

Supporting Electronic Health Record Systems Management:  
A Mixed-Methods Exploration of Operating Models

By

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## **ABSTRACT**

**Background:** Informatics and information technology (IT) leaders in healthcare organizations (HCOs) face increasing pressure to justify the substantial resources needed to manage electronic health record (EHR) systems. Demonstrating the value of EHR systems is difficult because there is no standard method for calculating EHR return on investment (ROI), nor is it known whether some EHR system operating models (organizational structures) are more beneficial than others. An expanded understanding of EHR operating models would enable EHR leaders to improve resource allocation decisions and to better demonstrate systems value.

**Objectives:** This study aimed to describe operating models U.S. HCOs use to manage their EHR systems and to identify characteristics of those models that may impact EHR systems management.

**Methods:** Informatics and IT leaders at hospital systems were contacted through professional online discussion groups and networks and invited to respond to an online survey. Responses to quantitative questions were analyzed and summarized using descriptive statistics.

**Results:** Twenty-eight informatics and IT leaders provided complete or partial survey responses. Respondents were predominantly physicians (20/28 respondents) with the title of Chief Medical Information Officer (CMIO, 14/28), and represented organizations in all regions of the U.S. Most respondents' organizations were multi-hospital, integrated delivery systems or academic medical centers (23/28) with operating budgets of \$100 million to \$5 billion (16/28). They predominantly used a single EHR system across their

institutions (23/28), used Epic (19/23 respondents), had previously implemented an EHR system (16/23), and put their first system in place before 2009 (16/23). Employees providing EHR support spent up to 80% of their time maintaining EHR systems, less than 40% of their time optimizing them, and less than 20% of their time evaluating them. The percentage of institutional operating budget represented by these employees ranged from 0.5% to more than 5.0%. Eighty-four percent of employees reported into the IT function. Most of respondents' organizations used formal intake, governance, and prioritization processes for EHR-related work requests. Fewer than half of respondents had stated EHR system-related goals and objectives, and one third employed metrics to measure progress. More than half of respondents said that their operating models had changed since their first EHR systems were implemented, and half indicated that their operating models affected EHR performance. Both positive and negative impacts of operating models on EHR performance were cited. Although some commonalities among the survey's qualitative responses were noted, the limited quantity of these responses made robust thematic analysis infeasible.

**Conclusion:** Although mature with respect to EHR systems experience, the HCOs surveyed spent most resources maintaining their systems and the least resources evaluating and optimizing them. Lack of concrete, EHR-specific goals and metrics may contribute to EHR leaders' executive peers viewing EHRs as IT systems to be maintained rather than as strategic assets to be optimized. Without clear goals for EHR systems management and supporting strategies and metrics, it will continue to be difficult for

EHR leaders to demonstrate the value of EHR systems and secure the resources needed to evolve them.

# INTRODUCTION

## Background

The Health Information Technology for Economic and Clinical Health (HITECH) Act of 2009 authorized the U.S. Department of Health and Human Services (HHS) to establish incentive programs encouraging the meaningful use of electronic health record (EHR) systems. Due in part to these incentives[1], by 2017, more than more than 96% of U.S. non-federal acute care hospitals had implemented an EHR certified by HHS, compared with 9% of hospitals that had implemented a “basic” EHR in 2008[2].

In technology, the systems development life cycle (SDLC) provides one framework for examining the process of developing information systems, including EHR systems[3]. The traditional SDLC approach includes phases for planning, analysis, design, implementation, and maintenance/support. With the first four phases of the SDLC now complete for most hospitals, healthcare organizations (HCOs) increasingly are focused on maintenance/support activities. Depending on the organization, these activities may include (Deborah Woodcock. Conversation with Bud Garrison, Epic Piper. 2018 Dec 11.):

- Provisioning users (providing appropriate system access)
- Installing application software updates (break fixes) and upgrades (add functionality)
- Installation of content updates (e.g., billing codes, terminologies)
- Troubleshooting hardware and software issues
- Developing and delivering group user training
- Providing users with individual at-the-elbow support and assistance using features
- Optimizing the system for individual users (e.g., creating charting tools)

- Optimizing the system for all users (e.g., identifying and implementing informatics best practices)
- Evaluating system performance (e.g., performing usability testing, determining if optimization interventions met their objectives)

With initial costs for hospital EHR implementations ranging to hundreds of millions of dollars[4-6], it is reasonable to estimate that the cost of these maintenance/support activities, including the management infrastructure needed to enable them, adds millions to tens of millions of dollars more per year to hospitals' budgets. As the U.S. healthcare system shifts to a value-based model and HCOs face increasing pressure to reduce expenses, demonstrating the value of clinical information systems to justify their substantial operating costs is a growing challenge for hospital leaders responsible for managing EHRs[7-9].

Numerous academic and health information technology (HIT) industry publications have explored methods for evaluating the return on investment (ROI), of EHR systems over their life cycle[9-18], and several studies have examined governance practices associated with specific EHR functions[19-21]. However, little information has been published describing the management infrastructure, or operating models – commonly understood in industry to mean the people, processes, and technology – HCOs use to manage EHR systems overall and to deliver organizational value[22, 23]. From an informatics perspective, using Sittig and Singh's eight-dimensional sociotechnical model as a lens, these operating models correspond to aspects of the People, Organizational Policies and Procedures, and System Measurement and Monitoring dimensions[24].

Developing a better understanding of these operating models would enable hospital leaders to make better-informed resource allocation decisions and more effectively articulate the value of EHR systems. The objectives of this study, therefore,



were to describe characteristics of the managerial operating models hospital systems use to support their EHR systems and to identify characteristics of those models that may have a positive or negative effect on EHR systems management.

## **METHODS**

### Study Design

As not much is known about operating models employed to manage EHR systems at a macro level, a descriptive, exploratory design was chosen for the study, and an anonymous online survey instrument comprising primarily quantitative questions was selected as both appropriate and feasible.

A pilot project was conducted to identify key dimensions of organizational models that should be considered when designing the survey. Pilot project interviews were completed with 13 participants, and major themes that emerged during thematic analysis informed survey question development.

The online survey instrument was developed iteratively, with key informants providing content and wording feedback on two survey drafts before questions were finalized. Comprising 54 multiple-choice and 6 free-text questions, the survey (**Appendix A**) was designed to take approximately 15 minutes to complete. Questions explored general respondent characteristics, the technology (EHR systems) managed by respondents, the people supporting and managing those systems, and the processes used to manage maintenance/support activities.

### Participants and Recruitment

The study's target population was health informatics and IT leaders, defined as those with titles suggesting knowledge of organizational structures and policies. These included executive-level (e.g., Chief Medical Information Officer), vice president, and director titles. The study design aimed for responses from at least 25 target population participants.

Following review and approval by the Oregon Health & Science University (OHSU) institutional review board (IRB), the study information sheet and invitations to participate in the survey were distributed using three primary channels: posts on the online communities of the American Medical Informatics Association (AMIA Implementation Forum and Nursing Informatics Working Group), the SmartServ email distribution list (comprising informatics leaders whose organizations use an Epic EHR system), and emails to key informants' professional networks. It was thought that these communities offered the best opportunity to reach the target population.

Reminder invitations were distributed using the same channels four weeks following the original distribution, and the survey was closed two weeks later (one week after the last response was received).

#### Data Collection and Analysis

Following IRB approval, the survey instrument was developed and deployed in OHSU's secure academic instance of REDCap. A link to the survey was included in recruitment posts and emails.

Survey responses were collected anonymously. After completing the survey, respondents were given an opportunity to indicate interest in receiving a summary of the survey results by sending an email message to DW.

Survey results were filtered by title to identify responses matching the criteria for the target population. Quantitative data associated with these responses were normalized, and descriptive statistics were generated. Qualitative responses for each question were compiled into Word documents, and a panel of four key informants was convened to perform thematic analysis using a top-down, open-coding approach[25,26].

Subsequently, an interview guide was developed (**Appendix B**) and, after IRB approval, three survey respondents who expressed interest in receiving summary results were invited to provide impressions of the results in order to gain additional perspective on the results' accuracy and validity (member-checking). Two of the three respondents were subsequently interviewed by phone; interview notes were handwritten and interpreted by DW.

## RESULTS

A total of 48 survey responses were received, including 20 from respondents outside the target population and 28 from respondents in the target population. Non-target-population respondents included operational informatics management and staff (e.g., Physician Informaticist, Nursing Informatics Manager, Application Support Analyst), educators and educational staff (e.g., Academic Director, Professor, EHR Educational Informaticist), clinicians, project managers, and consultants. Five respondents in the non-target-population answered all survey questions; 15 answered some of the questions. Twelve respondents in the target population answered all survey questions; 16 answered some of the questions. Overall response characteristics by title are shown in **Table 1**.

