Nursing domain of CI governance: recommendations for health IT adoption and optimization

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ABSTRACT

Context There is a lack of recommended models for clinical informatics (CI) governance that can facilitate successful health information technology implementation.

Objectives To understand existing CI governance structures and provide a model with recommended roles, partnerships, and councils based on perspectives of nursing informatics leaders.

Design, Setting, Participants We conducted a cross-sectional study through administering a survey via telephone to facilitate semistructured interviews from June 2012 through November 2012. We interviewed 12 nursing informatics leaders, across the United States, currently serving in executive- or director-level CI roles at integrated health care systems that have pioneered electronic health records implementation projects.

Results We found the following 4 themes emerge: (1) Interprofessional partnerships are essential. (2) Critical role-based levels of practice and competencies need to be defined. (3) Integration into existing clinical infrastructure facilitates success. (4) CI governance is an evolving process. We described specific lessons learned and a model of CI governance with recommended roles, partnerships, and councils from the perspective of nursing informatics leaders.

Conclusion Applied CI work is highly interprofessional with patient safety implications that heighten the need for best practice models for governance structures, adequate resource allocation, and role-based competencies. Overall, there is a notable lack of a centralized CI group comprised of formally trained informaticians to provide expertise and promote adherence to informatics principles within EHR implementation governance structures. Our model of the nursing domain of CI governance with recommended roles, partnerships, and councils provides a starting point that should be further explored and validated. Not only can the model be used to understand, shape, and standardize roles, competencies, and structures within CI practice for nursing, it can be used within other clinical domains and by other informaticians.

Key words: Clinical Informatics, Nursing Informatics, Governance, Interprofessional, Health Information Technology, Model development

INTRODUCTION

Adoption of electronic health records (EHRs) is rapidly increasing at integrated health care systems (IHSs) across the United States.1 This adoption is the start of a movement toward intelligent clinical systems that optimize patient care by exchanging information, supporting decision-making, and facilitating the coordination of care delivery among members of the care team and with patients. The configuration, implementation, and optimization of a vendor-based EHR require significant clinical informatics (CI) expertise.2 CI is defined as the application of informatics and information technology to deliver health care services and is referred to as applied CI and operational informatics (www.amia.org). Recently, Detmer and Shortliffe described the distinction between CI and health information technology (HIT): “Clinical informatics is not simply ‘computers in medicine’ but rather is a body of knowledge, methods, and theories that focus on the effective use of information and knowledge to improve the quality, safety, and cost-effectiveness of patient care as well as the health of both individuals and populations.”3

The CI governance structure and roles needed for successful EHR adoption is an understudied, though frequently discussed, topic with local and national implications for EHR adoption. One key discussion point is the phenomena of “lumping” (grouping together) or “splitting” (keeping siloed) the roles of those working in various clinical domains, such as nursing, medicine, and other health professions, within a CI governance structure. This notion has been debated, including the position that “circumscribed roles related to deployment and configuration of electronic health records in pursuit of...
meaningful use" are not CI roles, unless those roles require individuals with CI cross-training such as a Chief Medical or Nursing Information Officer. This position implies that some roles focused on EHR adoption may be considered CI roles and others not, depending on the level of competency training required. There is a need to understand the CI roles, partnerships, and councils that are emerging to provide empirical justification of the resources and CI training necessary for successful EHR implementation and ongoing optimization. At the national level, comparing roles and organizational structures can establish clear metrics to measure health IT investment and demonstrate its economic value. Nurses, being the largest health care workforce and a type of clinician particularly skilled at coordinating care and understanding workflows, serve as the vast majority of clinically experienced staff who are directly involved with configuring, implementing, and optimizing the EHR for all clinical disciplines, not just nursing. The aim of the study was to understand existing CI governance structures for EHR adoption and optimization and provide a model with recommended roles, partnerships, and councils from the perspective of nursing informatics leaders.

