeleton crew of support, and the calls were much less." (Free clinic)

"At-the-elbow" support. On-site, "at the elbow" support is critical, especially in the beginning:

> "I think the biggest that that we've learned is, more hands-on, elbow-to-elbow support at the initial go-live…. Having one person, elbow-to-elbow, for every two doctors…was the goal ratio of on-site support. And that was not manifest in many of our clinics. And so, there would be some clinics with ten providers that would have only two on-site support [people], and so that really slowed them down from that standpoint." (Medical group in multi-state health system)

> "But that base of at-elbow support that we had and the pre-training, prior to the… [EHR] go-live, really limited a lot of the struggles…that others may have if they aren't as diligent in the pre-preparation at…go-live…. Things have been going very, very well. We've had…a large amount of support, elbow support…. We've had clinical support, physicians that have worked…with the system for a long time, that helped." (Outlying community and critical access hospitals and practices in academic health system)

Develop local expertise. Training local experts to provide in-house support is a desirable long-term strategy:

> "In our being the first wave…, [support] would be from the vendor. But in future waves, we did have the support of local experts…. Now we have people trained, so we'll have our own on-site support." (Medical group in multi-state health system)

> "And as we got closer to our go-live, we…engaged what ultimately turned out to be over 700 super-users to help with our implementation. They were trained above and beyond our normal end-user trainers, and sat in on some of the training sessions for the end-users to understand what their questions were, and were…at the elbow for the first 2-4 weeks of go-live, providing…at-the-elbow support and supplementing our go-live command center help desk. They additionally have continued to be resources at their areas after we've gone live as… local sources of knowledge and expertise." (Public health system)

Address and track issues. Multiple respondents mentioned the importance of a command center and tracking and responding to support tickets in a timely fashion:

> "And the… [EHR] command center being aware of these tickets going into the IS department… [ensures] that everybody who's working knows issues concurrently. It wasn't like they were just putting them off, and 'We'll deal with them next week.' They were being solved on the fly." (Outlying community and critical access hospitals and practices in academic health system)

Timely escalation of issues and having support from top-level leaders helps keeps situations under control:

> "…they did try to have super-users on the floor who could guide you through your documentation, if you were really having trouble. Or if you really had trouble that the super-user couldn't help, then they would call one of us…, the expert in that department. We would help, because we've been through the history of it." (Metropolitan health system)

> "In the beginning...a director was leading the implementation and then there were charge people…on a unit…. And there were shifts and so there was a charge person over this shift. And then if it needed to get escalated, it went to the director. If it needed to get escalated, it went to the vice-president… [of the vendor and health system] or both, depending on the situation …. We had things go wrong, like at one of the big conversions in the middle of the night. All the servers went down…so then we had to escalate to the right people at the right time, and get everybody on the

phone, and get the backup. Everybody had to be aware of how to handle downtime. It was a big deal." (Metropolitan health system)

"… [The CMIO] spent a boatload of time out here for the first two weeks, helping us put out fires as they arose, because we were as ignorant to the new system as our colleagues were. So, it was nice to have somebody with that depth and breadth of experience to say, 'No, this is how we handled it in the [sites that were already live].' So, we were able to get ahold of things and wrestle them to the ground before they became…big issues. We were managing the issues before the issues managed us." (Outlying community and critical access hospitals and practices in academic health system)

Success Metrics

Respondents described success metrics such as user satisfaction, patient satisfaction, clinician productivity, time for encounters, ease of finding information, completion of charts, time clinicians work after-hours, revenue, number of IT tickets, time for resolution of tickets, and progression of implementation. A key benchmark was return to baseline. Although productivity and revenue are not necessarily the most robust metrics, they are objective measures that are easy to collect and track over time:

"A lot of our metrics were, around patient visits, and billing, coding, financials…. they're not the most amazing metrics but what keeps our organization's lights on. And so those are the ones that we honestly focused on…, amount of time to coming back to where we were prior to go-live, and…exceeding those metrics…, how soon

we exceeded…our pre-go-live numbers…. Internally, we obviously looked at incidents, number of help desk tickets, time to resolution. [We] focused on internal departments that were getting more tickets or having longer time to close than others…, trying to get resources out to them, so that we could address their issues quicker and get them resolved sooner." (Public health system)

"Overall success is…user acceptance post-go-live, and…using it… [getting] educated enough and trained that they're comfortable…. Another one is...level of break-fix that are entered…, things that are broken that need to be fixed.... Clinical revenues, finance…. for the patient side, it's a better experience. So, patient's not having to…give information from one provider over to the other with a known hub system, that ability to share that information across the board…, hugely a factor in the patient satisfaction score of, 'Did this work for you?' …. System or IT side…, you have a fairly clean build. You have a good, supported go-live. You have delivered on-time and…on budget, in a way that…met the needs of your planning…. another real metric is return to baseline…. have we made a change, implemented the changes, gotten people trained correctly? And are we processing patients back to…before…we moved to this new system? …. are we more efficient…?" (Academic health system)

"…we're just looking at the fact that our physicians are all documenting in the system.... how many people sign their charts, making sure that we have access to their data. We're still learning what our metrics really should be…. The nurses…look

at every patient who has been through the clinic after the clinician leaves to make sure that there's documentation there, and if their diagnosis is in there…. We're doing our best to make sure our charting is up to speed." (Free clinic)

"…one of the things would be satisfaction, both from the provider standpoint and the clinical associate standpoint. Number two would be time…if that had an impact over time or work, lunchtime…, to validate that we aren't hurting our employees more. And the third would be looking at "pajama time." Making certain that the after-clinical-hours documentation is reduced…ensure that the time that physicians are documenting in a non-clinical setting, or at home, to get caught up for the next day, is reduced…. So, the intermediate metrics that we're looking at are: one would be closing the referral loop… Another is having a better ability to understand where our charge entry lag is…. It's a lot more transparency for managers, directors, and administrative leaders to see where we're having struggles at. So those metrics have been improving for us." (Medical group in multi-state health system)

Learning and Iteration

A common theme was that system-wide implementations are iterative, involving experience, learning, and adjustment which are applied to successive improvements and implementations. This learning would be expected to be greater for transitions between EHRs, given that there is less overall experience and literature than with conversions from paper:

"So, the process has been very educational, very iterative…. it's been a very large learning experience…. And you learn that maybe…you need to do things differently. We tried to improve our process…. So, it's been a really interesting process, and…I'll continue to work, learn a lot as we continue down finishing this up." (Multi-state health system)

"…one of the disadvantages of our region was that we were part of a larger [multi-state health system] and were the first phase of going live with the transition. So, we did not have a lot of internal experts with the electronic health record. And so, that was a stumbling block for the first wave. But I think it improved for the second and third, fourth, and future fifth waves." (Medical group within multi-state health system)

"…[we] learned from each implementation of what we could change both on training, system setup, routing, flow of certain things that we went through from one implementation to the next…. we've improved from one to the next. It's almost like we had a reset, because we're a new organization with a new team that's doing this. It's not the same team that it was for the first two." (Academic health system)

"…as we became more experienced…, it became easier, no matter what we did, because we learned to identify an issue, put a little group together, find out why the issue was occurring, and come up with a solution…relatively quickly…. I anticipated a lot of more problems here at [the free clinic] …than we have experienced. I'm

knocking on wood. I really expected that we would have more technical things…. the companies as well have become more experienced. The things that…cropped up aren't as overwhelming as they were at the beginning." (Metropolitan health system and free clinic)

How Are EHR-to-EHR and Paper-to-EHR Transitions Different?

There is less available information about EHR-to-EHR transitions, and there are issues that are not present in conversions from paper. These include decisions on what to do with multiple systems resulting from mergers. Migrating legacy data is a major challenge, which is closely related to subsequent access to legacy data and systems. These issues are shown in Table 5.