**Table 1: Number of Responses by Title and Completion Status**

	<b>Answered All Questions</b>	<b>Answered Some Questions</b>	<b>Total</b>
<b>Executive-level or VP title</b>	10	12	22
<b>Other leadership title</b>	2	4	6
<b>Leadership subtotal</b>	12	16	28
<b>Other non-leadership title</b>	5	15	20
<b>Total</b>	17	31	48

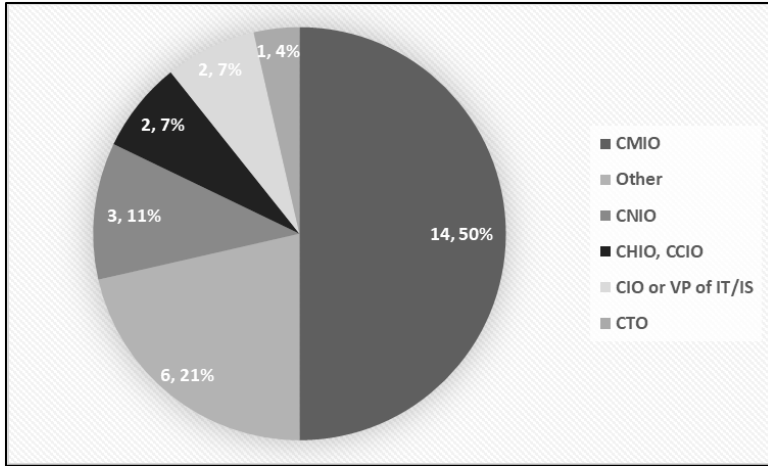
The following analysis is solely based on target population responses.

### Target Population Characteristics

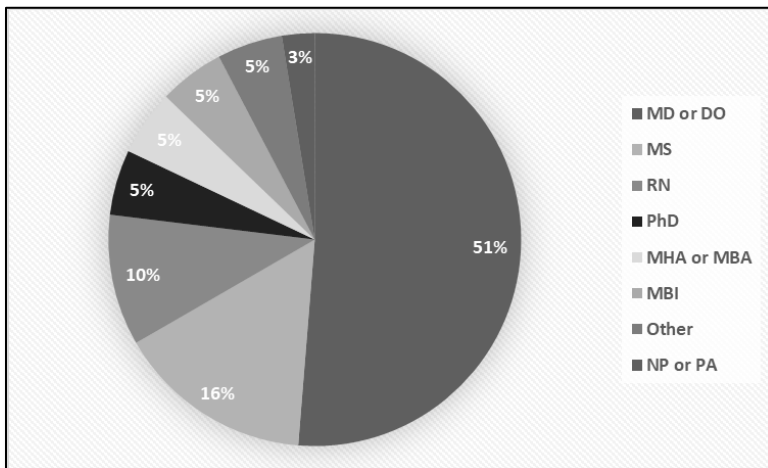
**Roles.** Half of respondents were Chief Medical Information Officers (CMIO), with 51% holding an MD or DO credential (some respondents held multiple credentials).

Response characteristics by title and by academic credentials are shown in **Chart 1** and **Chart 2**.

**Chart 1: Response by Title (n=28)**



**Chart 2: Responses by Academic Credentials (n=28)**

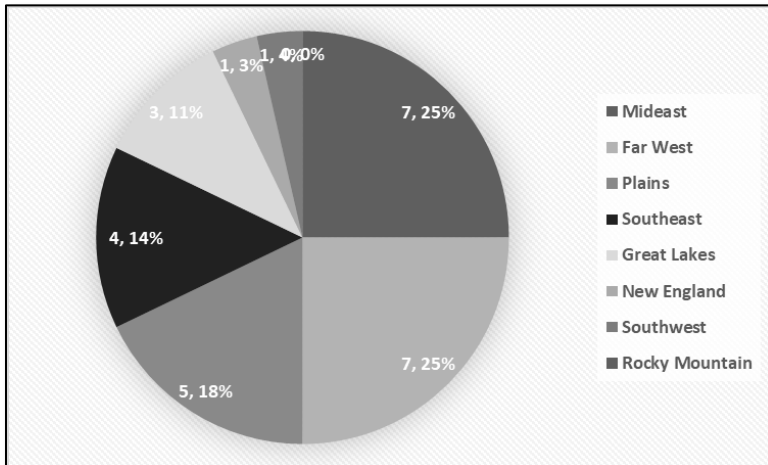


**Location and size.** Respondents represented all regions of the U.S., with the Midwest (mid-Atlantic) and Far West regions each supplying 25% of responses, and the Plains region providing another 18%. Responses representing multi-hospital, integrated delivery systems predominated (50%), with academic medical centers representing 32% of responses. Organizations with operating budgets (revenue) of \$1 billion to \$5 billion

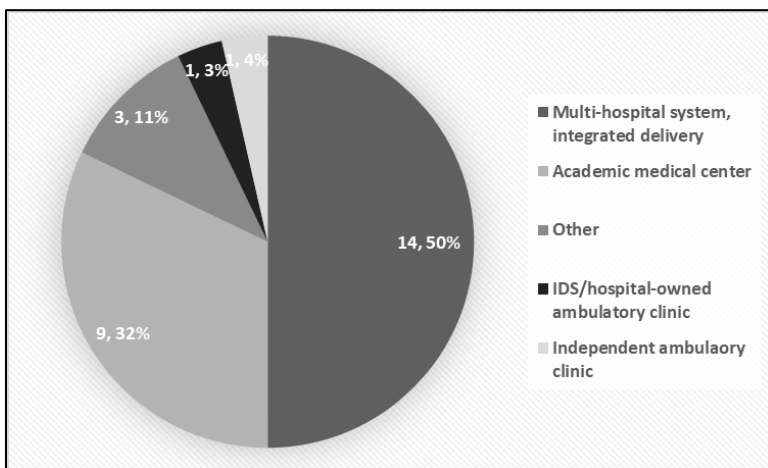
accounted for 39% of responses, with organizations having \$100 million to \$1 billion supplying an additional 18%. Three respondents did not know their organization’s operating budget, and three respondents provided numbers that appeared to be improbable and were excluded from analysis.

Response characteristics by region, organization type, and operating budget are shown in **Chart 3**, **Chart 4**, and **Chart 5**.

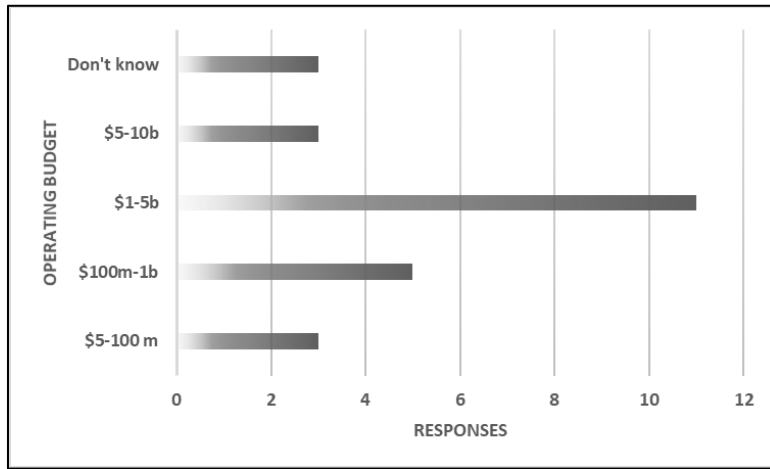
**Chart 3: Responses by Region (n=28)**



**Chart 4: Responses by Organization Type (n=28)**



**Chart 5: Responses by Organization Operating Budget (n=25)**



Based on a comparison of records by organization region, type, and budget, it is unlikely that responses were received from multiple respondents in the same organization.

Technology: EHR System Characteristics

Eighty-two percent of respondents worked in organizations using a single EHR system to serve their inpatient and ambulatory facilities. These organizations tended to use Epic (83%), had implemented more than one EHR system (70%), and put their first system in place before 2009 (70%).

Respondents whose organizations used more than one EHR system (18%) tended to use systems other than Epic for both their inpatient and ambulatory facilities (67% in both cases). For two-thirds of these respondents, their first inpatient system was their current system, and all implemented their first systems before 2009. On the ambulatory side, all respondents indicated that their current system was their first, with two-thirds implementing their first ambulatory system before 2009. **Table 2** shows a comparison of responses for single and multiple-EHR systems by EHR type and implementation date.



**Table 2: Percentage of Responses by EHR Type and Implementation Date**

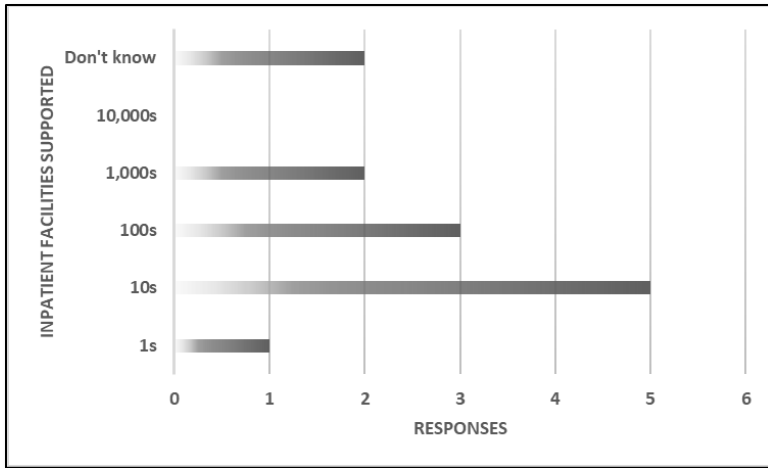
	<b>Single EHR (n=23, 82%)</b>	<b>Multiple EHRs (n=5, 18%)</b>	
		<b>Inpatient</b>	<b>Ambulatory</b>
<b>Primary EHR system</b>			
<b>Corner</b>	9%	--	--
<b>Epic</b>	82%	33%	33%
<b>MEDITECH</b>	--	--	--
<b>Other</b>	9%	67%	67%
<b>Year of first implementation</b>			
<b>Before 2009</b>	70%	100%	67%
<b>2009-2013</b>	22%	--	33%
<b>2014-2018</b>	4%	--	--
<b>Don't know</b>	4%	--	--
<b>Current implementation is the first?</b>			
<b>Yes</b>	30%	67%	100%
<b>No</b>	70%	33%	--

Approximately half of target population respondents answered the remaining questions in the survey. This sub-population shared most of the same general characteristics as the total target population: they were predominantly CMIOs holding physician credentials and representing large HCOs using single (Epic) systems that were not their first; and implemented their first systems before 2009. Unlike the total target population, no New England organizations were represented.

