

# Lessons Learned for Collaborative Clinical Content Development

S.A. Collins<sup>1,2,3</sup>; K. Bavuso<sup>1</sup>; G. Zuccotti<sup>1,2,3</sup>; R.A. Rocha<sup>1,2,3</sup>

<sup>1</sup>Partners Healthcare System, Wellesley, MA; <sup>2</sup>Division of General Internal Medicine and Primary Care, Brigham and Women's Hospital, Boston, MA; <sup>3</sup>Harvard Medical School, Boston, MA

## Keywords

Knowledge management, content development, standardization, governance, program evaluation

## Summary

**Background:** Site-specific content configuration of vendor-based Electronic Health Records (EHRs) is a vital step in the development of standardized and interoperable content that can be used for clinical decision-support, reporting, care coordination, and information exchange. The multi-site, multi-stakeholder Acute Care Documentation (ACD) project at Partners Healthcare Systems (PHS) aimed to develop highly structured clinical content with adequate breadth and depth to meet the needs of all types of acute care clinicians at two academic medical centers. The Knowledge Management (KM) team at PHS led the informatics and knowledge management effort for the project.

**Objectives:** We aimed to evaluate the role, governance, and project management processes and resources for the KM team's effort as part of the standardized clinical content creation.

**Methods:** We employed the Center for Disease Control's six step Program Evaluation Framework to guide our evaluation steps. We administered a forty-four question, open-ended, semi-structured voluntary survey to gather focused, credible evidence from members of the KM team. Qualitative open-coding was performed to identify themes for lessons learned and concluding recommendations.

**Results:** Six surveys were completed. Qualitative data analysis informed five lessons learned and thirty specific recommendations associated with the lessons learned. The five lessons learned are: 1) Assess and meet knowledge needs and set expectations at the start of the project; 2) Define an accountable decision-making process; 3) Increase team meeting moderation skills; 4) Ensure adequate resources and competency training with online asynchronous collaboration tools; 5) Develop focused, goal-oriented teams and supportive, consultative service based teams.

**Conclusions:** Knowledge management requirements for the development of standardized clinical content within a vendor-based EHR among multi-stakeholder teams and sites include: 1) assessing and meeting informatics knowledge needs, 2) setting expectations and standardizing the process for decision-making, and 3) ensuring the availability of adequate resources and competency training.

## Correspondence to:

Sarah A. Collins, RN, PhD  
Partners Healthcare Systems  
93 Worcester St.  
Wellesley, MA 02481  
Telephone: (781) 416-9287  
Fax: (781) 416-8912  
E-mail: sacollins@partners.org

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## Introduction

Accelerated adoption of enterprise-wide vendor-based Electronic Health Records (EHRs) has increased across the country since the Health Information Technology for Economic and Clinical Health (HITECH) Act in 2009, largely to meet requirements for Meaningful Use [1, 2]. The accelerated nature of this work results in the allocation of limited resources and time for the completion of critical steps in adopting a vendor EHR system. EHR vendors typically provide customers with generic content for an EHR system, requiring the customer to configure the content to meet the specific clinical needs of their site(s). Careful configuration of EHR content is critical for a system that is optimized for patient care [3]. Effective content configuration requires methodological approaches to knowledge management for standard clinical terminology representation and structured data capture as an integral part to achieving interoperability, continuous innovation, and a learning health system [3]. Terminology mapping that is internally consistent and useful is dependent on the creation of content with a standardized structure and nomenclature that is reflective of the actual work done by clinicians [4]. These knowledge management efforts facilitate the usability, functionality, and efficiency of an EHR overtime and the capability of the system to improve clinical decision-support, patient safety, and continuity of care [4].

Configuration and implementation of an EHR for a healthcare organization is a resource intensive process involving a variety of clinical, business, HIT and informatics stakeholders [5]. Due to this resource intensive process, an organization's ability to simultaneously attend to important informatics and knowledge management principles, such as mapping to standard reference terminologies and optimization of content for decision support and data reuse, is frequently limited [3]. Often, knowledge management and content optimization processes are only attended to as post-implementation activities [6]. Established governance (e.g., decision-making) processes, clear expectations, and adequate resources to maintain informatics standards facilitate the development of content that is ready, not only for mapping to standard reference terminologies, but also optimized for decision support, data reuse, reporting, and information exchange [7]. The speed at which EHR deployments are occurring is unprecedented within the healthcare system. Governance and internal institutional processes to support rapid and large-scale configurations of vendor-based EHRs warrant attention. This attention should focus on movement toward best-practice recommendations for clinical content development, particularly to ensure that the content is optimized for long-term maintenance as patient care needs evolve.