Information, Guidelines, and Recommendations

In contrast to paper-to-EHR conversions, for EHR-to-EHR transitions, there is a lack of standard guidelines and recommendations:

"There's not a whole lot of best practices…. There isn't one best practice." (Multi-state health system)

Participants reported that most recommendations and guidance came from EHR vendors. Other sources of information included colleagues in other organizations (which may have been references provided by vendors), professional organizations, and consultants:

Issue	Detail
Information, Guidelines, and Recommendations	• Less expertise and literature on EHR-to-EHR transitions • Prior experience with EHR transitions • Information and guidance primarily from EHR vendors • Consultants, colleagues, professional organizations
Single Enterprise versus Multiple Systems	• Single enterprise system facilitates information sharing • Multiple systems support specialized workflows • Challenges exchanging information between multiple systems
Transitions to Related versus Different System	• Transitions more difficult between different systems • Different architectures, functionality, and interfaces
Transition from Locally Developed to Vendor System	• Adjusting from local to vendor control of application/data • Loss of ease of customization for specialized workflows • Need to adapt workflows to vendor tools or vice versa
Migration of Legacy Data	• Selection of data for migration • Age of data to migrate • Data migration approach • Data cleanup and validation • Data migration challenges • Incompatibility between systems • Free text challenges • Difficulty finding information after migration
Access to Legacy Systems	• Temporarily run old and new systems concurrently • Eventual conversion to read-only legacy access • Remove read-only access or keep available indefinitely • Old information can always be accessed by request
Overall Challenges in EHR Transitions	• Transitions are costly and time-consuming • More challenging than expected • Lack of guidelines and expertise • Resistance to change • Workflow differences between EHR systems • Interoperability is challenging
Are EHR-to-EHR Transitions or Conversions from Paper More Difficult?	• EHR-to-EHR transitions are more difficult • Users are accustomed to the prior system • Users have developed customizations and workarounds • Need for learning new interfaces for different EHRs • Expectations higher for EHR-to-EHR transitions

Table 5. Issues and challenges unique to EHR-to-EHR transitions.

"…when we…signed on with… [the EHR vendor], we very much followed…[their] model, and…a lot of their guidance and history and plan of how to do their implementation. As you know, we were not in any way the first…[vendor's] go-live....so, they have done this successfully at many different organizations of various size and complexity. And so, we relied a lot on their expertise in terms of implementation and go-live." (Public health system)

"You can talk to different physicians, different CMIOs, different people who lead health systems about how much data do you move, what do you move, how do you move it? Do you do it programmatically? Are you able to?" (Multi-state health system)

"I've gotten different opinions…. I've spoken to providers with different health systems…that have transitioned EHRs, whole bunch of other places I could reference, as well through AMDIS [Association of Medical Directors of Information Systems]. Everyone did things in different ways…. We employed...impartial consultants to help us do this, so it wasn't deemed that anybody was trying to influence one way or another…. You talk to different consultants. They'll tell you different things…." (Multi-state health system)

Given the relative lack of available guidelines and experience, EHR transitions are especially challenging for early adopters. While initial information and guidance may come from vendors, it is important to develop in-house expertise:

"…being the first wave…, [information and support] would be from the vendor. But in future waves, we did have the support of local experts." (Medical group within multi-state health system)

Enterprise versus Multiple EHR Systems

When multiple EHRs are in use in an organization, either because of prior decisions or mergers, leaders must decide how to integrate these EHRs. Although most organizations sampled in this study transitioned to single, enterprise systems, one system's long-term strategy is to use two different EHR systems, one for hospital inpatient care and one for ambulatory settings. Workflows in hospitals and outpatient facilities differ greatly, and each EHR system is highly optimized for its setting. Health professionals were highly accustomed to these systems, and did not want to change to a single system across the organization:

"All of our states, all of our hospitals use… [EHR system 1] for the inpatient. That's our strategy…. [EHR system 2 features] really try to optimize the physician workflow. They're built around ambulatory efficiency…. An office is very different than a hospital, and unfortunately, sometimes...vendors have tried to take…an inpatient application and forced it down the throats of office providers. When in an office, you might see literally 40 or...50 patients in one day…. They're just moving from room to room to room. And the system needs to be set up to help them get what they need, but not overflow them with things they don't need…. [EHR system 2] …focuses on productivity and helping the providers…see what they need." (Multi-state health system)

Although there are challenges with sharing data between multiple systems, the benefits outweigh the costs:

> "There's some benefits in our current EHR that outweigh the disadvantages of having to go through two EMRs on a regular basis. So, our office staff still feel like the new EMR is a better product than what we had previously." (Medical group within multi-state health system)

Transitions between Related versus Different EHR Systems

Not surprisingly, it is easier to transition between identical or related EHR systems than to change to completely different systems. There is variation in difficulty, depending on how different the interfaces and architectures are:

> "[EHR 1 to another instance of EHR 1] …, on the scale of easy to hard, easier, but it's still hard, because everybody does their stuff a little different…. What they use…for event, or for what things they turned on or are not turned on in the system, it's all a little different. But it's still [the same system] …. So, it's structurally easier…. Let's convert from one to the other…it's just difficult." (Local community health system and academic health system)

It is more challenging to transition between different EHR systems, with some variation in difficulty, depending on how different the interfaces and architectures are:

> "[Legacy EHR 1 to a different EHR system] …, it's a little bit different, because it's a collection of software, so the lab data is the lab data…. So, there are a lot of organizations that have… [legacy EHR 1] labs but…some other EMR. So, getting that [lab] information…is a little bit easier. The information from the EMR, difficult.

> And [legacy EHR 2 is a] …front-to-back system. It's a lab, it's billing, it's practice management, it's an EMR, it's everything kind of all combined into one. It's supply chaining, it does everything. So that is a difficult thing, because it is organized as its own island…and communicates in its way…. But the… [new EHR] system and the whole and the way the data structure is…different from [legacy EHR 2] …, it's harder." (Local community health system and academic health system)

> "These vendors don't make them exactly the same…, they're similar…. Some people have it …in one place. So, I think because the systems are often set up differently, that's where the challenge lies." (Multi-state health system)

Transition from Locally Developed to Vendor System

One leader described the contrasts that emerged during the transition from a locally developed, best-of-breed system to an enterprise vendor system. This system was highly customized for the needs and workflows of the institution and evolved gradually and iteratively in response to internal requests. The organization was able to create new tools or modifications as needed, resulting in highly customized solutions. With an enterprise vendor system, the organization did not have this flexibility and needed to make the vendor system work:

> "Our organization has a lot of history…with build and development of electronic medical records…. We had a lot of things that may have been slightly different…as well as a lot of end-users that were a lot more savvy and knowledgeable and had a lot more ideas around workflows…. We were very accustomed to, if we needed x, we

asked…and they built it.... In a large, vendor model, they have what they have, and we can figure out to make it work for our organization…. It was definitely a different model—we have to figure out how to adapt these distinct tools or adapt our workflows to the tools…rather than asking someone to change the tool…or add to the tool to make it do what we want to do. And so, organizationally, that was definitely a change that admittedly...we are still in some ways adapting to." (Public health system)

Migration of Legacy Data

Data migration is unique to EHR-to-EHR transitions and is a major undertaking. Key issues are detailed in Table 6. There were many different approaches mentioned, with regard to the types of data elements, how far in the past to go for historical data, methods for migration, and timing of the migration. For one organization within a larger system, a central decision had been made not to migrate any data, but after discussing various options, it was decided that some data would be migrated:

"Initially, we were informed that we were not going to have anything migrated over…. We had to work toward trying to figure how we could…stand… [the new EHR system] up and make it functional for the providers, the end-users. And that resulted in exploring. Okay, could we do a CCD [Continuity of Care] document? Could we do manual extraction…? [Having nothing migrated] …would be one more barrier that a provider or an end-user would have to be dealing with at the time of go-live…. If somebody's taking an hour to see the patients because they have to put the