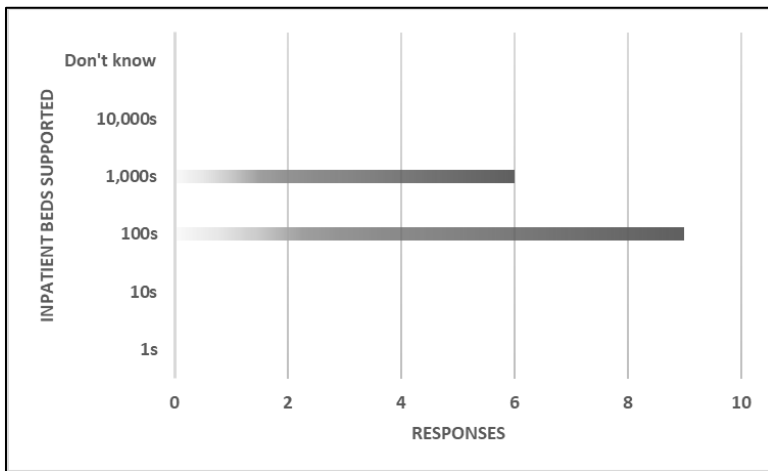
**Facilities.** Most of respondents' EHR systems supported tens of inpatient facilities (18%; range: 4-35) comprising hundreds (32%; range: 166-900) or thousands (21%; range: 1,500-3,500) of beds. Their EHRs predominantly supported tens (21%;

range: 4-70) or hundreds (32%; range: 100-500) of ambulatory clinics (**Chart 6, Chart 7, Chart 8**).

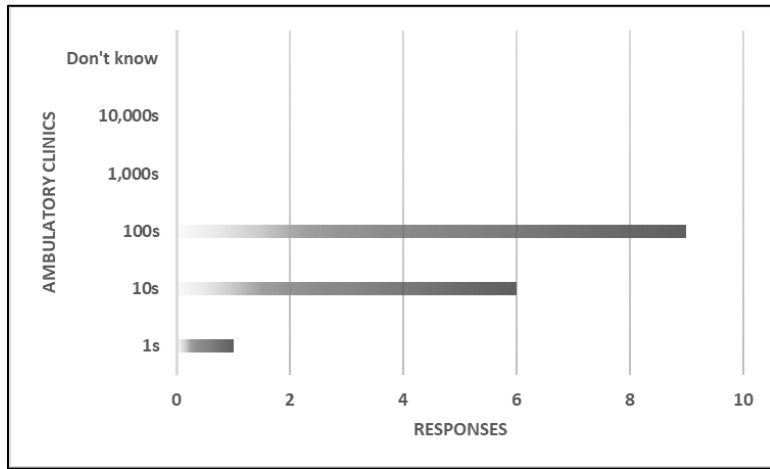
**Chart 6: Responses by Number of Inpatient Facilities Supported (n=13)**



**Chart 7: Responses by Number of Inpatient Beds Supported (n=15)**



**Chart 8: Responses by Number of Ambulatory Clinics Supported (n=16)**



**Users.** Two thirds of respondents’ EHR systems supported thousands of clinical users (67%; range: 3,000-8,000), hundreds or thousands of administrative users (43% and 29%, respectively; range: 100-5,000), and hundreds of research users (40%; range: 100-300). Three respondents reported supporting hundreds or thousands of “Other” users, type(s) unspecified. A comparison of response characteristics by user type is shown in

**Table 3.**

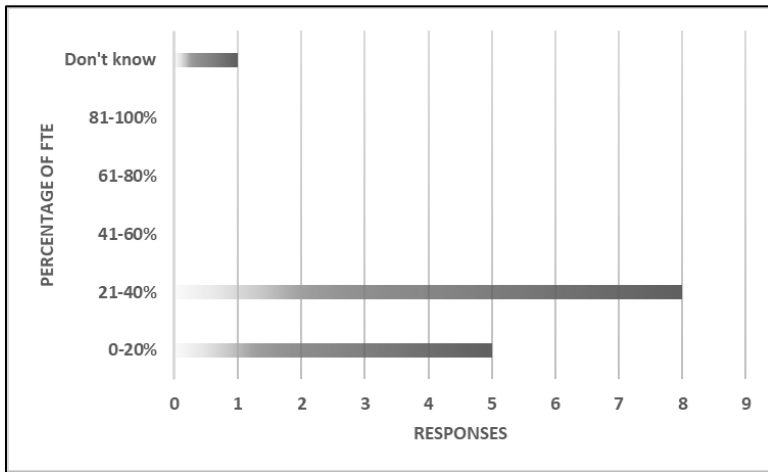
**Table 3: Percentage of Responses by EHR User Type**

Number of Users Supported	Clinical (n=15)	Administrative (n=14)	Research (n=15)	Other (n=5)
<b>0</b>	--	--	14%	20%
<b>1s</b>	--	7%	13%	--
<b>10s</b>	--	--	13%	--
<b>100s</b>	13%	43%	40%	20%
<b>1,000s</b>	67%	29%	--	40%
<b>10,000s</b>	13%	7%	7%	--
<b>Don't know</b>	7%	14%	13%	20%

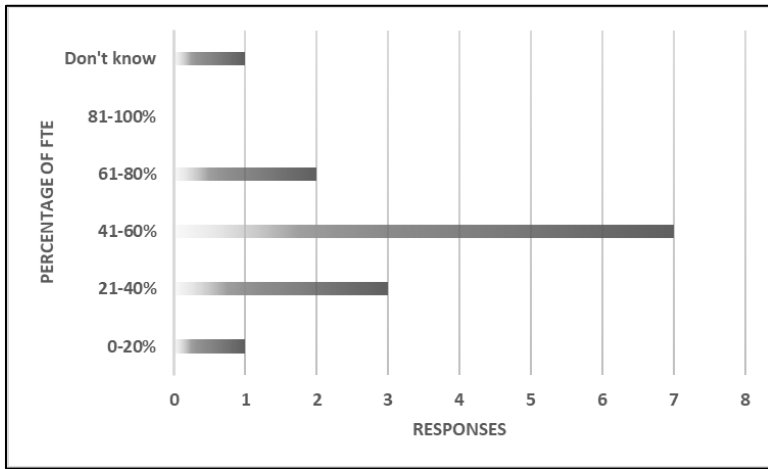
People: Employee Resource Characteristics

**Activities.** Employees spent the most time maintaining EHR systems and the least time evaluating systems performance. They spent 21-80% of their time maintaining the EHR (e.g., implementing break fixes, installing platform upgrades, upgrading clinical content), less than 40% of their time implementing or optimizing the EHR (e.g., responding to user suggestions, initiating and implementing evidence-based best practices, performing usability testing), and less than 20% of their time evaluating the EHR (e.g., measuring the impact of interventions designed to improve EHR performance), providing users with at-the-elbow support or training, or performing other activities (e.g., providing access, configuring hardware, supporting affiliates). Response distributions for each of these activities are show in **Charts 9-15**.