METHODS
Study design and sample
We conducted a cross-sectional study through administering a survey via telephone to facilitate semistructured interviews from June 2012 through November 2012. Our inclusion criteria included nursing informatics leaders in the role of executive or director of an IHS that had at least one acute care hospital and we defined as a pioneer organization in enterprise-wide EHR adoption. We defined an IHS as a pioneer organization if it had multiple years of experience in configuration, implementation, and optimization of an enterprise-wide EHR and had reached Health Information Management Systems Society (HIMSS) Analytics’ Electronic Medical Record Adoption Model (EMRAM; HIMSS Analytics, Chicago, IL) level 6 or greater, or were undergoing enterprise-wide EHR adoption. Nine organizations had achieved HIMSS level 6 or greater, or were undergoing enterprise-wide in- 

consent was obtained. The interviews were audio-recorded and transcribed. The survey consisted of the following 4 sections: (1) organizational characteristics, (2) participant characteristics, (3) governance structure, and (4) lessons learned (see online appendix A). The governance structure section included 2 parts that repeated the same set of questions about decision-making, committees, interprofessional collaboration, roles within their organization, as well as facilitators and barriers for successful CI governance. The first part was specific to the overall CI governance of the organization and the second part was specific to the nursing informatics domain. Throughout the interview, the interviewer elicited the participants’ perceptions by asking probing questions such as the following: (1) Can you tell me about how well that has worked? (2) What changes have been made or would you suggest?

Data analysis
Interview data were iteratively analyzed using grounded theory techniques of open, axial, and selective coding to identify overlapping themes related to governance structure and CI roles. We used NVivo (QSR International Pty Ltd, Melbourne, Australia) qualitative data analysis software to perform open coding to identify and describe phenomena found in the interview data, axial coding to relate those codes to each other, and selective coding that served as the organizing principles for our developed model. Data were collected until thematic data saturation in our open coding was reached. In addition to NVivo coding, diagrams of each IHS’s organizational CI structure were drawn and iteratively compared and synthesized into an amalgamated diagram of CI roles, partnerships, and councils for nursing. These diagrams and coding results were used to iteratively develop the model of CI governance for the nursing domain with recommended roles, partnerships, and councils. Initial coding was performed by SAC, independently validated by JM and DA, and discussed in group sessions with SAC, JM, and DA for consensus in thematic coding results and development of the model.

RESULTS
Organizational and participant characteristics
The 12 semistructured phone interviews lasted between 30 and 60 minutes each and had a 100% response rate. The interviews were conducted with 6 Chief Nursing Information Officers (CNIO), 4 Directors of Nursing Informatics, 1 Chief CI Officer, and 1 Chief Information Officer. All participants had a clinical nursing background. The highest level of formal education for each participant comprised the following: doctor of nursing practice (n = 3), postmasters certificate informatics (n = 3), masters in nursing or business administration (n = 5), and bachelor’s degree (n = 1).

The participants represented health systems with a range of 1-35 hospitals per system and an average of 12 hospitals per system. All health systems (12 of 12) used vendor-based EHRs. Nine health systems used 1 EHR vendor enterprise-wide, and 3 used a blend of multiple EHR vendors across the health system but were moving toward 1 integrated enterprise-wide EHR. Nine organizations had achieved HIMSS
Analytics’ EHR adoption level 6 and 1 had achieved HIMSS Analytics EMRAM level 7. The remaining 2 organizations did not use HIMSS criteria but had mature systems that were undergoing enterprise-wide standardization and optimization of prior EHR implementations (i.e., legacy systems or blend of EHR systems) for integration of a vendor-based EHR across sites. The shared and overall goal of EHR implementation and optimization among all participating sites was to achieve an enterprise-wide standardization of the EHR across the IHS.

Only 16% (2 of 12) of the participants described that their organization included all clinical disciplines in their definition of CI governance structure. Eight participants defined CI at their organization as including only nursing and allied health professionals, 1 participant defined it at her organization as only nursing, and 1 participant stated that her organization did not define CI. The participants that excluded medicine from their organization’s definition of CI considered medical informatics to be a separate operational focus. Six of the nursing informatics leaders reported through nursing to the Chief Nursing Officer (CNO), 3 reported through information systems (IS) to the Chief Information Officer (CIO), 2 reported through a combination of nursing and IS to both the CNO and the CIO, and 1 reported through IS to the Chief Medical Information Officer (CMIO).