Issue	Detail
Selection of Data for Migration	• Driven by patient care concerns, not records or research • Seek input from representative clinical users • Wide variation in types and amounts of data chosen • Priority for data most likely to be needed and used • Preference for structured data • Problems, allergies, medications, immunizations, and related data elements highest priority • Migrate key notes, e.g., operative reports, discharge summaries • Migrate imaging and pathology reports but not original images • Images themselves left in legacy systems or scanned • Some sites did not migrate any old data
Problem List Challenges	• Problem lists become large and outdated • One approach: do not move, users rebuild from active diagnoses • Opposite approach: place all historical diagnoses into problem lists, clinicians must remove inactive diagnoses
Age of Data to Migrate	• Great variation in what data considered too old to migrate • Priority for more recent data and active patients • Priority for data that can be migrated and will be needed • Different ages for different data elements, even within one site • Approximate range of one to five years • Older data not migrated, keep in legacy systems or data warehouse
Data Migration Approach	• Great variation in approach and timing • Automated database extraction • Abstraction via Continuity of Care Documents (CCDs) • Structured, coded data moved easily • Previously transmitted or shared data, such as from electronic prescribing, laboratory reports, and patients seen in multiple facilities, may be more available and accurate • Manual entry necessary if automated methods unavailable • Hybrid approach: data import, CCD abstraction, manual entry • Scanning for notes and images
Data Cleanup and Validation	• Automated and manual processes • May be easier to move too much data and clean up later • Manually check chart before encounter or ask patient to confirm • May be source of frustration long after go-live
Data Migration Challenges	• Complex, costly, and time-consuming • Disagreements about what and how much to migrate • EHR systems may have different, non-matching data elements • Need for easy access vs. difficulty of accessing legacy system • Old data rarely needed or accessed • Procedures and orders particularly challenging • Free-text: map to discrete data or as text, or do not migrate? • Some EHRs do not support data migration • Difficulty finding data

Table 6. Data migration issues.

> demographic information in, that doesn't make much sense. If we can…get that set up as much as possible and get that provider or end-user back up to their normal productivity as soon as possible, that has a whole host of downstream effects with revenue cycle, with patient satisfaction, and with maintaining our mission…." (Outlying community and critical access hospitals and practices in academic health system)

Selection of data for migration. When migrations were performed, the primary drivers and approaches varied widely, even within the same organization. Migration decisions were driven primarily entirely by operational and patient care concerns rather than medical records or research:

> "Our focus of data conversion…was solely for clinical purposes. It wasn't for medical records, it wasn't for medicolegal, it wasn't for billing. It was truly just for clinical operational purposes…. [Medicolegal and research needs] weren't our focus in terms of our data migration." (Public health system)

All interviewees emphasized the importance of seeking clinician input from different disciplines, specialties, and groups for different areas of the data migration:

> "…we actually went piece by piece with some of our physician leaders…, saying, 'Do you want us to move problems? Do you want us to move allergies, or do you think we should do some manual abstraction?' …. Because they said… 'Within the last year and a half, most of the things...that I need right this minute, for this visit, are in there'.... So, we created this transformation leadership committee...that had representation from all of the medical groups.... And then they all were involved….

> And more than just one…from each group, to talk about this…. 'What data do you really want? Do you really want us to move this or that?'" (Multi-state health system)

> "We polled…all of our providers and clinicians…on what information they wanted and for what duration, and we definitely talked department by department. I had…dozens of meetings with various…clinical representatives to…weigh in that, and got…the whole spectrum of, 'We need everything' to 'We want nothing' …. And ultimately pulled clinical leadership and IT leadership together to…make the final decision based on the feedback of those groups." (Public health system)

There was much variation in the types of data chosen for conversion. Some systems migrated as much as possible:

> "…we're basically trying to bring all the pieces of data over…because there's two EMRs that we're trying to consolidate into one." (Academic health system)

Typically, certain data elements were not migrated because of a low likelihood that the information would be necessary or used:

> "And for the second hospital, we didn't convert anything over…. We shared a lot of patients because the hospital systems where they were getting labs done were already integrated, so there were labs available…but we didn't convert old stuff over…. We didn't do any historical loads whatsoever…. once they got in, the data that was in the record already was…, if they're an active patient, we have information on them. We have…recent labs and radiology and stuff that comes across, but not their entire

record, historically…. How many pieces of data do you need from an inpatient stay…? What are you going to do with that? Nothing. There's nothing you're going to do with that. No one looks at that. They look at a discharge summary and a procedure report and the labs." (Local community health system)

"We basically said, we're not taking hospital vitals. We're not going to take that data over. The data still exists, if someone wants to access it and do some research on it. It'll be in the data warehouse. But it's not going to come over into the… [new EHR system]. The file is all the vital signs from a prior hospital stay…. nobody looks at that now, even though it's in there." (Academic health system)

"The old stuff was not moved over. It stayed in the old system, kind of like we do here…. We have the old stuff in [the document imaging system], and the new stuff in… [the new system]." (Metropolitan health system, free clinic)

A common theme was that it was necessary but challenging to balance the areas of greatest priority:

"Challenges included…what to bring. Do you want to bring every single visit note over, or how are you going to bring it? In what format can the new EHR ingest it? You don't necessarily want to move every single piece of data, because it might not be pertinent." (Multi-state health system)

Respondents cited key data elements, such as problems allergies, medications, and immunizations ("PAMI")(12) as well as demographic information and clinical notes as top priorities for migration.

> "We needed to move…problems, allergies, meds, immunizations, and then notes…. any patient had a record in the new… [EHR] system…their address, their phone number, all that." (Multi-state health system)

> "We did spend a lot of time with pharmacy doing height, weight, allergy, and med back-loading, and order back-loading…. everything related to medications." (Metropolitan health system)

> "The main data elements we moved over were past medical history, past surgical history, confirming the medications, allergies (confirm them), social history…and family history." (Outlying community and critical access hospitals and practices in academic health system)

> "With our transition..., the big priority…was getting discrete data about vaccines…. My concern with going from… [the legacy system] to… [the new system] was ensuring that those vaccine records moved seamlessly, because it is quite time-consuming." (Medical group in multi-state health system)

Key documents such as clinical notes, operative reports, discharge summaries, imaging reports, and pathology reports were migrated. Images themselves were often left in

legacy systems only, such as for radiographs, or scanned in, such as in the case of electrocardiographs:

> "[The new EHR system will] … give the report…. they don't see the image. So, they can see you had a chest x-ray, and they can click on it and open it and it says… 'evidence of infiltration, lower lobe,'…but you can't see the image. If you want to see the image, you'd have to log into… [the old system]." (Multi-state health system)

Non-EHR sources of information could be used to improve accuracy. For example, allergy information from Surescripts, used for electronic prescribing, could be more accurate and current than the allergy list in the EHR system:

> "We had a lot of difficulty, believe it or not, moving allergies. We tried to, but…sometimes, they're not codified. People…write in things like… 'has allergy to this [medication],' and how do you move that…. We did download from Surescripts, so we could get the most recent [information]." (Multi-state health system)

Problem list challenges. Problem lists are important in patient care but often become large and contain inactive diagnoses. Respondents described two contrasting approaches for handling problem lists. The first was to not migrate problem lists at all and require clinicians to add active and relevant diagnoses to the problem list.