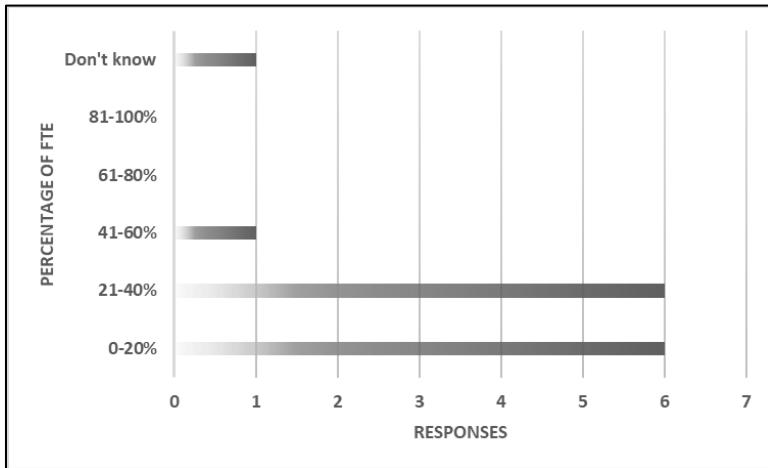
**Chart 9: Percentage of Full-Time Equivalent (FTE) Implementing EHR Functionality (n=14)**



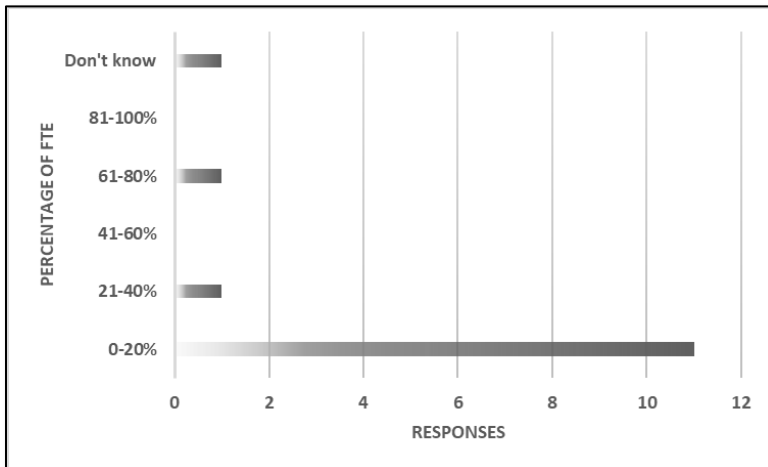
**Chart 10: Percentage of FTE Maintaining EHR Systems (n=14)**



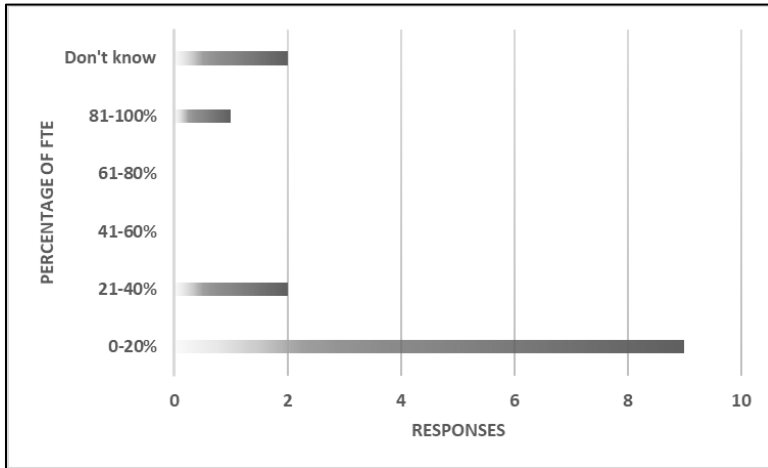
**Chart 11: Percentage of FTE Optimizing EHR Systems (n=14)**



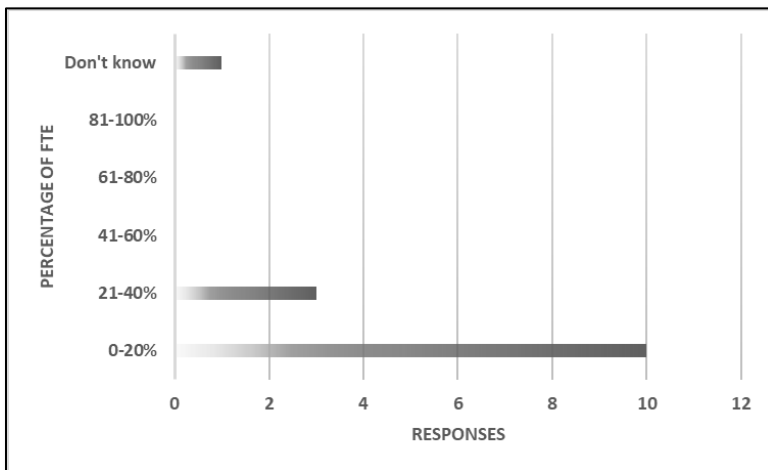
**Chart 12: Percentage of FTE Evaluating EHR Systems (n=14)**



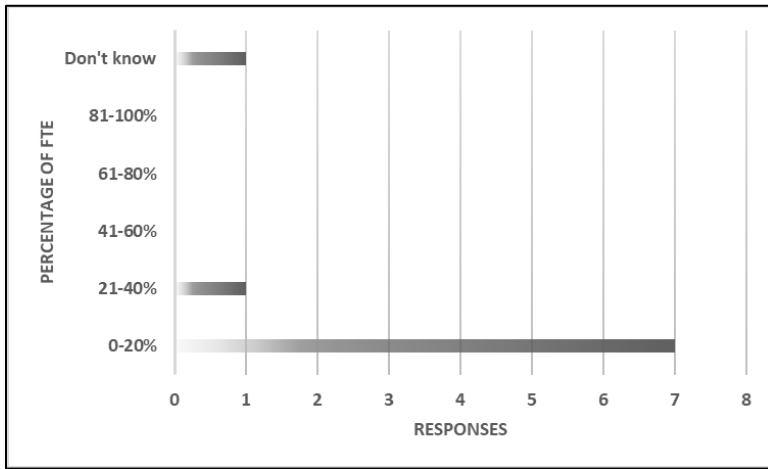
**Chart 13: Percentage of FTE Employees Providing At-the-Elbow Support for EHR Users (n=14)**



**Chart 14: Percentage of FTE Training EHR Users (n=14)**

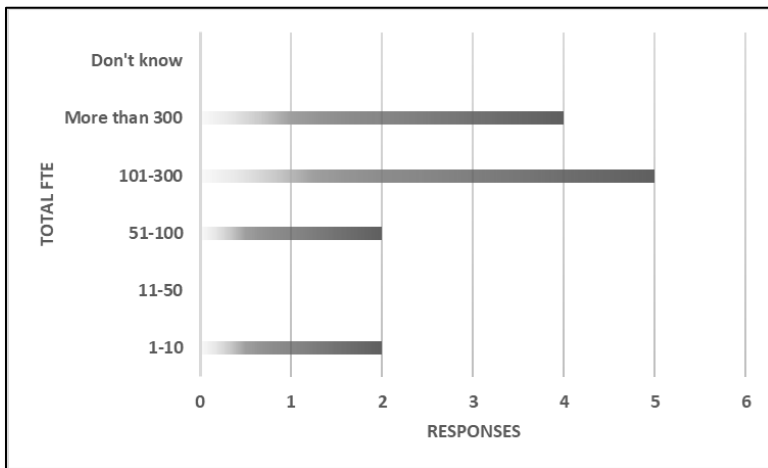


**Chart 15: Percentage of FTE Performing Other EHR Activities (n=9)**

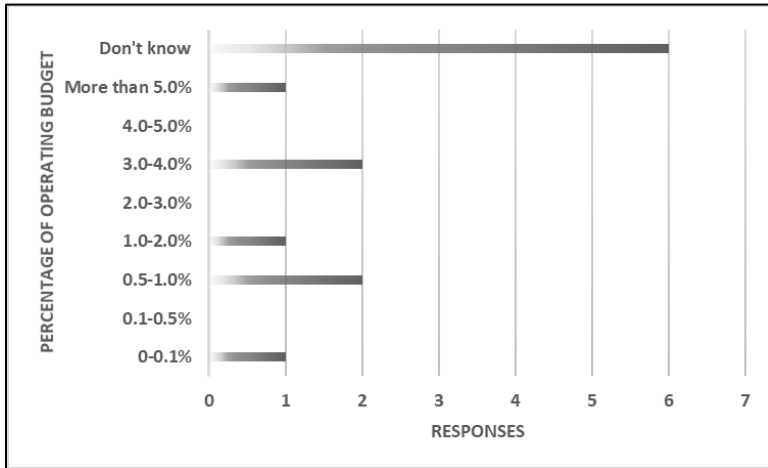


**Employee resourcing.** Most organizations surveyed (70%) employed more than 100 people to support their EHR systems, with 39% employing between 100 and 300 people, and 31% employing more than 300 people. Estimates of the percentage of institutional operating budget these employees comprised ranged from less than 0.1% of operating budget to more than 5.0%; almost half (46%) of respondents did not know what percentage they comprised. Distributions for these responses are shown in **Chart 16** and **Chart 17**.

**Chart 16: Total FTE Supporting EHR Systems (n=13)**

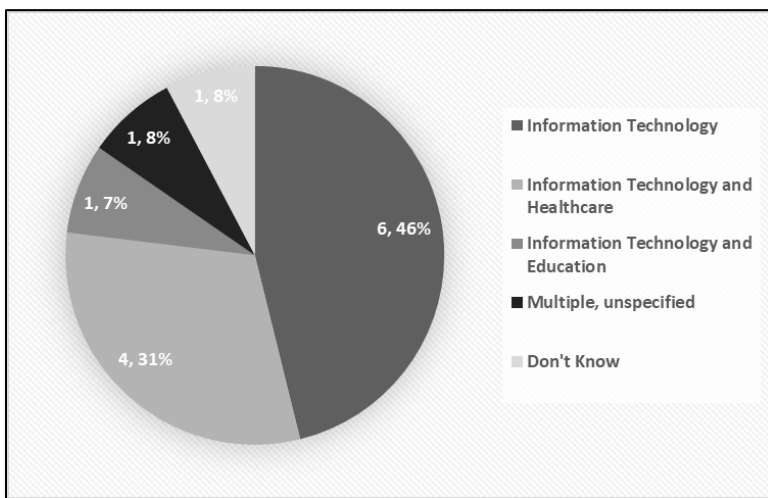


**Chart 17: Percentage of Total Operating Budget Represented by FTE Supporting EHR Systems (n=13)**



**Employee reporting structure.** Nearly half (46%) of respondents indicated that the FTE supporting their EHRs reported into the information technology (IT) function, with an additional 31% of FTE reporting into the IT and healthcare functions. No FTE reported solely into the healthcare, education, or research functions. **Chart 18** shows the breakdown of reporting structure responses.