Coding results: attributes of model of CI governance for nursing domain
A total of 128 open codes were developed, each with an average of 13.8 references to the interview text. These 128 open codes were organized into 18 axial coding categories. The categories were synthesized into attributes in our “Model of CI Governance for Nursing” with recommended roles (figure 1), partnerships (figure 2), and councils (figure 3).

Selective coding resulted in the following 4 high-level themes of our developed model: (1) Critical role-based levels of practice and competencies need to be defined. (2) Interprofessional partnerships are essential. (3) Integration into existing clinical infrastructure facilitates success. (4) CI governance is an evolving process (table 1). Overall, the themes indicated that existing clinical governance structures were used to insert CI roles throughout the organization, and these roles leveraged interprofessional partnerships across siloed clinical governance structures.

Critical role-based levels of practice and competencies need to be defined
Our coding defined the following 11 nursing roles within clinical and nursing informatics at 5 levels within a health care organization: (1) CNO, (2) CNIO, (3) Director of Professional

<table>
<thead>
<tr>
<th>Clinical Informatics Practice</th>
<th>Key Roles</th>
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<tbody>
<tr>
<td><strong>Levels of Practice</strong></td>
<td><strong>Roles</strong></td>
</tr>
<tr>
<td>Top Leader that Values, Invests in, and Supports Interprofessional Informatics</td>
<td>Chief Officers (e.g., Nursing, Medical)</td>
</tr>
<tr>
<td>Centralized and Strategic Leader with Decision-making Authority and Operational Oversight</td>
<td>Chief Information Officers (e.g., Nursing, Medical)</td>
</tr>
<tr>
<td>Experts to Evaluate and Optimize System Design and Align and Enhance Interprofessional Informatics Practice</td>
<td>Director of Professional Competencies, Director of Clinical Process Transformation, Clinical Informaticians</td>
</tr>
<tr>
<td>Respected Leaders to Manage Projects, Make Decisions, and Engage Clinicians to Ensure Strategic Goals, Practice Goals, and End-User Needs Are Met</td>
<td>Clinical Informatics Managers, Clinical Informatics Champions</td>
</tr>
<tr>
<td>Expert Clinicians and End-Users that Communicate Clinical Relevance for System Design</td>
<td>Training Specialists, Clinical Informatics Coordinator, Super Users, Subject Matter Experts</td>
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</tbody>
</table>
### Figure 2: Model of CI Governance for Nursing: Critical Partnerships.

<table>
<thead>
<tr>
<th>Key Nursing Informatics Roles</th>
<th>Key Interprofessional Partnerships*</th>
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<tbody>
<tr>
<td>Chief Nursing Officer</td>
<td>Chief Medical Officer</td>
</tr>
<tr>
<td>Chief Nursing Information Officer</td>
<td>Chief Information Officer</td>
</tr>
<tr>
<td>Director of Professional Competencies</td>
<td>Chief Analytics/Knowledge Officer</td>
</tr>
<tr>
<td>Director of Clinical Process Transformation</td>
<td>Medical Informatician</td>
</tr>
<tr>
<td>Nurse Informatician</td>
<td>Director of Clinical Systems</td>
</tr>
<tr>
<td>Clinical Informatics Managers</td>
<td>Directors of Analytics/Knowledge Management</td>
</tr>
<tr>
<td>Nurse Informatics Champions</td>
<td>Physician Informatics Champions</td>
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<tr>
<td>Training Specialists</td>
<td>Clinical Systems Managers</td>
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<tr>
<td>Clinical Informatics Coordinator</td>
<td>Super Users</td>
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<tr>
<td>Super Users</td>
<td>Nursing Subject Matter Experts</td>
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<tr>
<td>Nursing Subject Matter Experts</td>
<td>Builders</td>
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<tr>
<td>Medical Subject Matter Experts</td>
<td>Clinical Analysts</td>
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*Example interprofessional partnerships are shown and not intended to be exhaustive of all roles and titles.