> "We ended up…not bringing over problem lists, bringing over only very limited medication and allergy lists. We looked at our legacy data and…most of our problem lists…were relatively unmanageable. We had many, many patients with over 100 problems…, medication lists that were years and years out of date…. we ultimately decided to not bring over problems or medication lists into, into active problems and

> medications…. We brought them over in a static PDF for clinical review…. it was in some ways, almost the opposite of the previous discussion of bringing over a lot of legacy data.…we have been having ongoing struggles with the accuracy of that data to the point where most people were not trusting it anyway. So, we made sort of what ultimately was a very difficult decision to, to present this statically but not bring it in dynamically…in an actionable way." (Public health system)

The opposite approach for problem lists was to place all diagnoses into the problem list and require clinicians to remove inactive diagnoses from the problem list:

> "…in our prior EMR, many of the physicians were not …using the problem list and medications, social history, quite as consistently as they should have. They were using prior diagnoses instead of having a true problem list. So, a decision was made to bring over every billable diagnosis and place it in our problem list. The benefit of that was that it helped cover those physicians that did not use our prior EMR consistently or correctly.… The disadvantage is, on every patient that we see for the first time in the new system, we have to delete quite a few diagnoses from the problem list…. I think the biggest difficulty going forward is with the decision to include all diagnoses, having to go through and clean up those diagnoses. So that's a continued process and problem." (Medical group in multi-state health system)

Age of data to migrate. There was much variation regarding the age in at which legacy data were considered too old to be worth migrating to the new system as opposed to being accessible via historical views or legacy systems only. Although some organizations had data for patients going back decades, they only migrated some data,

prioritizing more recent information for active patients. The reported range of data migrated was one to five years. Factors to consider include whether affected patients were still active, the ease of matching data elements in different systems, billing implications, and the likelihood that the information would ever be needed:

> "…we had…come up with our own best practices around how far back were we going to move data. Do you bring a patient who hasn't been seen in six years...if you don't know if they're going to be seen…? From a billing perspective, a patient is considered new if they have not been seen within three years…so can you bill a new patient…. We'd start moving data from three years…. And then notes, up to 18 months. Just based on talking to our physicians…. 'Within the last year and a half, most of the things…that I need right this minute, for this visit, are in there'…. because it was so much data. We had to do it based on appointment…. So, the first ones [patients] that would be moved were the ones that had appointments…the first week after go-live." (Multi-state health system)

> "…we have a lot of years of legacy data…. Ultimately, [we decided] …to only bring in a certain number of years of data back…. We did pull a lot of clinical data over the past five years into our new system to try to reduce the need…to go in our legacy systems…. Our goal was to migrate over enough legacy data that they would have very little need to go into the old systems or find old data elsewhere, outside of… [the active EHR system], to do clinical work." (Public health system)

The age of records to migrate was not uniform for different data elements, even within a single organization:

> "…it was not a universal five years…. Five years was…a somewhat arbitrary number. There [are]…minimal good studies in terms of what is the right amount of data. There is some limited kind of use data that says that clinical data over…a year old is only looked at x percent of the time. And as it gets older and older, it's looked at less and less. And so, we kind of used some of that data to say, we…want 3-5 years of clinical data…, with the knowledge that even five years is probably…too much, and that notes from four years ago are probably not that relevant, but…might be…. we kind of settled…. There were some things that we opted to bring back even further. Admission and discharge summaries, we brought back for as long back as we had in the system. We brought back colonoscopies and endoscopy procedures. We brought back cardiology caths [catheterizations] and pathology results for as far back as we had in the system. But…everything else that wasn't kind of specifically called out, we did about five years." (Public health system)

If these data were needed, then they could be accessed by request or through legacy systems.

Data migration approach. There was great variation in the timing and method for data migration and validation. Some respondents reported extensive data migrations and abstractions, such as via Continuity of Care Documents (CCDs), of many years of patient data into new EHR system that were performed far in advance of go-live:

> "You can run what's called a CCD document, which basically gleans pertinent information from the legacy system that's in a structured data field, puts it in a, for a lack of a better way of framing it…a disk, and that disk can then be imported into the

new system and uploaded. All that patient's basic demographic information comes across." (Outlying community and critical access hospitals and practices in academic health system)

Coded information was easier to move. Activating interfaces for incoming data on active patients can populate the newer system even before the formal migration of historical data:

"If you're able to turn interfaces on for lab, radiology, pathology, transcription, that you can actually get while you're building out the project and getting ready for go-live. If you have about a year of information of active patients that comes over, you do better than pulling all the historical data in." (Academic health system)

Although they had intended to perform automated data extractions, some organizations reported that their legacy EHR systems did not support database abstraction and that staff entered and checked essential patient information into the new EHR systems manually. This manual entry and validation occurred as late as the day before the next patient encounter following go-live or even during a patient encounter:

"For ambulatory visits, there were diagnoses…that were entered into the system…They were manually moved from…other systems, and as part of coder review. Ultimately, that was determined to be what was billed. But that was never in a system that our clinicians could see." (Public health system)

"So, the night before a conversion, we would have a huge team…going to every floor and going through every patient and converting all their orders…. They would

move… [the orders] into [the new EHR system] …. We were doing a lot of report running and uploading … [diagnoses]. But the actual patient data…was manually uploaded…. have two computers sitting side-by-side, and take information from the one and put it into the new system…. Nobody wanted to do [manual entry]. Everybody…initially thought that it would be able to be…ported over somehow. But it just didn't work…. [The new EHR] has its own language, [the existing EHR] …has its own language…. They couldn't make the fields match up." (Metropolitan health system)

Incentives encouraged health professionals to help with the manual data entry until information for most patients was in the new system:

"We offered them, to come in after-hours, overtime to do it on their own time, and people were willing…because they wanted the extra time, and that process has not stopped, because we stood up enough charts for the first month.... the second month, you still have new patients coming into the new system that were in that old system. So, you still have to keep on doing that process for a series of months until…. 80% of the patients that you've seen are already in the new system, and then the 20% that aren't, you now have the time to put the one-offs if they do come in to see you." (Outlying community and critical access hospitals and practices in academic health system)

Some organizations used a hybrid approach, combining automated and manual methods:

"What we chose to do is…a combination of both. For the legacy EMR systems that could get a CCD document produced, we were able to import that data, and then we augmented that data with somebody manually importing even more data…. for the

first visit, it's not a 'virgin' visit…. There's a basic past medical, past surgical history, a social history, medications, allergies..…. The other legacy systems really pretty much went in cold…. When the docs came in the morning…, they had to look on the old system for the all the stuff [before]…the cutover…. they had to either enter it manually or refer back to the legacy system…. The only thing that CCDs pulled over…was minimal data. It pulled over the problem list.... It did move medications over, and it moved allergies over, and that was pretty much about it. The rest was all manual extraction." (Outlying community and critical access hospitals and practices in academic health system)

For procedures and orders, there was a need to convert from free text to discrete data to enable decision support functionality:

"Especially the medications and the medication formularies…, things were really important to be correct…. with allergies is that we had two situations: where they're coded and…they didn't code them correctly…. It was really important to get into the [new EHR] system that the allergies got coded correctly…. We actually had clinical people making sure those allergies were entered correctly…. Originally, in [order entry], they were free text. And so, we needed them to be discrete. Because if they're free text, then they can't utilize the interaction checking." (Metropolitan health system)

For some sites, scanning was used to transfer notes and images such as electrocardiograms (EKGs):

> "Where you get into trouble is, things like EKGs. We didn't have a good way to move EKGs. So, they had to…either just move the report or actually print and then scan it back into… [the new EHR system]." (Multi-state health system)

> "The images were scanned into the next [system]…. But the clinical notes were scanned over so you can review them…. The way that [the legacy EHR system] worked, it created a PDF at the end of every visit, and those PDFs were integrated into… [the new EHR system]. So, you can see, the majority of the time, a PDF from the prior EHR." (Medical group in multi-state health system)

Data cleanup and validation. An important step was resolving data issues and confirming that data were migrated accurately. Cleanup and validation occurred through manual and automated processes:

> "I think that the right decision was made…. There may be too much data, but at least it's data that can be deleted, versus having to do more data entry." (Medical group in multi-state health system)

> "So, the process was that someone in the office was supposed to look the day before, look…do kind of a chart prep, right? Check and see, was the data there? And they're supposed to review it. You're not just supposed to accept that what we migrated technologically, it's correct. You're supposed to…, when you see the patient, recheck it. Say, 'Do you really have an allergy to penicillin?' Or did somehow this get coded wrong? Then you had to confirm each thing." (Multi-state health system)

Data validity may continue to be a serious concern long after implementation of the new system:

> "…there was a three-week period…before we went live where the data did not migrate…. in those patients, we have to still, on a regular basis, enter our old electronic health record to ensure that the data has been brought over…. one of the concerns we had and continue to have, anytime we see a new patient or a patient that's new to our current EHR is, did all the data come across? And so, all of our clinical staff and our front office continue to have both electronic health records open on a daily basis…. It is a manual process…. every day, even today, I look at my next day's schedule and ensure that what I want in there is in there. And I get ready for the next day…by ensuring that everything is abstracted appropriately." (Medical group in multi-state health system)

Data migration challenges. All respondents expressed that their data migrations were challenging. These difficulties spanned the entire migration process, including discussion, decision making, implementation, accessing the information in the new system, and overall expectations. Clinical users expressed widely varying opinions on the optimal data elements and duration of data to migrate. Many clinicians wanted old data to be maintained in the new system, although data older than 1-2 years or beyond the most recent patient encounters are rarely accessed. It was necessary to reconcile these differences and balance the immediate and operational needs for efficiency versus the time and effort needed for soliciting clinical input and achieving buy-in and consensus, pre-populating patient records in the new EHR for continuity, and reducing the need to

manually re-enter data or access legacy systems. Because of differences between EHR systems, there may not be clarity on how to migrate the data and where to store it in the new system.