**Chart 18: Organization Functions Into Which FTE Supporting EHR Systems Report (n=13)**

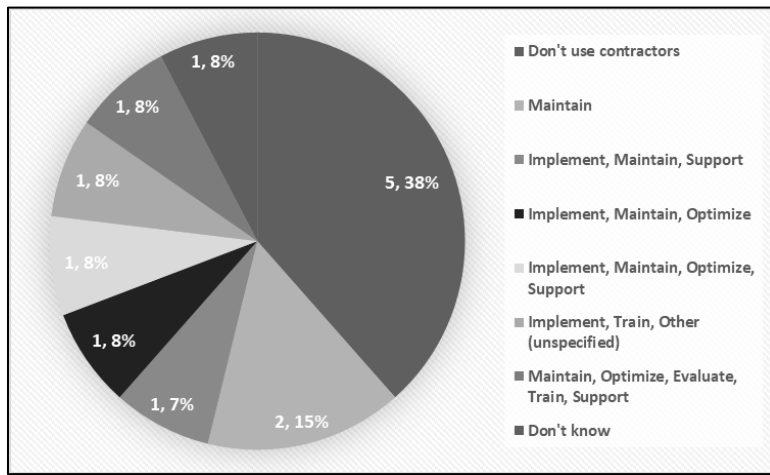




**Use of contractors.** Nearly 40% of respondents did not use contractors; 39% used them to perform multiple functions, and 15% used them only to perform maintenance.

The distribution of contractor functions is shown in **Chart 19**.

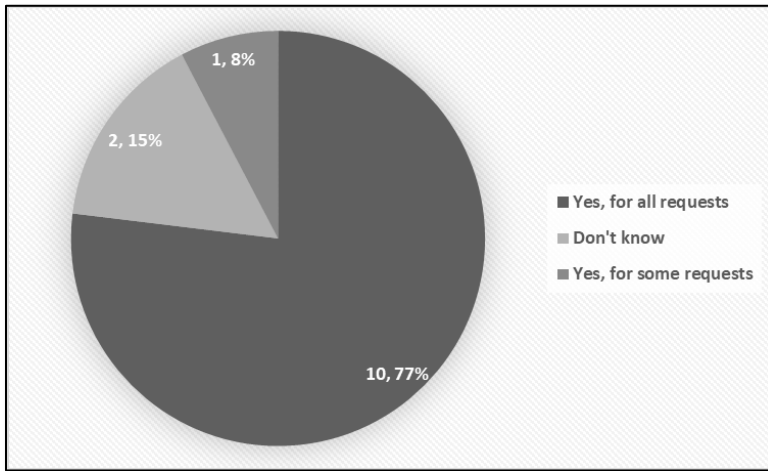
**Chart 19: EHR Support Activities Performed by Contractors (n=13)**



Processes: Work Management

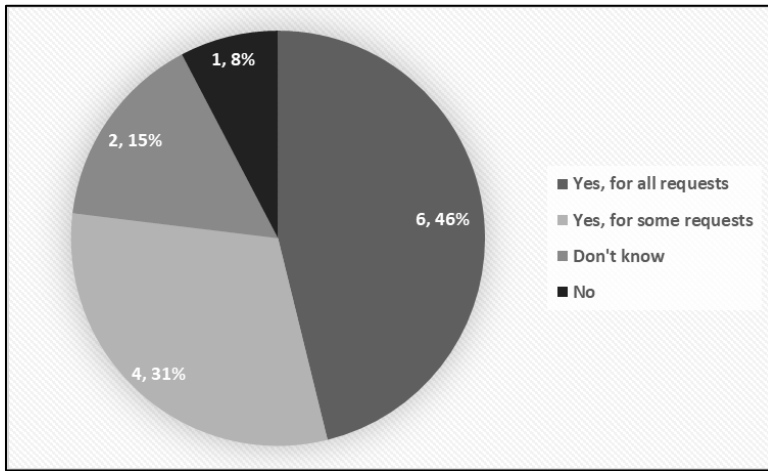
**Intake.** Post-implementation work performed on EHR systems come from many different sources (EHR users, support staff, and leadership, vendors), and include changes taking from a few minutes to a few hours to complete, mini-projects lasting a few days or a few weeks, and major projects lasting months or years. Intake processes provide a way to submit, track, and report on these requests. Eighty-five percent of survey respondents indicated that their organizations had a formal process for managing incoming work requests, with most (77%) using that process for all types of requests. The remaining 15% of respondents said they did not know whether their organizations had a formal process for request intake (**Chart 20**). One respondent (ID 32) indicated that “sometimes emails only” was the intake process.

**Chart 20: Use of Formal Intake Process for EHR Work Requests (n=13)**



**Governance.** The value of EHR work requests varies greatly; and while some requests are essential, others are optional. Formal processes for reviewing and approving EHR work requests are used to identify which requests are likely to add value (and how much value they add) and are therefore worthy of resource commitment. Seventy-seven percent of respondents indicated that their organizations had a formal governance process for reviewing and approving EHR work requests, with 46% saying they used their process for all requests and 31% noting that they used their process for some requests. Eight percent of respondents said that they did not use a formal process, and 15% said that they did not know whether their organizations used a formal process (**Chart 21**).

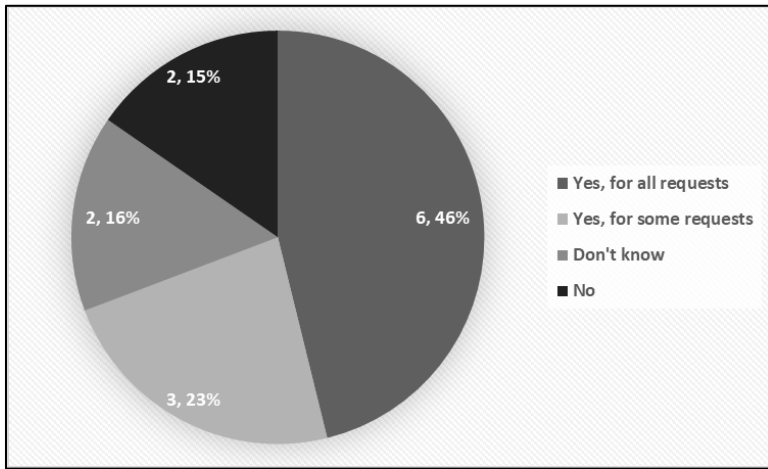
**Chart 21: Use of Formal Governance Process for EHR Work Requests (n=13)**



In their free-text comments (**Table 4**), some respondents described processes that were “loose,” and others that were more structured. They also distinguished between scope of work requests (e.g., “break/fix or small effort work” and “project work”).

**Prioritization.** Work requests approved for execution typically cannot all be worked on simultaneously. Formal processes for prioritizing approved work requests are used to allocate work across groups and individuals and to ensure that the right work is being performed at the right time. Sixty-nine percent of respondents indicated that their organizations used a formal process for prioritizing work requests, with 46% saying they used a formal process for all requests, and 23% indicating they used their process for some requests. Fifteen percent of respondents said they did not use a formal process, and another 15% said they did not know if their organizations used a formal process (**Chart 22**).

**Chart 22: Use of Formal Prioritization Process for EHR Work Requests (n=13)**

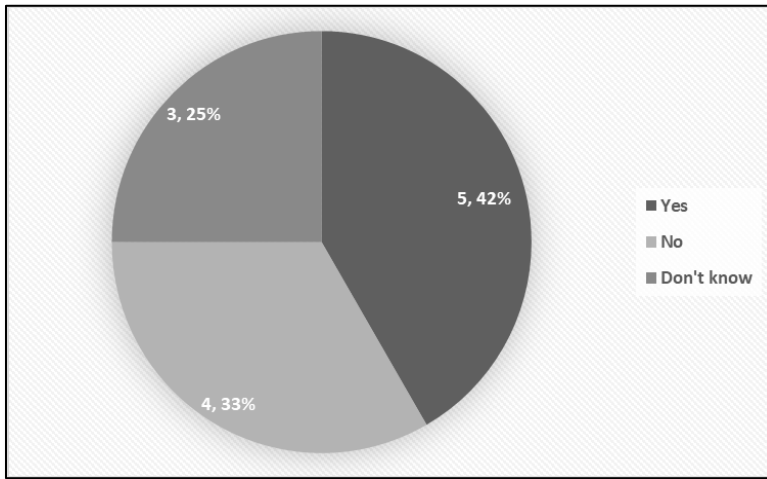


In their free-text responses (**Table 5**), respondents again noted variation in how structured or “loose” the prioritization processes were, and in the types of work prioritized, based on scale and scope (“small work efforts”).