### Figure 3: Model of CI Governance for Nursing: Hospital Shared Governance Councils.

**Interprofessional Council Structure Recommendations**

- **Executive Steering Committee**
  - Nursing and Patient Care Services Executive Council
  - Interprofessional Clinical Informatics Advisory Steering Committee (Co-Chairs CNO and CMIO)
  - Medical Executive Council

- **Interprofessional Clinical Informatics Workgroup** (Co-Chairs Nurse Champion and Physician Champion)
  - System Standardization Council
  - Patient Safety Council
  - Patient Advisory Council
  - Front Line User Group Council
  - Clinical Process Advisory Council
  - Clinical Analytics Advisory Council

*Interprofessional cross-council coverage*
The role of Director of Professional Competencies emerged from our data and, to our knowledge, is a new role. We have defined it based on our data as the role responsible for implementing and conducting a program to build CI competencies for employees in CI roles. This role was recommended as essential to implement a program that results in employees with role-based CI competencies across all care continuum settings. The timeline for EHR implementation projects is fast, and overall efforts to raise the CI competencies of people working on them have not caught up:

One participant stated, “There is a lot of confusion about CI as a discipline.... I am working....to develop a web-based description of nursing informatics practice....so that they understand we have a responsibility to advance competencies.”

Across organizations at the lower level of the hierarchy, nurses are doing interprofessional HIT work, including training and supporting workflows that cut across clinical domains such as nursing, medicine, and pharmacy. “One nurse....is primarily responsible for clinical decision support and alerts....nursing and clinical documentation, but also CPOE and our physician electronic notes.”

Nursing informatics roles at the lower level of the hierarchy may start as part-time but typically become full-time, given the workload. One nurse leader explained that “these nursing roles are 50% committed to the HIT project and then they stay in their [clinical] roles for the other 50%. However, as it has evolved, almost all....are fully committed.”

During the interviews, an important question was raised, What will these noninformatics-trained, full-time–employed clinicians do once an EHR implementation project ends and resources decrease? Participants did not provide further pertinent comments or answers to this question, which was posed and then probed during the interviews; rather, they conveyed that they were aware this might be a future issue for organizations.

### Table 1: CI Governance Themes and Examples of Theme in Action

<table>
<thead>
<tr>
<th>Theme</th>
<th>Example of Theme in Action</th>
<th>Model Component</th>
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<tbody>
<tr>
<td>1. Critical role-based levels of practice and competencies need to be defined</td>
<td>Nurses on the ground are responsible for multi-professional CI work</td>
<td>Roles (Figure 1)</td>
</tr>
<tr>
<td>2. Interprofessional partnerships are essential</td>
<td>Parallel system and hospital level roles</td>
<td>Partnerships (Figure 2)</td>
</tr>
<tr>
<td>3. Integration into existing clinical infrastructure facilitates success</td>
<td>Committees embedded in hospital shared governance structures</td>
<td>Councils (Figure 3)</td>
</tr>
<tr>
<td>4. CI governance is an evolving process</td>
<td>Periodic re-evaluation of committee participants, end-user engagement, and definition of informatics roles</td>
<td>Overall implications for Governance Structure</td>
</tr>
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</table>

Interprofessional partnerships are essential

Figure 2 demonstrates the roles and critical partnerships across domains and the implications for lumping and splitting of clinical domains within roles along the CI hierarchy. The stated roles are intended to demonstrate common critical interprofessional partnerships and are not meant to be an exhaustive list. Within a CI governance model, organizations typically split clinical domains at the top of the organizations’ CI hierarchy (CNIO and CMIO), but lump domains—primarily within the nursing reporting structure or IS reporting structure—at the bottom of the organizations’ CI hierarchy. This was clearly articulated by one leader:

We follow the ANA [American Nurses Association] scope of practice which includes focusing on all disciplines [professions]. At the bottom level we have CI support specialists and they support medicine as well as nursing and other disciplines [professions]. But at the highest level we distinguish between nursing and medicine. We have a CNIO and CMIO who are very closely partnered and model that partnership all the way down.