## Objective

To further our understanding of best practices for a Knowledge Management (KM) team involved in EHR content creation and configuration, we conducted a formal project evaluation of the roles, governance, project management, and resources for the KM team's effort within the Acute Care Documentation (ACD) project at Partners Healthcare Systems (PHS). The ACD project was a multi-site, multi-stakeholder project at PHS that developed highly structured clinical content for configuration in an EHR with adequate breadth and depth to meet the needs of all types of acute care clinicians at two academic medical centers. A detailed description of the project is included below.

## Methods

To situate our approach in evaluating the role, governance, and project management for the KM team's work in standardizing clinical content, we followed the six-step Program Evaluation Framework endorsed by the Center for Disease Control and Prevention (CDC) [8]. The six steps are:

1. engage stakeholders
2. describe the program
3. focus the evaluation,
4. gather credible evidence,
5. justify conclusions, and
6. ensure use and share lessons learned [8].

## Engagement of stakeholders

The KM team at PHS is comprised of team leaders, informaticians, knowledge engineers, terminology engineers, and software developers, many with clinical training and experience. Individuals within the KM team who specialized in clinical documentation content led the informatics-related efforts of the ACD project. The study investigators (i.e., authors) were leaders and informaticians from the KM team. The investigators engaged individual members of the KM team who had worked on the ACD project as key stakeholders to participate in the evaluation. One of the study authors (KB) also participated in the survey as a key stakeholder. There were eight key KM team stakeholders that had worked on the ACD project and were invited to participate in the qualitative survey. These KM team stakeholders were knowledge engineers, terminology engineers, and software developers, some with clinical training and experience. The evaluation sought to gather their feedback and insight about the KM team's work in the ACD project based on their experiences. Of note, the KM team was an independent team distinct from the content authoring teams, clinical and business stakeholders at the academic medical centers, and the Joint Clinical Content Committee, all of which are described below.

## Description of the Program

In 2007 PHS began a large strategic initiative the ACD project. The aim of the ACD project was to develop content for electronic acute care documentation that was standardized across the two major academic medical centers at PHS, Brigham and Women's Hospital (BWH) and Massachusetts General Hospital (MGH). BWH and MGH are large research based teaching institutions in the metropolitan Boston area with longstanding internally developed, highly tailored, and innovative clinical applications that accommodate diverse workflows but often lack standardization within and across institutions. Taking into account clinical needs, regulatory reporting, and data reuse requirements, along with maintenance and sustainability principles for knowledge management, PHS set the goal for the creation of standardized clinical content that was:

1. highly structured,
2. shared across both institutions, and
3. captured adequate breadth and depth to meet the needs of all types of acute care clinicians.

The content was developed for all clinical disciplines (e.g., nursing, medicine, social work, physical therapy, nutrition, occupational therapy) and sub-specialties (e.g., cardiology, neurology, critical care, labor and delivery, surgery) in the acute care setting. Examples of the types of clinical content created included structured templates for: initial patient assessments, progress notes, procedure and peri-operative care notes, checklists, event notes, transfer notes, discharge notes, clinical assessment scales, and flowsheets. For example, we standardized the data element names and value sets on the initial nursing assessment template across all inpatient units at the two sites to ensure that the same data was collected on every patient by a nurse upon hospital admission. The content created included over 11,000 structured data elements used in over 1,000 template instances, as well as medication content. PHS heralded this multiple stakeholder project for its high level of day-to-day involvement and stakeholder buy-in from clinicians of all health professions and clinical, management, and leadership levels across the two academic centers. Content creation occurred during multiple accelerated design sessions. The accelerated design sessions involved numerous clinical users meeting for an entire day per session to discuss and vote on content and design decisions. These sessions were highly collaborative in that they included clinical users representing both institutions and all clinical domains and disciplines. The sessions were designed to be a scholarly activity by leveraging evidence-based literature to ensure that content decisions reflected best practices and the highest level of evidence.

The KM team created a standard process based on the International Standards Organization/International Electrotechnical Commission (ISO/IEC) 11179 standard for representing metadata [9]. The KM team's work involved creating, structuring, and naming clinical content to avoid ambiguity and duplication, while facilitating re-use within the system and mapping to reference terminology standards. The KM team also implemented and promoted collaborative tools, such as eRoom<sup>®</sup>

(<http://www.eroom.net/>) and Microsoft LiveMeeting® (<http://www.meetingconnect.net/live-meeting/>), to enable remote work between content authoring teams and stakeholders at BWH and MGH, while decreasing the need for frequent in-person meetings and time lost to travel between sites [10]. At the advent of the ACD project, expectations were communicated by the KM team to clinical and business stakeholders for adherence to informatics standards for content development.