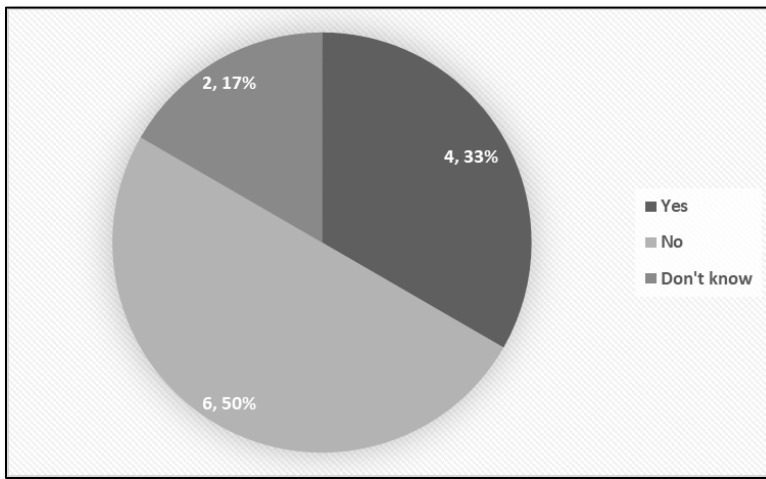
People: Leadership

**Goals and metrics.** Less than half of respondents’ organizations said they had stated strategic goals and objectives with respect to EHR system management, and one third said they employed metrics to measure progress toward EHR system goals and objectives (**Chart 23, Chart 24**).

**Chart 23: Stated Goals and Objectives Related to EHR Performance**



**Chart 24: Use of Metrics to Measure Progress Toward Goals and Objectives**

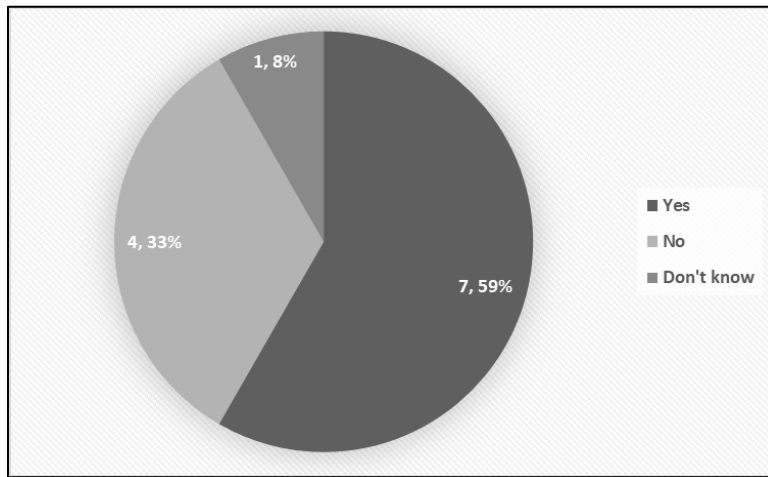


Free-text responses to these questions included a mix of outcome and process goals and metrics aligned with those of the organization overall and IT function specifically (**Table 6, Table 7**). One respondent stated that their goals and objectives were guided by their core vendor strategy; during member-checking, a key informant indicated that the comment was theirs, and explained that this strategy reduced the need for internal development resources (and therefore EHR management cost), but also reduced their organization's capacity for innovation. Both key informants who

participated in member-checking indicated that their organizations struggled to define meaningful EHR system metrics.

**Changing operating models.** More than half of respondents said that their operating models had changed to varying degrees since their first EHRs were implemented (**Chart 25**).

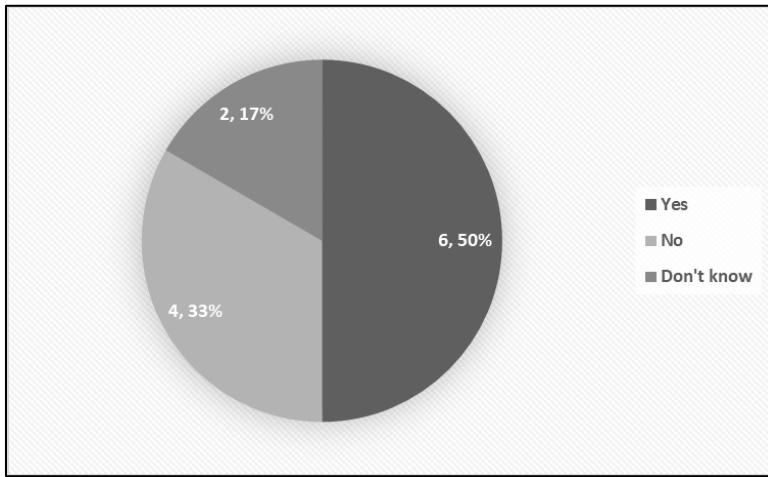
**Chart 25: Has the Operating Model Changed Since First Implementation? (n=12)**



In free-text responses (**Table 8**), one respondent indicated that “some processes have evolved but basic principles have remained unchanged.” Others referred to having a more “mature” model, a model with more operational than IT control, and a model that was more “integrated and more data-focused.” One respondent noted that their model is “constantly evolving as situations demand, as EHR complexity increases, as regulations change, and priorities alter.”

**Operating model impacts.** Half of respondents believed that aspects of their operating model affected EHR performance (**Chart 26**).

**Chart 26: Has Operating Model Impacted EHR Performance? (n=12)**



In their free-text responses (**Table 9, Table 10**), one respondent observed that “...there was a long period of time where technology was seen as a utility as opposed to a strategic asset. Recent clinical leadership changes are refocusing energy on the value and optimization of utilization of the EHR – this will be good for the system.”

Several respondents commented on aspects of leadership impacting impact EHR management. “We rely on clinical leadership to define strategic goals,” wrote one. Said another: “Our interim CIO was previously CMIO and is still a practicing clinician. He understands clinical needs and tries to be responsive whenever possible.” However, wrote another, “high-level C-suite leaders other than the CIO and CMIO are rather clueless when it comes to the EHR.”

There is “lack of interest at the highest levels of the organization in investing in technology and the people that can optimize the system,” noted one respondent. Another felt that there was “inadequate investment in initial and followup training...inadequate investment in ongoing clinical informatics followup on the floors and ambulatory

sites...inadequate attention to new projects...inadequate attention to routine updating and review as well as routine maintenance.

“All things considered,” the respondent continued, “I think our organization has done a reasonable job of getting our system up and running so that it can be used for clinical care. However, we certainly are not following best practices in many domains. We also have lots of missed opportunities.”



## **DISCUSSION**

This study describes characteristics of operating models – technology, people, and processes – supporting the EHR systems of 12 large U.S. HCOs through the eyes of physician-trained informatics and IT executives.

EHR technology in these organizations was first implemented before 2009; this, and the fact that their current EHR systems were not their first, suggest that these organizations have completed the entire EHR SDLC at least once, and have had at least 10 years of experience implementing and maintaining EHR systems. Their current use of a single system suggests that they value integrated systems that work across inpatient and ambulatory contexts and that are capable of supporting thousands of users in diverse roles.

The hundreds of people supporting these systems spent most of their time performing reactive maintenance activities, such as implementing break fixes, installing platform upgrades, and updating clinical content. Less time was spent implementing new functionality and in proactively optimizing the systems. The least amount of time was spent evaluating systems performance and providing users with direct support in how to use the systems more effectively and efficiently, which also are proactive activities.

Support staffs reported into the IT function, which may view the EHR as simply one of many information systems requiring maintenance; as a result, HCO leaders may not view EHR systems as strategic assets to be continuously improved and that may require a management approach different from those used to support other information systems. The wide variation in staff spending as a percentage of operating budget – from 0.5% to more than 5% – may indicate that HCOs are experiencing challenges in

establishing staffing models that meet the organizations' needs, or that institutions value informatics and IT personnel differently.

Most HCOs used formal processes for tracking incoming EHR-related work requests, determining which requests should be accepted, and prioritizing accepted work requests. Some HCOs evaluated and prioritized all requests, while some evaluated and prioritized only certain types of requests. This suggests that EHR leaders believe that not all work requests may add value, and that decisions need to be made a priori about which types of requests should be evaluated, given resource constraints and organizational priorities.

The verbatim responses to the intake, governance, and prioritization questions suggest two challenges associated with work request management processes: [1] methods used to scope work requests for evaluation, and [2] how loosely or tightly structured evaluation and prioritization processes should be. Verbatim responses related to scoping referred to request size, but did not indicate how size was measured or the range of sizes, with the exception of one comment (“I think > 40 hrs but they keep changing the cutoff”). Absent from scoping comments were additional potential drivers such as regulatory requirements, patient safety issues, or number of users potentially affected. Similarly, verbatim responses regarding process structure did not specifically indicate what constituted a “tight” or “loose” process, although one respondent suggested that intake via email message (“sometime emails only”) may indicate a loose process.