The visualizations of each IHS’s governance structure (which informed figures 1 through 3) and the participants’ perceptions of the components that made that governance
structure successful clearly displayed parallel roles at the system level and the hospital level for CI governance. These parallel roles were corroborated in our interview data, as one participant remarked: “Yes, there are counterparts throughout the governance structure between nurses and physicians and at the top level we all sit together... this is happening at all levels, at the unit level, departmental level, hospital level, and health system level.” Based on this data, our Model of CI Governance for Nursing is intended to be generalizable to both the system and hospital level. Yet, while this parallel approach is seen as beneficial, one participant explained its challenges:

“At a corporate level managing governance for hospitals is really tough. So how much do you direct from a corporate perspective down to a hospital level and how much do you let the hospitals do their own thing. I think we have got to also look at where standardization is key and where we can have variability.”

Integration into existing clinical infrastructure facilitates success
Our model aims to demonstrate how CI efforts may successfully integrate with existing shared governance structures for the nursing domain. Participants’ examples of this successful integration were expressed as the following: (1) “Nursing Informatics Council brings together nurses from OB, rehab, ED, and critical care... also IT nurses.” (2) “Within our nursing governance, our quality council, our educator’s council, and other different groups... we have Nursing Informaticist as a regular member.”

The shared governance council structure illustrated in Figure 3 is embedded within a typical but simplified hospital shared governance structure to convey contextual information on how such a model may be implemented.12-14

The EHR steering committee is an interdisciplinary committee. It has representatives from physician groups, administration, and clinical departments. We have a cross-section of membership and bring people in ad hoc depending on the topic. We have representatives from our medical records department, case management. I [CNIO] sit on it. Several people from the Clinical IT steering committee sit on the EHR Steering Committee. It is several of us, the CNO, CMIO and me. I partner closely with the CNO, and the CMIO partners closely with the CMO. In other words you have your operational VP, and each of us in the senior IT role partner with them. So we are all there together. I help Chair the Clinical IT Steering Committee. I co-Chair it with the CNO.

CI governance is an evolving process
Leaders interviewed believe that CI governance is an evolving process in a system that is “always trying to do things better and smarter.” Governance and council representation should be revisited as an organization’s clinical applications mature because “the real value... since we have sort of a mature system, would be to bring in front line users... versus clinical educators.” An interprofessional and shared governance structure for CI may facilitate that evolution by “trying to decrease our number of committees. We have a new CIO who is more collaborative than our old CIO... and we are trying to integrate IT and informatics.”

These evolving processes include new informatics roles to evaluate complex problems and align solutions with strategic initiatives such as Accountable Care Organizations. One participant states:

My role... is not in the day to day operations [anymore]… I am truly in a position where I can get out with the leadership and the front line staff and learn what the challenges are, lead initiatives to improve our processes, our workflow and our utilization of the EHR... make sure that whatever we put in place serves not only the physicians well, but also works with the nurses’ workflow and ultimately the patient, who is at the center of everything we do. In the past I was more of a firefighter. Now I think I can make a difference and an impact with what I do.

Lessons learned, perceived barriers, and facilitators to success from the nursing domain
Effective communication within an organization is critical. Specifically, top-down communication must clearly delineate strategies and tactics for achieving system standardization, processes for change management decisions, the capability of the EHR, and expectations for professional competencies. Bottom-up communication must include transparent processes for patient-safety issues, change management requests, end-user requests, and workflow requirements.

The characteristics of CI governance that facilitated successful implementation and adoption of EHRs were: (1) experienced clinicians who had CI skills and competencies to articulate clinical and technology needs; (2) a CI strategy that fit within the organization’s overall strategic plan; (3) explicit guiding principles for CI decision-making that were common among all councils and aligned with the overall EHR strategy; (4) an escalation process for contentious decisions; (5) CI councils with inclusive representation modeled after shared governance; and (6) full-time CI staff who did not have patient care responsibilities.

Barriers to success included a lack of resources for the following: (1) staff development that included professional CI competencies; (2) EHR training; (3) hiring of experienced clinicians into CI/EHR roles; and (4) iterative optimization of the EHR system post-implementation. Other barriers included decreased support and perceived value of CI from the organization’s leadership post-EHR implementation.
Finally, we found a significant challenge to be the inherent organizational complexity of an IHS. A main challenge for CI work within an IHS has been finding the balance between standardizing the EHR at the health system level while allowing for appropriate autonomy of practice decisions at each hospital, particularly taking into account the limitations of existing vendor-based EHRs.