Close collaboration and processes for vetting and approval of content were established with the Joint Clinical Content Committee, which was a committee independent of the KM team. The Joint Clinical Content Committee included clinical and compliance stakeholders and authoring teams from each site. The Joint Clinical Content Committee was responsible for vetting the clinical appropriateness of the ACD content and adherence to compliance regulations for documentation. Business stakeholders from each site were responsible for strategic planning, budgeting, and overseeing the timely achievement of deliverables consistent with project goals. The business stakeholders were engaged with the KM team and aware of the KM team's role as informatics and content management experts. The investment to facilitate standardization of the content created across sites and user teams was large, as was the level of clinical engagement. As with most large, multi-site and multi-stakeholder projects, processes related to governance, decision-making, project management, and allocation of resources were established prior to the start of the project and evolved as challenges and facilitators to success were recognized.

## Focus of the Evaluation and Gathering of Credible Evidence

This evaluation is focused on the KM team's perspective, experience, and responsibilities related to four foci for the development of standardized clinical content:

1. the KM team's role,
2. governance (e.g., decision-making processes),
3. project management, and
4. resources.

To gather credible evidence from key KM team stakeholders (step four in the CDC program evaluation framework) a voluntary, semi-structured, online, confidential survey was developed based on qualitative data collection methods. The qualitative survey was organized according to the four foci outlined above. The survey was designed to elicit descriptions of successful and challenging activities, as well as barriers and facilitators to these successes and challenges for each focus. Specifically, for each successful and challenging project activity we asked focused, but open-ended questions about project roles, communication and collaboration, governance and decision-making, informatics practice standards and processes, project management, timelines, and resources (i.e., people, tools, processes, information, and infrastructure). The survey consisted of a total of forty-four questions to adequately cover each topic (see online ► Appendix).

The small size of the team studied, and the inclusion of the team's managers as investigators in the study, posed a challenge in maintaining anonymity of each participant's answers. Managers have a high level of familiarity with the individual work and experiences of those that they manage and would likely have been able to associate anonymized narrative responses to the individual member of the KM team. Therefore, the primary author (SC) who did not have managerial responsibility performed the open coding and was responsible for maintaining the integrity and confidentiality of the raw data and analysis. Other investigators analyzed the open coding results and all investigators collaborated in the data analysis to identify the lessons learned and recommendations. Coding linkages were maintained using QSR International's Nvivo 10 software [11] between the participant responses, open-coding results, lessons learned, and specific recommendations. These linkages serve as the audit trail for the analysis. To justify conclusions and ensure trustworthiness of the data analysis we conducted peer debriefings and member checks. Peer debriefings were small group sessions with the study investigators to validate the lessons learned and recommendations against the open coding and thematic results. Member checks were conducted with the key KM team stakeholders (survey participants) in a focus group style session. During this session, member checks were elicited by presenting and validating the results of the analysis and audit trail and soliciting feedback and revisions, as needed. The member checks provided an opportunity to validate the investigators

interpretation of the survey responses, ensure it was consistent with the participants' intended meaning, refine the coding if there were discrepancies between the investigators interpretation and the survey participants intended meaning, and refine recommendations as needed. Results were shared with all stakeholders, including the ACD project leadership and KM team members through written reports and in-person presentations.

## Results

### Justification of Conclusions and Sharing of Lessons Learned

Six out of eight KM team members completed the online voluntary survey within four months of the end of the ACD project. All eight KM team members participated in the focus group style member check session. Four respondents answered 100% of the questions, one respondent answered 81% (36/44) of the questions, and one respondent answered 34% (15/44) of the questions. On average, the length of the participants' answer per survey item was twenty-two words (range of 1-163 words). Survey responses identified facilitators and barriers to both successful and challenging sub-projects and tasks. The open coding resulted in eleven initial high level categories, each with multiple codes:

1. barriers;
2. facilitators;
3. decision-making process;
4. expectations;
5. informatics standards;
6. participant role;
7. project management;
8. not useful resources;
9. useful resources;
10. responsibility without authority; and
11. timeline.