**Limitations.** Although they informed interpretation of quantitative data, the limited quantity of qualitative responses made robust thematic analysis infeasible. It might have been possible to achieve a greater number of responses by distributing the

survey to members of the Healthcare Information and Management Systems Society (HIMSS); however, HIMSS contacts did not respond to inquiries regarding participation. Distributing the survey to individual members of the target population was also considered, but developing a list of those contacts and their email addresses was infeasible given limited resources.

The audience for one of the primary survey distribution channels was Epic users, which may have skewed responses to the question regarding EHR system [83% of respondents reported using Epic, while it is estimated that 58% of hospitals with 500 or more beds use Epic[27]]. Similarly, members of the professional networks to which the survey was distributed were primarily based in the Pacific Northwest, which may have skewed responses to the question regarding location.

While feasible, the survey was not an ideal tool in that it was able to collect only high-level data. While key informants participated in survey development to reduce ambiguity in question wording and avoid leading respondents, it was not validated, and it is possible that respondents interpreted the meaning of questions differently. The REDCap survey software was unable to ensure answers across the activities questions summed to 100%, so it's possible that these answers were under- or over-reported. The reverse was also true: wording some questions in a more directive way might have produced more meaningful responses. The study may not have identified dimensions of the operating models that are important to consider in developing an overall understanding of EHR management infrastructure.

**Future work.** This initial, high-level study of EHR system operating models suggests many directions for future investigation. Additional studies might identify and

examine additional characteristics of operating models not considered here, or more closely examine individual characteristics more closely. A study focusing specifically on the composition and nature of the groups supporting EHR systems might yield information useful to HCO leaders as they establish and evolve staffing models. Another might examine the criteria HCOs use to evaluate and prioritize work requests in order to direct staff more effectively and efficiently. It also might be useful to examine the metrics used to measure EHR performance used and the methods HCOs use to develop them so leaders can better make the case for investment in EHR systems management. Studying operating models in smaller, more resource-constrained HCOs may also be useful.

## **CONCLUSIONS**

Although experienced in EHR system implementation, the HCOs surveyed allocated most of their staffing resources to reactive and “lights-on” activities that maintain EHR systems, and fewer resources to proactive activities that could help them strategically optimize those systems. Informatics and IT leaders in these organizations lacked concrete EHR-specific goals and metrics, and the value of EHR systems was not understood by their executive peers.

Without strategic EHR roadmaps supported by specific goals and metrics related directly to their organizations’ goals, it will continue to be difficult for EHR leaders to make effective resource allocation decisions, to demonstrate the value of their systems, and to obtain the operating and investment resources necessary to evolve them.

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## TABLES

Table 4: Governance Process, Verbatim Responses

<b>ID</b>	<b>Response</b>
4	It is loose but it exists
17	governance is applied to "project" work requests but not to break/fix or small effort work
44	Requests that require actual EHR fixes have to go through a clinical informatics review, a separate review is needed for requests requiring a substantial work effort (I think > 40 hrs but they keep changing the cutoff)

Table 5: Prioritization Process, Verbatim Responses

<b>ID</b>	<b>Response</b>
32	Historical IT Steering
17	True for 90+% of work, however some small work efforts are completed on the fly and are not prioritized
44	Yes but loose

Table 6: EHR Goals and Objectives, Verbatim Responses

<b>ID</b>	<b>Response</b>
4	2 year roadmap developed
11	we have a core vendor strategy. so we try to utilize epic for everything it can
29	annual goals are set to align with institutional and overall IT goals
31	too numerous to either mention or detail here. The primary principle is patient oriented--outcomes, morbidity/mortality, readmission rates, utilization of the EHR specifically, alert and other CDS analysis, .... I could go on

Table 7: EHR Metrics, Verbatim Responses

<b>ID</b>	<b>Response</b>
5	Our IT goal are a subset of our operational goals, intended to support the broader goals of the organization.
29	SMART metrics
31	multiple; user metrics, alert and other CDS data, order set usage, and of course promoting interoperability--as well as others including proprietary ones.

Table 8: How and Why EHR Operating Model Has Changed, Verbatim Responses

<b>ID</b>	<b>Response</b>
4	Matured New people/leaders Roadmaps More Data focus
5	Much more operational control rather than IT driven.
11	we function more as an integrated system than we did before.
17	some processes have evolved but basic principles have remained unchanged.
31	constantly evolving as situations demand, as EHR complexity increases, as regulations change, and priorities alter
44	We have used vendor contract services at various times for example with large scale rollouts for training and initial implementations. We have also used vendor contract services for maintenance/optimization issues but are moving away from that because our own IT staff often have to make adjustments or revisit the vendor build to align with our existing build. Also, our own people have to do validation testing on the build anyway and involving the vendor often introduces further delays, multiple communication loops, etc. When they aren't familiar with our configuration, they sometimes give incorrect advice that makes matters worse. Initially we had our EHR servers on-site. This did not work well and there was loads of down-time. We are now remote hosted which is a HUGE improvement.

Table 9: Positive Impacts of Operating Model on EHR Performance, Verbatim Responses

ID	Response
4	Governance not bureaucratic but is a little loose
14	Complicated
17	We have had varying levels of interest, engagement and skill in clinical leadership. We rely on clinical leadership to define strategic goals and there was a long period of time where technology was seen as a utility as opposed to a strategic asset. Recent clinical leadership changes are refocusing energy on the value and optimization of utilization of the EHR - this will be good for the system
29	Informatics is separated from EHR which can be challenging at times
31	Our institution has detailed a good many of the specifics in our public announcements, research, and press coverage.
44	1. Our interim CIO was previously CMIO and is still a practicing clinician. He understands clinical needs and tries to be responsive whenever possible. When aspects of the EHR design are cumbersome and associated with poor usability, he "gets it" and advocates to get things changed. 2. We have a subgroup of our IT staff who are really bright, creative and good at using the build tools and other configuration aspects of our system. They are a pleasure to work with in making system improvements and troubleshooting bugs. (We also have a subgroup of IT staff who are long-time employees and do minimal work, which frustrates our leadership. We are all state/union employees so deadwood can be hard to avoid.) 3. Remote hosting has been a big help.

Table 10: Negative Impacts of Operating Model on EHR Performance, Verbatim Responses

ID	Response
4	Training is weak Analytics immature
14	Complicated
17	lack of interest at the highest levels of the organization in investing in technology and the people that can optimize those system.
31	Poor EHR usability, navigation, and navigability are the highlights.
44	<p>1. Inadequate investment in initial and followup training. Physician training is a single 4 hour session. You can ask for a individual session in the clinic, but few people do. And our EHR has lots of "training issues" --- major usability problems that any normal person would call a bug or defect but that the vendor calls "working as designed" (aka WAD) and/or a "training issue".</p> <p>2. Inadequate investment in ongoing clinical informatics followup on the floors and ambulatory sites. Such followup/observation would generate lots of information about usability because there are serious usability problems. In addition, people don't report these issues and frustrations to the help desk so without clinical informatics followup the issues remain unaddressed.</p> <p>3. Inadequate attention to new projects. We have been waiting for 6 years to get the specialty package installed for behavioral health and it's still several years out on the project management timeline.</p> <p>4. Inadequate attention to routine updating and review as well as routine maintenance. For example, we have not done a formal review of CPOE order sets since going live almost 10 years ago.</p> <p>5. Insufficient use of available metrics to try to identify and assist clinicians who are struggling with the EHR. Our vendor does make such data available to end users but our organization has never used it to drive improvements.</p> <p>6. Issues with Citrix servers, network connectivity, virtual desktop (for hospital applications), etc. (We're running Windows 7 and outdated browsers.) Underpowered computers also seem to affect performance negatively at times.</p> <p>7. High level C-suite leaders other than the CIO and CMIO are rather clueless when it comes to the EHR.</p>

Table 11: Additional Thoughts, Verbatim Responses

ID	Response
44	<p>Many of the maintenance and optimization issues would be much less time-consuming if the vendor product was better designed. Our vendor's tools for doing note builds, order set builds, structured data entry forms, decision support alerts, etc. are clunky at best. Multiple steps and clicks are often needed for a simple step. Adding new staff requires multiple individualized steps rather than being able to add staff in batches, save frequently repeated steps in a batch, etc. Although not related to the EHR, per se, we spend a lot of IT time/effort pulling data out of the EHR (e.g, via Crystal Reports, SQL) for business/operational/regulatory analytics. It is not easily retrievable otherwise and many of the "canned" reports within the EHR are actually inaccurate. (Even ones used for meaningful use reporting. And we use one of the major EHR vendors....) All things considered, I think our organization has done a reasonable job of getting our system up and running so that it can be used for clinical care. However, we certainly are not following best practices in many domains. We also have lots of missed opportunities. For example, we are just completing a \$70 million building that will house critical care units, outpt oncology, children's hospital and other services. The new oncology rooms are set up so that the physicians can't sit to use the computer and if you're shorter than 5'8" you can't reach the keyboards comfortably even standing up. Also, the computer screen (on its extensible arm) comes between the physician and the patient and the back of the screen is about a foot from the patient's face. The rooms are too small for any other arrangement and the counters are too small and too high to place a laptop there in lieu of the wall mounted computer. The biggest challenge to EHR performance, efficient use, usability, physician burnout, etc. is the software. They keep rolling out improvements but none of them fully do what you need and there are still major design flaws that result in chronic safety concerns. The vendor's on-site "engagement leaders" have become less and less responsive over the years (now that they've locked us into their product).</p>
46	absurd questionnaire.