One leader of a health system that performed an extensive data migration stated that the effort was so difficult and costly that it may have not been worth it, given prior successful transitions without significant data migrations. Although it is reassuring to have access to as much as possible, it is unlikely that anyone will ever need the old data:

> "So personally, I would say, migrate nothing, and use historical views…if you need to.… we didn't want to lose anything. So, we did a lot of work…. you had to set up the data structures.... You have the data, where is it going to go…? Does it even exist? And what piece of that data stream makes the most sense…? And that project turns into…its own project. Potential frustration because you really can't move everything over…. And sometimes it's cleaner and easier on the cognitive load of the doc to say, 'This is historical, look here….' And after about 6 months of being in the current system and once everybody's over, no one's looking back…. Because the way the electronic record works is, all stuff is updated as you go. You shouldn't have to historically look back. If you update the problems…it should update the meds…. It's not like you lost anything. You've just got to look at it in a different way." (Academic health system)

Leaders may encourage discussions and accept consensus decisions despite disagreeing with final outcomes. While these decisions may result in more difficulty without yielding

noticeable long-term benefit, it may be more important to conserve political capital for future challenges:

> "There's only so many things that you could go to battle for in a project this large. And if someone wants to put the money and the effort to actually move everything, even though…at the end of moving everything is just, 'I feel good that I moved everything,' …because they don't want to have to worry if someone's saying, 'I didn't get a piece of data,' then fine. Don't fight that battle anymore…. There… [are] too many other ones…. people in general…wouldn't know any different…. it could have been as easy as putting everything in historical results, and they would have been fine. So, we had to go through this…long and drawn-out process…. We did the next [transition], but there isn't anything other than the patients that are shared in the system, and it worked just as well also. No one, literally knew anything different." (Academic health system)

Differences in EHR architectures and data formats caused difficulties with data migrations. Procedures and orders, such as surgical procedures, medications, and diagnostic tests, were cited as areas of great difficulty. Although data standards for diagnostic tests helped migrations, differences in user interfaces and order catalogs made them challenging:

> "Labs and radiology…reports..., regardless of what system, it's a little bit easier…. Might not be in the format that you are used to, but at least you could get it in and put it in the right folder. But the system and the whole and the way the data structure is,

it's different from [the old EHR system].…I would say, it's harder." (Local community health system and academic health system)

"If they're not using a controlled terminology, you can't really bring in problems that are free-texted in unless someone is going to manually evaluate them. We ran into issues, for example, where one of the systems was using SNOMED codes for procedures and the other system was using CPT codes. So, it would have been a whole process to try and map those and…the free text." (Multi-state health system)

"…on some of the more complicated units with complicated patients, it was very labor-intensive to make sure you made the right selections in the order catalogs. Order catalogs are…a little bit different from hospital to hospital. So, you needed to make sure that you were ordering the correct things for that hospital. For formularies…, they weren't all the same…. there were some differences from hospital to hospital. So, pharmacy teams were working on…medication entry. It was just a lot of information. When I think about it now, I think, 'Wow, how did we do that?'" (Metropolitan health system)

"You see [data mismatches] …in lab. Because the instruments are calculated differently, so they're going to result out in millimoles versus osmoles…. There's a crosswalk of…what each legacy system has and then making sure that it's somehow rectified prior to going live. It's a daunting task...that has to do with legacy names such as your nomenclature and library in your radiology order set, how things are

ordered in the legacy system versus how they're ordered in the new system. You have to crosswalk that to say, 'Well this is how we did it, this is how we ordered it before. This is how you will order it in the future.' It's similar…yet different." (Outlying community and critical access hospitals and practices in academic health system)

Free-text data presented special challenges. Strategies for managing free text included not migrating free text, migrating high-priority text only, or performing extensive conversion to discrete data:

"A lot of these smaller systems allow people to free-text things in. You can't really write programs to necessarily match the free text…. The data just doesn't move, because there's so much free text." (Multi-state health system)

"The discrete data that we chose not to move over was social history and some family history because…in our prior EHR, those were more free-text fields. So, the only social history that we had moved over was smoking history, and then family history. It's variable on how the on end-user inputted them in the prior EMR as to whether they would come across as discrete data." (Medical group in multi-state health system)

Inability to access migrated information may be an ongoing challenged after go-live of the new system:

"…there's still frustration, of providers, of not everything coming over." (Medical group within multi-state health system)

"However, the process of uploading the old records into… [the new system] was not what was promised to us. We thought we would have a much more organized approach. And…our scanned records here at… [the clinic] are so much garbage in them, that there's a lot of garbage to look through…. when we put things into… [the legacy document imaging system], they were able to be placed into a category, like a progress note, an H&P [history and physical], a consult, or a lab result…. When we uploaded that information...to [the new system], it came in as blobs. We could have taken the time….it was extremely labor-intensive to put things into the right categories historically. And it did not flow easily…. So, there's a lot of that information that's in [the document imaging system] that would never even be of any value in court to substantiate anything because you can't read it." (Free clinic)

Access to Legacy Systems

All sites ran old and new EHR systems concurrently during a transition period to allow time to complete charting, process test results, and resolve accounting in the old system:

"There's no standard.... How old do you leave the other one active? …. you need to leave it up, because first of all, results, you turn a switch, and all of a sudden…all the interfaces are coming to the new place. But what about the labs that you ordered the day before…that just came in…? We told them to finish all their notes…within one week…. But then, by three weeks…we turned it to read-only…. They still have

access, even now…. You have to leave things open for billing reasons…to get your claims out of the old system." (Multi-state health system)

"…the systems themselves stay open and live to run down your [accounts receivable], because that's usually your billing system. So, when we convert over…for [two smaller hospitals], their… [EHR] system's going to stay up…until their [accounts receivable] run down….it might be…a year, because they close out the books…and we can actually shut it down." (Academic health system)

All respondents reported that users would eventually have read-only access to old systems to view old data, either for a limited time or indefinitely:

"And we just turned off… [the old EHR], but they still had to have it in the background for retrieval of records…. You could go look at the stuff in the… [old EHR] system, but…we didn't convert it over, we didn't pull it in." (Metropolitan health system)

"So, we still use… [the document imaging system] as a way to look back at what happened with our old patients. It's less and less now. We're coming up on a year since our conversion…but we still have everything available on our old… [document imaging system's] server." (Free clinic)

"…we continued to use… [our homegrown system] for our research data extracts…. we'll continue to have access to the legacy data for medicolegal extracts." (Public health system)

"If they need more stuff, they could go into the other application and then we can move it either through a manual process, meaning they could either…try and send it, print it out, [or] scan the last visit note." (Multi-state health system)

"They log on, and it's view-only access.... That is a document that's in stone…. they can't change it. They can't add or delete. They can look at it. They can look back on all the notes, all the labs…. We will still have those records, and if need it, someone will be able to pull it. The access that everybody has for view, or to see now, is scheduled to last approximately a year." (Outlying community and critical access hospitals and practices in academic health system)