From this rich coded data set, we identified our final results which are comprised of five lessons learned and thirty specific recommendations associated with the lessons learned (► Table 1). A comprehensive representation of the positive experiences, as well as negative experiences, cited by respondents that directly informed the lessons learned are represented as facilitators and barriers in ► Table 1. The identification of five specific lessons learned is consistent with our objective to understand best practices for the KM team's role, governance, project management, and resources. The five specific lessons learned are:

1. assess and meet knowledge needs and set expectations at the start of the project;
2. define an accountable decision-making process;
3. increase team meeting moderation skills;
4. ensure adequate resources and competency training with online collaborative tools;
5. develop focused, goal-oriented teams and supportive, consultative service based teams.

Lessons one to four each relate to one of our objective foci, respectively:

1. role,
2. governance,
3. project management, and
4. resources.

Lesson five emerged from our synthesis of the evaluation across all four objective foci.

To assist with the implementation of lessons learned and specific recommendations for future projects, we categorized the thirty recommendations along four axes based on our validated analysis of survey responses:

1. a process that needs to be defined prior to the start of project,
2. training that should be conducted prior to the start of project,

3. team responsibility throughout the project,
4. resources that should be established at the beginning of a project and maintained throughout a project.

These axes are included in the key at the bottom of ► Table 1 to indicate the recommendations associated with each axis. For example, in ► Table 1 the first lesson learned, “Assess and meet knowledge needs and set expectations at the start of the project” is associated with recommendations one through seven. Of those, recommendations, numbers one through four are part of axis 1 because they involve analyses and engagement that should be conducted prior to start of project. Recommendation five involves training about informatics standards and processes prior to the start of the project and is, therefore, part of axis 2. Finally, (as shown in ► Table 1) recommendations six and seven are part of axis 3 because they specify that the definition of, and adherence to, timelines is a responsibility throughout project.

## Discussion

Our evaluation of the ACD project highlighted a set of challenges in communicating and enforcing the significance of informatics standards to other stakeholders who are charged with meeting competing clinical and business expectations within a time constraint. We maintain that the expectations of each group of ACD stakeholders were not directly competing, in that evidence-based, vetted clinical content can be developed with standardized structure and nomenclature. However, timeline and resource constraints (human and otherwise) impose external demands to prioritize informatics, clinical, and business stakeholder expectations. We found that clinical requirements were well understood by the multi-stakeholder group and easily gained traction when cited as a rationale for content development requirements. On the other hand, knowledge management and informatics rationales for content requirements were not as well understood and required more formal processes to garner and maintain support of, and adherence to, during decision-making and content development. The maintenance of support for knowledge management and informatics standards was perceived as one of the most challenging aspects of the project. To mitigate these challenges, this evaluation identified five specific lessons learned:

1. assess and meet knowledge needs and set expectations at the start of the project;
2. define an accountable decision-making process;
3. increase team meeting moderation skills;
4. ensure adequate resources and competency training with online collaborative tools;
5. develop focused, goal-oriented teams and supportive, consultative service based teams.

A HIT project is highly interdisciplinary in nature given the mix of clinical, technical, and business backgrounds of individuals involved. This interdisciplinary mix is seen especially in our concluding recommendations for:

1. Early engagement of all clinical leaders to set expectations of technical process, dependencies, and requirements,
2. Provision of formal training about informatics standards and processes, and
3. Establishment of a KM team leader with authority to ensure that standards are abided by.

Our findings highlight the challenges of having team leaders with varied backgrounds (clinical versus IT) and training (patient care versus project management). Clinicians are typically not trained in effective meeting moderation skills and competency in using online collaboration tools. Moreover, we identified that managing expectations for accountability for decisions, adherence to project goals, project charters, and documentation of all decisions is a significant challenge. Our recommendation is not to silo teams based on their background and training, but rather to promote the acquisition of team meeting moderation and project management skills and to set clear expectations for governance processes at the beginning of a project.

Project management and resource challenges included the organization of effective and appropriately sized teams for completion of focused sub-projects and the effective use of online tools to pro-

mote remote collaboration. We acknowledge that there are benefits and difficulties to both sub-project teams that are too large and too small. The specific sub-projects, tasks, and timeline that a team is charged with should inform how to establish sub-project team size and all sub-project teams should designate an accountable individual as a sub-project team leader, regardless of whether the team is large enough to warrant an official project manager.