# APPENDIX

## A: Survey

### Electronic Health Record Systems Management Survey

We appreciate you taking time to respond to this anonymous survey.

Little is known about the operating models (people, processes, and technology) healthcare organizations use to derive value from their EHR systems. Your responses will be valuable in helping us develop a better understanding of factors that may support decision-making around EHR resource management.

The survey comprises primarily discrete questions, and will take approximately 15 minutes to complete. Your responses will be kept confidential.

If you have any questions about the survey, please contact co-Investigator Deb Woodcock (woodcocd@ohsu.edu)

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What is your title?

- CMIO
- CNO
- CHIO, CCIO
- CIO or VP of IT/IS
- CTO
- Other (please provide below)

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Other title:

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What academic credentials do you hold?

- MD or DO
- RN
- NP or PA
- PhD
- MHA or MBA
- MS
- MBI
- Other (please provide below)

---

Other credentials:

-----

---

In which U.S. region is your institution located?

- New England (CT, ME, MA, NH, RI, VT)
- Mideast (DC, DE, MD, NJ, NY, PA)
- Great Lakes (IL, IN, MI, OH, WI)
- Plains (IA, KS, MN, MO, NE, ND, SD)
- Southeast (AL, AK, FL, GA, KY, LA, MS, NC, SC, TN, VA, WV)
- Southwest (AZ, NM, OK, TX)
- Rocky Mountain (CO, ID, MT, UT, WY)
- Far West (AK, CA, HI, NV, OR, WA)

---

What type of healthcare organization is your institution?

- Academic medical center
- Community health center clinic
- Critical access hospital
- Multi-hospital system, integrated delivery
- IDS/hospital-owned ambulatory clinic
- Independent ambulatory clinic
- Other (please provide below)

---

Other organization type:

\_\_\_\_\_

---

What is your institution's current annual operating budget (in USD)?

\_\_\_\_\_

---

Do you use a single EHR system across your institution (inpatient and ambulatory facilities)?

- Yes  
 No

---

In what year was your institution's first EHR implemented?

- Before 2009  
 2009-2013  
 2014-2018  
 I don't know

---

What is your institution's primary EHR system?

- Cerner  
 Epic  
 MEDITECH  
 Other (please provide below)

---

Other primary EHR:

\_\_\_\_\_

---

Is this your institution's first EHR?

- Yes  
 No  
 I don't know



**Please answer the following questions with respect to your institution's inpatient EHR.**

In what year was your institution's first inpatient EHR implemented?

Before 2009  
 2009-2013  
 2014-2018  
 I don't know

What is the primary EHR system used in your institution's inpatient facility(ies)?

Cerner  
 Epic  
 MEDITECH  
 Other (please provide below)

Other primary inpatient EHR: \_\_\_\_\_

Is this system your institution's first inpatient EHR?

Yes  
 No  
 I don't know

**Please answer the following questions with respect to your institution's ambulatory EHR.**

In what year was your institution's first ambulatory EHR implemented?

Before 2009  
 2009-2013  
 2014-2018  
 I don't know

What is the primary EHR system used in your institution's ambulatory facility(ies)?

Cerner  
 Epic  
 MEDITECH  
 Other (please provide below)

Other primary ambulatory EHR: \_\_\_\_\_

Is this system your institution's first ambulatory EHR?

Yes  
 No  
 I don't know

**Please answer the following questions with respect to the primary group(s) supporting your primary EHR and its users.**

How many patient care units do these group(s) support?

\_\_\_\_\_

How many inpatient beds do these group(s) support?

\_\_\_\_\_

How many ambulatory clinics do these group(s) support?

\_\_\_\_\_

**Approximately how many EHR users of the following types do you have?**

Clinician users (physicians, nurses, LPs, MAs, therapists, technicians)

-----

Administrative users

-----

Research users

-----

Other users

-----

**Approximately what percentage of the EHR support groups' total FTE is spent performing the following functions?**

Implementing EHR functionality (e.g., bringing new locations, new applications online)

0 - 20%  
 21 - 40%  
 41 - 60%  
 61 - 80%  
 81-100%  
 I don't know

Maintaining the EHR (e.g., implementing break fixes, platform upgrades, clinical content updates)

0 - 20%  
 21 - 40%  
 41 - 60%  
 61 - 80%  
 81-100%  
 I don't know

Optimizing the EHR (e.g., responding to user suggestions, initiating and implementing evidence-based best practices, performing usability testing)

0 - 20%  
 21 - 40%  
 41 - 60%  
 61 - 80%  
 81-100%  
 I don't know

Evaluating EHR performance (e.g., measuring the impact of interventions to improve EHR performance)

0 - 20%  
 21 - 40%  
 41 - 60%  
 61 - 80%  
 81-100%  
 I don't know

Providing at-the-elbow support and feature assistance

0 - 20%  
 21 - 40%  
 41 - 60%  
 61 - 80%  
 81-100%  
 I don't know

Providing end-user group training

0 - 20%  
 21 - 40%  
 41 - 60%  
 61 - 80%  
 81-100%  
 I don't know

Other function(s) (please describe below)

0 - 20%  
 21 - 40%  
 41 - 60%  
 61 - 80%  
 81-100%  
 I don't know

Please describe the other function(s)

---

How many total FTEs are employed to perform these functions?

- 1-10
- 11-50
- 51-100
- 101-300
- More than 300
- I don't know

---

What percentage of your institution's total annual operating budget do these FTEs comprise?

- 0 - 0.1%
- 0.1 - 0.5%
- 0.5 - 1.0%
- 1.0 - 2.0%
- 2.0 - 3.0%
- 3.0 - 4.0%
- 4.0 - 5.0%
- More than 5.0%
- I don't know

---

Into which functional area(s) of your institution do these FTEs report?

- Information Technology
- Healthcare
- Research
- Education
- Other (please provide below)
- I don't know

---

Other functional area(s)

---

Does your institution utilize contractors to perform any of the functions listed above (implement, maintain, optimize, evaluate, train, support)?

- Yes (please describe below)
- No
- I don't know

---

Which of these function(s) do contractors perform?

- Implement
- Maintain
- Optimize
- Evaluate
- Train
- Support
- Other (please describe below)
- I don't know

---

Other function(s):

**Please answer the following questions with respect to the processes and technology supporting your primary EHR and its users.**

Does your organization use a formal intake process for EHR work requests?

- Yes - for all requests
- Yes - for certain types of requests (please describe below)
- No
- I don't know

---

Please describe the types of requests.

---

Does your organization use a formal governance process for reviewing and approving EHR work requests?

- Yes - for all requests
- Yes - for certain types of requests (please describe below)
- No
- I don't know

---

Please describe the types of requests.

---

Does your organization use a formal process for prioritizing EHR work requests?

- Yes - for all requests
- Yes - for certain types of requests (please describe below)
- No
- I don't know

---

Please describe the types of requests.

---

**Please answer the following questions with respect to EHR leadership.**

---

Does your institution have stated strategic goals and operational objectives with respect to its EHR systems?

- Yes (please describe below)  
 No  
 I don't know

---

Please describe your goals and objectives.

---

Does your institution employ metrics to measure progress toward these goals and objectives?

- Yes (please describe below)  
 No  
 I don't know

---

Please describe your metrics.

---

Has the institution's operating model (people, processes, technology) for EHR management and support changed since its first EHR was implemented?

- Yes (please describe below)  
 No  
 I don't know

---

Please describe how your operating model has changed, and why it has changed.

---

Are there particular aspects of the operating model that you believe significantly impact EHR performance positively or negatively?

- Yes (please describe below)  
 No  
 I don't know

---

Please describe the aspects you believe affect EHR performance positively.

---

Please describe the aspects you believe affect EHR performance negatively.

---

Please use this space to provide any additional thoughts you'd like to share with the study team.

## B: Interview Guide

*STUDY00019289: Electronic Health Record Operating Models*

### **Interview Guide**

*updated 4/3/19*

Following survey completion, the co-investigator will contact survey respondents who have requested a summary of the survey findings via email and ask if they would be willing to participate in a short (less than 30-minute) phone call to review and provide feedback on selected survey data. This *member-checking* activity helps support qualitative data validity and analysis.

The co-investigator will ask respondents the following questions:

- What are your impressions as you review the responses to the question “Please describe your goals and objectives”?
- What are your impressions as you review the responses to the question “Please describe your metrics”?
- What are your impressions as you review the responses to the question “Please describe how your operating model has changed, and why it has changes3d”?
- What are your impressions as you review the responses to the question “Please describe the aspects you believe affect EHR performance positively”?
- What are your impressions as you review the responses to the question “Please describe the aspects you believe affect EHR performance negatively”?
- What are your impressions as you review the responses to the question “Please use this space to provide any additional thoughts you’d like to share with the study team”?