**Model of CI governance for the nursing domain**

Based on our data, we developed a model of CI roles, partnerships, and councils for the nursing domain. Within a CI governance structure, our model may help delineate roles that require formal CI education, training, and competencies while distinguishing from roles that require health IT workforce education and certification training requirements. The model conveys inclusive and cross-disciplinary representation on all councils to promote cross-population of ideas and alignment of efforts. For example, a nurse should sit on the physician advisory council, and a physician should sit on the nursing advisory council. Additionally, each council should include a representative with expertise or seniority in that particular area that can act in an advisory role as necessary, and 1 of the 2 co-chairs of each council should be a front-line end user.

Importantly, the extent of representation by formally trained informaticians on each council was unclear in our data. It was clear, however, that organizations struggled with the lack of trained informatics roles available for EHR implementation projects. These roles include a range of formally trained informaticians and health IT professionals that have taken informatics courses and obtained certifications. In some cases, organizations have formally responded to this lack of training with the implementation of roles such as the Director of Professional Competencies.

Our data indicated that a CI workgroup could serve as an effective forum for daily CI decision-making. Contentious decisions may be escalated to an Interprofessional CI Advisory Steering Committee. The organizations interviewed perceived that the integration of CI councils into the existing shared-governance council structure led to collaborative interprofessional councils with appropriate representation and empowered decision-making that are capable of handling contentious decisions and mitigated the need for frequent escalation.

**DISCUSSION**

IHSs that have successfully implemented an EHR can offer strategies for success and lessons learned to other institutions catching up on the implementation of CI governance and EHR adoption. EHR standardization is a means to achieve safe and efficient systems for patient care, and it is widely believed, based on theoretical and empirical data, that there is great clinical and economical value in health IT. A common understanding of a best practice model for CI governance roles, partnerships, and councils may facilitate understanding and standardization of best practices for effective health IT and measurement of contextual factors of health IT for comparative evaluation of the value of health IT across systems.

Defining the clinical domains included in operational CI governance structures within health care systems is critical. The phenomena of lumping CI work across clinical professions and domains at the bottom of the hierarchy may initially be seen as a solution for greater integration across traditionally siloed professions, but it may be problematic given that most CI and strategic decisions are made at higher levels within the hierarchical governance structure. For example, a CI Coordinator who is an experienced nurse may offer valuable insights into the workflow dependencies of computerized provider order entry (CPOE), but those insights may not become visible if the organization’s CI strategy and governance structure is a barrier to bottom-up communication. Conversely, the finding that domains are typically lumped together at the bottom of a CI hierarchy raises questions about the allocation of resources within one domain’s reporting structure. Nursing informatics leaders spoke about the need for greater visibility of this cross-domain work to garner resources for adequate staff to conduct interprofessional CI/EHR work and support and align competency expectations.

It is clear from our findings that maintaining distinct, but partnered, leadership roles for each clinical domain are critical. These critical leadership roles and partnerships are conveyed in figure 2 (eg, CNIO to CMIO to CIO). Further investigation should be conducted to discover if and how constituents from all clinical domains and informaticians should have shared representation in CI roles.

A centralized CI group comprised of informaticians who are experts in topics such as knowledge management, information modeling, and reference standards for an EHR implementation project was not apparent in our data. This may be due to limitations in our data collection techniques such as the survey questions used. However, we believe that those potential data collection limitations do not fully explain the lack of emergence of a centralized CI group of formally trained informaticians from our data because none of the visualizations of each organization’s governance structure included such a group. We did find evidence of councils consistent with promoting foundational CI principles such as a system standardization council. However, our data suggested that the representation on such councils was clinically focused and did not emphasize expert input from formally trained clinical informaticians. As an applied and interprofessional discipline, CI for EHR and health IT adoption at health care organizations require expertise and activities across a variety of informatics areas such as clinical decision support (CDS), workflow integration, requirements analysis, usability, and feasibility. Interestingly, one published analysis described CDS for clinical guidelines as a complex and advanced area that requires managing system dependencies (eg, workflow integration, knowledge management) and associated it with later adoption in the context of HIMSS Analytics’ EMRAM and...
Meaningful Use.19 Our data demonstrated that organizations realized their CI governance structure needed to evolve as their EHR implementation project matured and that informatics roles evolved to enable thoughtful problem identification and systems-based solutions leveraging informatics principles as opposed to roles that were “more of a firefighter.” One interpretation of this data in the context of other published literature suggests that as the complexity of an EHR implementation project and system increases, there is a greater need for CI roles with formal training to handle the implementation of advanced and complex features aligned with HIMSS Analytics’ EMRAM levels 6 and 7 that require management of multiple dependencies across clinical settings and domains.2,18,20 Further research should explore this notion across a wider sample of data.