"When we went from the first… [hospital] conversion…, within three months, no one looked in the clinical portal…. [For the second hospital with a different EHR], it was 6-8 weeks that…maybe a billing person had to go somewhere in there, but not really clinical. Because your data is…current, right? If you update the record…, they had cancer..., you put it in there, and you have it. What other piece of information do you need? If you need to access that path report that they had cancer, adenocarcinoma 18 years ago, it's still there. You just access it historically instead of in the current portal…. We actually turned off the access [for the first hospital] .... we left it open…two years. And [access for the second EHR] was…a year." (Local community health system)

Historical information can be requested through the enterprise data warehouse (EDW) and not necessarily through the active EHR system. In some cases, the break in continuity can affect research studies, and researchers needed to factor the migration into their planning:

> "Our research extract groups have definitely had their work cut out for them in terms of trying to continue studies that predated our changeover into the new system for continuity. Our researchers were well aware of this, and…a lot of them ended up ending studies just before we went live or held up starting them until after." (Public health system)

Overall Challenges in EHR Transitions

Participants reported that EHR transitions were costly and challenging, especially for early-phase organizations and sites:

> "When you move someone…you invest a lot, as far as work, as far as…financial, as far as teaching people…. when you move someone…you invest a lot. As far as work, as far as…financial, as far as teaching people…. we don't make the decision lightly. No one does." (Multi-state health system)

Lack of guidelines and expertise. Given the lack of standard guidelines and experience, organizations did not have internal expertise:

> "…one of the disadvantages of our region was that we…were the first phase of going live with the transition. So, we did not have a lot of internal experts with the

electronic health record. And so, that was a stumbling block for the first wave." (Medical group within multi-state health system)

Resistance to change. Individuals become used to the old EHR system and may strongly resist changing to the new system:

"…our joke is always, 'The best EHR that you ever used is the last system you used.' As much as people hate using their current EHR, they'll talk about how bad it is. When you put them on a new system, they'll still become accustomed to it.... So, it's anything new, it's hard, so a lot of it this change management, and…once they move across, they'll become productive. But there's still that period of time…." (Multi-state health system)

There may be adjustments if users do not have prior experience with enterprise systems:

"And then I've also heard for some people, this is their first time being on a system-wide EMR. And so, they are not enjoying the fact that other providers are in their patient's chart and can update and make adjustments in that." (Medical group in multi-state health system)

Workflow differences. Leaders reported workflow difficulties with transitions, especially between mergers and acquisitions due to different processes between facilities and EHR systems. For example, uniform access privileges based on user roles may vary by facility and result in the inability to perform key patient care tasks:

"The Achilles heel of these changes…is assessment of workflows: cross-walking workflows, and access, access, access, access. The vast majority of issues…, those

first few days of go-live were access issues…. If we would have been able to spend more time getting ahead of that before we went to the go-live, that really would have been mitigated…. The access directly ties to the workflows. If you don't identify those workflows and what those people need, how are you going to know what access they need...?" (Outlying community and critical access hospitals and practices in academic health system)

One local health system that joined a larger system had different workflows and user roles from those of the parent organization:

"In the… [larger system], they have an infusion center. Here we don't. Our infusion center is our same-day surgery, outpatient surgery area…. all the processes and workflows…had to be modified to allow one group of nurses and one group of people to do two or three different functions…. that has to do with…giving them access to be able to do more than just what their main task is…. Our ambulatory surgery nurses… [were given] access for an ambulatory outpatient surgery nurse. They didn't have access as an infusion nurse…. It's really appreciating the workflows..., what the employees' duties are…, the access they need…. Nobody looked at the workflows…. And that's just one example. There [were]…many instances...where…, 'We didn't know you did that.' 'Well, yeah, I do that on a daily basis. Nobody asked me.'" (Outlying community and critical access hospitals and practices in academic health system)

Some departments and groups have highly specialized workflows and systems which do not integrate well into enterprise system. Adding appropriate modules or content can ease

the transition, but it may be necessary to continue using niche systems, workarounds, or paper until a suitable solution is found that works well in the new system:

> "…when we did the conversion of the NICUs [neonatal intensive care units], they ran them at the same time for a while. Because they were collecting certain data out of their old system, they did run those two together. But for the most part, when we converted, we went, we converted. No more of the old system." (Metropolitan health system)

> "If there's…a niche module that we want for a provider that is happy to the content that they have, we can do that." (Multi-state health system)

> "Gynecology-oncology and oncology do not use our current EMR. They use a [separate vendor]-based product. Cardiology interfaces, with the testing that they do, stress testing, echocardiography…, continue to be a difficult interface, and the current workflow for them is to print the information and then have it uploaded into [the EHR system] …. Pulmonary spirometry and pulmonary function testing is…a difficult interface, and…that workflow is on paper and scanned in. Neurology, the EMGs [electromyographies]…do not have a great interface, so there are three different workflows…. Wound care is done in some clinics, and finding workflows and efficiencies… has been difficult…. the procedures on the outpatient setting are just difficult and cumbersome. They're not easily personalized and so, the best way to address those is through adding another layer using dictation and a voice recognition software with macros, because the standard just point-and-click type or a

pre-completed procedure note is just not acceptable in those situations….” (Medical group in multi-state health system)

Interoperability is challenging. The ability to share and exchange data was a major driver of EHR transitions. Although the new systems have improved interoperability, organizations face challenges and may not achieve desired levels of interoperability:

> “The one thing that I recognized early on which we’re still working on is interoperability…. we could get all this information out of the documentation in an EHR, but you couldn’t get it and use it anywhere…. Unlike a bank…because it’s all numbers, you can have that interoperability, whereas in healthcare, interoperability is so difficult. If someone comes here…and I send records somewhere, those records cannot be uploaded in any way to another system very easily.” (Free clinic)

> “…we had a lot of problems sharing data. We would be faxing things, but…that’s not really sharing data, and then they would have to print it and scan it back into the record…. So, it’s improved a lot…by using one system. There’s still challenges…. What we’ve been doing, is trying to get different vendors...to sit down together and try and really look at how we can get better integration between the two [systems]…. You need integration so that stuff’s just flowing, but it’s really difficult…. I don’t know that it’s been moving as quickly as it should.” (Multi-state health system)

EHR-to-EHR versus Paper-to-EHR: Which is More Difficult?

Respondents reported that transitions from EHRs are more difficult than transitions from paper records. Interfaces between EHR systems are different, and users become accustomed to using their specific EHR:

> "It might almost seem…easier to move someone who's already using an EHR onto a new EHR, versus someone who's on paper, to move them onto an EHR. But I've actually found, and I've talked to some other of my physician leaders, and they agree that it's harder. It's more of a challenge to take people from one EHR to another…than from paper to an EHR…because people become very accustomed to their EHR. They build up…muscle memory, they're used to clicking a certain place…. Their brain has become accustomed to it…. These user interfaces are not exactly the same…. It's almost more of a challenge to teach people who are coming off of one EHR who've been comfortable with it a new EHR as opposed to someone on paper." (Multi-state health system)

There has been more tolerance for transitions from paper to EHR, in which the EHR systems were seen as new, necessary, and highly beneficial. Organizations and individuals have invested much time and effort in their EHR systems, including the development of specialized workarounds. There are higher expectations with EHR-to-EHR transitions:

> "Paper-to-EHR is probably much easier. EHR-to-EHR…, you feel like you did it once already, and you really don't want to change now…. paper-to-EHR, the writing is on the wall…. we're the last bastion of organizations now to electronic…. EHR-to-