CI governance roles, partnerships, and councils must actively provide adequate breadth and depth of informatics knowledge as it applies to the clinical setting in the context of clinical information systems. The following are examples of CI projects that require both breadth and depth of expert informatics knowledge: (1) useful CDS that target the appropriate user and workflow while avoiding unintended consequences21–24; (2) shared documentation platforms for patient-centered care planning; and (3) effective data governance to reduce duplication of clinical content as a critical foundation for a learning health system.25 Teams with adequate breadth of CI knowledge to draw upon will avoid unanalyzed assumptions that may lead to dissatisfaction with electronic health records (EHRs) at best and unsafe patient care environments at worst. Likewise, as technology advances, teams with adequate depth of CI knowledge will be better prepared to handle innovations such as shared documentation that require increasingly complex engineering and policies to support emerging models of collaborative and patient-centered care.26,27 In addition, emerging roles within the information services governance structure must be included as collaborative partners to support the work of achieving a learning health system such as chief analytics and knowledge officers and their respective departments and roles.28

Harnessing clinical expertise is imperative to convey clinical needs and prevent unintended consequences. Experienced clinicians working in CI and EHR roles must acquire understanding and competency in anticipating how complex technology introduces new patient safety risks.29 The Office of the National Coordinator for Health IT developed certification curriculum to expand the health IT workforce, and made it publically available. A strong understanding of CI principles, safety cultures, and interprofessional collaboration can mitigate risks, yet the appropriate level of understanding and competency per role remains unknown. Additionally, it appears that an appropriate structure and engagement model for a centralized group of informatics experts within an EHR implementation project has not been realized. Further investigation is needed to map the critical role-based functions of CI professionals to CI and/or EHR workforce training and competencies.

CONCLUSION
We know that an effective system is greater than the sum of its parts, and we conclude that effective CI governance comprises well-defined professional and practice-based roles, critical interprofessional partnerships, and shared interprofessional councils.30 There is a significant need for further research to evaluate if the best practice for CI governance and health IT work involves lumping or splitting clinical domains, and at what level within an organization hierarchy this would be appropriate. The interprofessional nature and patient safety implications inherent in CI work heightens the criticality for attention to best practice models for applied CI governance structures in IHSs to ensure adequate resource allocation and role-based CI and interprofessional competencies. The model proposed in this study is based on nursing informatics leaders’ perceptions of successful roles, partnerships, and councils based on their experience as leaders in formalizing and optimizing the CI governance at their IHS. Further research should validate and extend our proposed model to incorporate the perspective of other clinical professional domains and informaticians involved in CI governance and HIT adoption. This would also provide a starting point to compare HIT implementation resources across sites for value-based comparisons. Finally, future work focused on CI governance should validate the proposed model as health care IT continues to evolve and extend beyond configuration and optimization of the EHR to include emerging technologies and the integration of clinical, financial, and administrative systems, and data analytics.

DATA SHARING
Reprint requests may be made by contacting the corresponding author.

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CONTRIBUTORS
SAC led the conception and design of the study with contributions from JM and DA. SAC led the data acquisition and analysis with contributions from JM and DA. SAC, JM, and DA contributed to the interpretation of data. SAC, JM, and DA contributed to the drafting and critical revisions of the manuscript for important intellectual content and for the final approval of the version to be published.

COMPETING INTERESTS
None.

SUPPLEMENTARY MATERIAL
Supplementary material is available online at http://jamia.oxfordjournals.org/.
REFERENCES


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