EHR's a little more difficult…. They remember certain things that were good and that thing that they hated beforehand, and now the new one, it's different. And workflows and everything change…. And then when you change, you almost have to break bad habits…. It's like I got from one car to the other car. And if we put you in one car, and we put you in another car, they both drive. But if all the controls on the one car were completely moved around, you wouldn't even know how to turn it on…. Paper, you know exactly how to do paper…. And the first time to the electronic record, you're building a mental map of what to do, and breaking that mental map is very hard…. all the stuff on the screen is changed all over the place, or functions differently…. EHR-to-EHR is harder." (Academic health system)

"Even as much as people dislike the current EHR they're using, they figured out workarounds…, things to make it more functional for them, and they're also usually invested in the EHR, as much as they don't like it. But as soon as they got on the new one, there's…that trough of disillusionment…. That exactly what you'd expect, and it's just that change…. If you're on paper, you don't have anything to really compare it to. I think the people that were on paper…knew that they needed to get an EHR, so it just was a little easier, I think, than moving from EHR to EHR." (Multi-state health system)

Outcomes

With good change management with an emphasis on shared benefits, users eventually accept and even embrace the new system:

> "[What won them over] …ended up being things that were beneficial for them and everybody else…, [helping them with] realizing that 'You might have a very good product for yourself...but you don't get any other records. So, you don't benefit from a shared clinical record.' Once they saw that, 'I can get information from the outpatient visit or the OR [operating room],' or 'I can actually pull information from other organizations….' That benefit greatly outweighed the 'I don't want to change functionality,' and 'I want it my own way.' That they were more…, 'I'm going to get all these other benefits' …. As soon as they switch over, though, [they] …realize that, 'I really liked the way the other thing did this, but I understand and I get all these other things…. I hate the way it does it now' …, but that's like with any software…. there's so much benefit of everybody being on the same record…. You share meds, you share allergies, you share labs. Everything comes across for you." (Academic health system)

> "[The physicians] …don't like…the actual electronic documentation, but they've adjusted to it. [The medical director] likes it. No, really. I have …cardiac fellows here once a month…. They've not used [the new EHR system], ever, and…almost every one of them has said, 'Wow, is this easy to use compared to what we have at [the hospital].'" (Free clinic)

Fortunately, productivity and satisfaction returned to or even exceeded baseline levels, often within a few months, although challenges may persist after go-live. Expected time to return may need to be adjusted for different settings and situations:

"[Our large community hospital] …, it was probably six to eight weeks globally to get back. [The smaller community hospital] …was probably back in about four weeks…. And the goal for [the teaching hospital] and [a larger community hospital] is going to be trying to get back to baseline within the first couple months…. It'll be a little different scale and complexity. But the goal for all of them is, get back to where you were as quickly as possible." (Academic health system)

"They were able to take our note formats and bring them in pretty seamlessly into our new system…. They're obviously from the old system, but they show up in the same way…the same note labels, same note categories, same service types, that a newly generated note would have. Which really makes the data conversion good…from a clinical standpoint, because our providers are able to easily find that data…. I continue to be very amazed and impressed by our data conversion process as well as because it has been…one of our huge successes in our go-live in providing all the data for our providers. In almost every case, we're able to say, 'Just look exactly where you look for the new data,' and the old data's there too. We're above and beyond [prior metrics] now. We hit that number…weeks after we went live." (Public health system)

"I hear from a lot of providers that there is concern about not being as efficient…. they can enter the data quicker than they can in the prior EMR, but they cannot find the information that they've inputted as quickly…. they see the advantages in the patient room…., but they see the disadvantages when they're looking at labs and x-

rays and patient phone calls.... when they're outside of the patient exam room…. Our current satisfaction [percentages] for physicians is in the 80s, and employees, is in the 60s…. [Referral loop and charge entry] metrics have been improving for us. Our patient satisfaction scores…took a dive during the go-live, but have subsequently returned to baseline or have improved…. lack of access is what caused the biggest dive. The lack of efficiency…. being unable to see patients as quickly. And so that postponed, that pushed off...access opportunities for the patients." (Medical group in multi-state health system)

Discussion

This study characterized key themes as identified by informatics experts leading multiple EHR-to-EHR transitions. There have been limited studies on EHR transitions, and many of these have focused on single organizations or settings. To my knowledge, this is the first in-depth qualitative study to explore perspectives of multiple clinical informatics leaders representing diverse organizations, settings, and EHR systems. This study confirms prior work on EHR transitions. EHR transitions are challenging, and need appropriate planning, expectations, training, and support. Given the lack of standard guidelines, much information comes from vendors and colleagues and may not be published in the scientific literature. There are many similarities between paper-to-EHR and EHR-to-EHR transitions, with a few differences. The respondents in this study all agreed that EHR-to-EHR transitions are more challenging as user expectations are different in an initial EHR adoption, and users are accustomed and loyal to old EHR systems.

Consolidation of health systems and improving functionality, interoperability, efficiency, and usability were primary reasons for EHR transitions rather than the regulatory compliance that drove initial adoption. Some adoption to meet regulatory requirements and incentives is still occurring given the changing regulatory landscape. It is much more efficient to have one or two unified systems than to support and train for locally developed or several EHR systems and manage multiple interfaces between systems. An important priority was easy access to patient information across the entire organization. Quality measures, such as consistency of experiences and practices for both health

professionals and patients as important reasons for transitions. As there is no perfect system, all systems involve compromises between conflicting stakeholder needs.

The consensus is that for large health systems, transitions need to occur sequentially in different sites based on size, readiness, problems with existing systems, available support, and other business needs. However, within a given site, the big-bang approach is preferred. Projects should be driven by clinical rather than IT priorities, and it is important to evaluate clinical workflows before go-live. Processes and workflows should be standardized whenever possible, but some local customization is ideal to accommodate different workflows between facilities.

Data migration is one of the most challenging aspects of EHR transitions. It is desirable to maintain continuity of the patient record, provide access to essential information, and avoid re-entering information unnecessarily. However, legacy information may be erroneous, entered in the incorrect location or format, or outdated. The data migration provides an opportunity to review the information and migrate what is most reliable and useful. While information is ideally migrated in advance, due to resource constraints or technical limitations, some manual re-entry and validation may be necessary. Health systems elected to migrate one to five years of most information and select older elements, determining that older information is only needed rarely. Legacy information should always be retained as appropriate and can be accessed through legacy EHR systems or database queries.

People and organizational issues should be kept in mind, as with any health IT project. EHR transitions in particular are major changes involving many stakeholders and workflows. Clinical and information technology leaders need to be involved. There is always a perceived need for more support and training, especially during go-live and at the point of care. Implementations are iterative, with unexpected results, requiring constant learning and adjustment, before, during, and after go-live.

This study has several limitations. A single individual, the author, coded the interview transcripts, limiting the ability to check for inter-coder reliability. Given the exploratory nature of the study and that participants were located throughout the U.S., data collection involved semi-structured interviews, without the benefit of triangulation using other methods. As the snowball approach was used to identify potential subjects, many participants may be in the same circles of informatics professionals.

The study only involved seven participants, but saturation was reached early in the study, suggesting coverage of the most important themes and concepts. Study participants were all health system and facility leaders and clinical informaticians, not end-users or information technology professionals. Clinical end-users, information technology professionals, and other stakeholders may have different perspectives. As six interviewees were physicians and one was a nurse, there was no representation from other health professionals, such as pharmacists or laboratory professionals. Most informatics professionals were based in major metropolitan areas, although the health systems included facilities located in small towns. Most interviewees led past and current

informatics implementations within large health systems, although one is based at a small, freestanding health facility. While some transitions were in progress or recently completed, some occurred years ago, which may have affected the accuracy of recall.

The purpose of this study was to obtain rich and detailed information from a small and diverse group of participants rather than information from large numbers of individuals. Although this research examines only six healthcare organizations in depth, it includes many years of collective experience in multiple organizations. The EHR transitions and data migrations in diverse organizations vary but share common features and illustrate quintessential challenges inherent in managing change in health informatics. Participants had varied backgrounds, organizations, and types of transitions and EHR systems. Thus, there were multiple variables that may have affected participants' situations, experiences, and perceptions. The consistency of patterns and themes suggests that their experiences and recommendations are broadly applicable to EHR transitions involving diverse organizations, settings, and EHR systems.

Conclusion

As most healthcare organizations have already adopted EHRs, future implementations will involve transitions between EHR systems. EHR transitions will continue to increase, driven by organizational, and regulatory, and functional needs. Recommendations from paper-to-EHR conversions, such as clinical leadership, planning, change management, training, and support, apply equally to conversions from paper and EHR transitions. EHR-to-EHR transitions are more challenging due to a lack of available information as well and workflow, data migration, and legacy system issues. Through experienced leadership, adherence to best practices for paper-to-EHR conversions, and understanding and addressing the unique challenges of EHR transitions, organizations can achieve positive outcomes and rapidly return to and exceed baseline metrics. The findings from this study provide a foundation for developing guidelines and recommendations for EHR-to-EHR transitions.

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Appendix A: Study Information Sheet

Northwestern University IRB ID STU00202767 and OHSU IRB ID STUDY00015969

Title of Research Study: Transitions between Electronic Health Record Systems: Exploratory Study of Expert Opinion

Investigator: Amy Y. Wang, MD

Supported by: This research is supported by Northwestern University.

Purpose: Why am I being asked to take part in this research study?

You have been invited to be in this research study because you are a health informatics expert with experience with transitions between electronic health record systems (EHRs).

Why is this research being done?

(1) The purpose of the research is to learn more about transitions between different electronic health record systems (EHRs). EHRs are computer systems used for recording patient information and taking care of patients in health care organizations, such as hospitals and physician offices.
(2) Health organizations may change from one EHR system to another. These changes are complicated. There is not a lot of information on the best way to carry out these changes.
(3) We want to learn if there are ways to improve changes between different EHR systems in the future.

What should I know about a research study?

Someone will explain this research study to you.
Whether or not you take part is up to you.
You can choose not to take part.
You can agree to take part and later change your mind.
Your decision will not be held against you.
You can ask all the questions you want before you decide.

Who can I talk to?

If you have questions, concerns, or complaints, or think the research has hurt you, talk to the research team at 312-503-3229.

This research has been reviewed and approved by an Institutional Review Board (IRB). You may talk to them at (312) 503-9338 or irb@northwestern.edu if:

Your questions, concerns, or complaints are not being answered by the research team.
You cannot reach the research team.
You want to talk to someone besides the research team.
You have questions about your rights as a research participant.
You want to get information or provide input about this research.

How long will the research last?
We expect that you will be in this research study for up to three months.

How many people will be studied?
We expect that between 4 and 15 people will be in this research study nationally.

Procedures: What happens if I say, "*Yes, I want to be in this research*"?
If you consent to the study, we will collect demographic information and professional credentials and send you written information describing the research and ask you to send us your CV or résumé. We will schedule a time for you to participate in a phone interview with a member of the research team. The interview will last up to 60 minutes. We will ask you about your experiences with transitions between EHR systems.

The interview will be recorded. The research team will transcribe the recording into a document and then write a summary of important points.

Within 1-3 weeks of the interview, we will send you an email with a written summary of the interview. We will request that you indicate if the summary is an accurate representation of what we discussed or that you send us comments and clarifications about what we discussed. When you send us your final approval or comments, then your participation in the study will be complete. We will then mail you your gift card.

When the study is completely finished, which may take up to a year, we will send you the results of the study.

What happens if I do not want to be in this research?
Participation in this research study is voluntary. You can refuse or withdraw participation at any time.

What happens if I say "Yes", but I change my mind later?
You can leave the research at any time. It will not be held against you.

If you decide to leave the research, contact the investigator so that the investigator will no longer contact you.

Choosing not to be in this study or to stop being in this study will not result in any penalty to you or loss of benefit to which you are entitled.

If you stop being in the research, the data already collected may be used in our analysis.

What are the risks of being in this study? Is there any way being in this study could be bad for me?
Although we have made every effort to protect your identity, there is a minimal risk of loss of confidentiality.

Will it cost me anything to participate in this research study?
Taking part in this research study will not lead to any costs to you.

Will being in this study help me in any way?
Although the study will not benefit you directly, you will be contributing your expertise to help other informatics professionals who are involved with EHR transitions. The results of the study and follow-up studies may help you with future EHR transitions.

Confidentiality: What happens to the information collected for the research?
Efforts will be made to limit the use and disclosure of your personal information, including research study data, to people who have a need to review this information. We cannot promise complete secrecy. Organizations that may inspect and copy your information include the IRB and other representatives of this institution.

Any data collected, including contact information, demographic information, professional credentials, notes, recordings, and transcripts, will be stored on secure, password-protected computer systems that are owned and managed by Northwestern University. Only the research team will have access to the data. The data will be kept for at least three years after study completion.

Personally identifiable information, such as names and contact information, will be destroyed when it is no longer needed for the study. Other, non-identifying study information will be retained and may be used for future studies.

Can I be removed from the research without my OK?
The person in charge of the research study or the sponsor can remove you from the research study without your approval. Possible reasons for removal include:

- You cannot schedule or participate in interviews within the study period.
- Investigators are unable to reach you.
- You are unable to provide adequate responses to interview questions.
- You are found not to have the necessary expertise for the study.
- You have not had adequate experience with EHR implementations or transitions as required for the study

Investigators will notify you by phone or email that you are being removed from the study.

What else do I need to know?
If you agree to take part in this research study, we will give you a $10 gift card for your time and effort. If you complete only part of the study, we will give you a $5 gift card. All subjects will be compensated, depending on the level participation. We will mail the cards to you at the end of your participation.

Appendix B: Introductory Questions for Semi-Structured Interviews

Introduction
Thank you for participating in this study to help identify issues and best practices for EHR transitions. There is not much research in these types of transitions, so transitions from paper-to-EHRs are a basis for comparison.

Personal background
Please describe your educational training, informatics background, organization, and current role in your organization (supplements what is in CV or résumé).

Experience with EHR transitions
Please tell me the story about your experiences and roles in prior EHR implementations and transitions, including paper-to-EHR and EHR-to-EHR.

(Prompts only as necessary)

- What were the major reasons and goals of your EHR transitions?
- Please describe major issues, drivers and barriers to EHR transitions.
- What were the key lessons learned?
- What might you have done differently?
    - Phased approach or "big bang?"
    - Run old and new systems concurrently?
        - For how long?
- What are your thoughts about change management in these transitions?
    - Training
- What are differences about changing between instances of the same EHR system vs. changing from one system to a different system (e.g., different product or vendor)?
- If there are more than two separate EHR systems, what is the best sequence for merging?
- What are your experiences and recommendations for the EHR data?
    - What do you think about merging into one system or adding separate systems? Why?
        - If you have separate systems, how should they interface with each other and patient data (e.g., HIE)?
        - If merging into one system, what do you recommend migrating or converting? Why?
        - What data should be included?
            - Everything or only partial?
            - How would you prioritize? Go all the way back to the beginning or just recent stuff and access rest through EDW?
    - How far back to go for patient data?
- What are your recommendations for addressing problems in the existing data?
- How would an organization balance the needs of clinical care, quality improvement, and research?

- Please describe any differences in EHR transitions in different settings and situations (e.g., inpatient, outpatient, enterprise, best-of-breed, academic medical center, community hospital, critical care hospital, multi-site/IDS, resource-poor, etc.)?
- Please describe differences between paper-to-EHR implementations and EHR-to-EHR transitions (e.g., different drivers, barriers, change management, and recommendations).
- Describe the ideal scenario for an EHR-to-EHR transition.
    - How would you determine success?
        - How would you evaluate?
        - What are criteria or metrics?

Closing
Please describe other comment or issues.

Would you suggest others to participate in this or the next phase of this study?

Thank you for your time and participation. I will send you a summary of our interview for review. You will have a chance to agree or add comments and clarifications. After I receive your agreement or comments, your gift card will be mailed to you. I will also send you a summary of the study results after the study is completed. Please contact me if you have questions about the study.