Moreover, we found that the scope of a sub-project was often delineated based on a clinical content goal (e.g., building a structured nursing assessment note), not the required technical processes to achieve that goal (e.g., requirements gathering, iterative prototyping, content validation, content build, system testing). This is likely an appropriate approach, but may increase the risk of inaccurate assumptions in determining the scope and responsibility for technical tasks. For example, during the ACD project some inaccurate assumptions included expectations that the KM team – a highly specialized technical content team – had the resources, time, and expertise to complete, or at least coordinate, a wide-range of other technical tasks, such as developing interfaces and comprehensive and iterative testing of the system. These assumptions and expectations likely occur because of the multi-disciplinary nature of EHR projects and the distributed expertise and knowledge of team members. It is imperative to define requirements and expectations for the appropriate supportive and collaborative "service-focused" teams (e.g., interface team, system testing team) that can provide a service or expertise across sub-projects prior to the start of project.

Allocation of resources is a challenge in all projects. Many large health care organizations have geographically distributed hospitals and employee buildings necessitating a balance between remote collaborative work and in-person meetings requiring off-site travel. Off-site travel, even within the same city, can be costly to the individual employee in terms of time and expenses incurred. The use of an online collaborative workspace can greatly reduce the need for frequent in-person meetings and off-site travel. Microsoft Sharepoint® and EMC's eRoom® are online collaborative workspaces that facilitate document sharing, editing, and team-based messaging and advanced functionality, such as team polling/voting. Naturally, teams may prefer to use one over the other, likely based on familiarity. Yet, in the ACD project, which included multiple teams, the continued use of both tools led to challenges in versioning documents and a lack of transparency in organizing and accessing documents which led to redundant and potentially out-of-date information.

Another collaboration tool, with a different and specific purpose, is Doodle Links® ([www.doodle.com](http://www.doodle.com)) a free online tool that facilitates the organizational challenge of coordinating individuals' schedules by allowing them to select their availability from a list of times to determine the best time for the majority of the team. Scheduling convenient meeting times among more than two individuals is a challenge, and many organizations do not have the resources to cover administrative support to schedule all meetings for a large project. Doodle Links® was perceived as more useful than Microsoft Outlook Calendar tools, because some individuals may not keep an updated, accessible, or complete Outlook Calendar for others to view. Finally, providing easy and convenient validation for parking for off-site meetings was a specific and concrete perk that was highly praised and made required off-site travel, especially within a high-traffic city, a more manageable challenge.

This project evaluation was limited to one HIT project within one healthcare system. However, the length and breadth of discussion in our responses, six out of eight survey response rate, and eight out of eight participation in the member check focus group session, increases confidence that the lessons learned and recommendations are representative of the range of experiences by individuals within the KM team that participated in the ACD project.

## Conclusions

Survey participants discussed many successful *and* challenging knowledge management and informatics tasks and efforts within the ACD project. Overall, significant project challenges included reliance on ad hoc processes, balancing competing resources, establishing adequate resources up-front, and managing expectations. Maintaining accountable decision-making, aligned with initial project expectations, and adherence to timelines was a significant challenge experienced by the KM team throughout the project. Resources such as online collaboration tools and project charters were highly valued. The role of the KM team to facilitate understanding of informatics standards and pro-

cesses was critical to project success, and the use of focused teams facilitated the deployment of informatics standards and processes. EHR configuration is a major undertaking and we propose that healthcare organizations consider our five lessons learned and thirty specific recommendations to ensure success.

## Clinical Relevance Statement

- Optimal EHR configuration requires development of standardized clinical content that can be successfully mapped to standardized reference terminologies.
- Adequate knowledge management processes and resources are necessary to develop content that is ready for mapping to standardized reference terminologies.
- Knowledge management requirements include assessing and meeting informatics knowledge needs among stakeholders, setting expectations for decision-making, and ensuring the availability of adequate resources and competency training.

### Conflict of Interest

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

### Human Subjects Protections

The study was approved by the Institutional Review board (IRB) at Partners Healthcare Systems (PHS).

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**Table 1** Lessons Learned and Specific Recommendations

Lessons Learned:	Specific Recommendations	Specific Barriers	Specific Facilitators
<p>1. Assess and meet knowledge needs and set expectations at the start of the project</p>	<ol style="list-style-type: none"> <li>1. Conduct an a priori analysis of system constraints before the start of each project for development of the project plan, specifically the development of specific and feasible goals and timelines for each project<sup>1</sup></li> <li>2. Perform a technical analysis as the first phase of each project to set two sets of realistic timelines based on the specific methods that will be used to achieve goals (see above): (a) timeline for implementation of best practice method, and (b) timeline for alternative method, if best practice method is not feasible or timeline is not met<sup>1</sup></li> <li>3. Early engagement of all leaders by KM to set expectations (documented in charter) for strict compliance with informatics standards and KM defined processes<sup>1</sup></li> <li>4. Early engagement of all clinical leaders to set expectations of technical process, dependencies, and requirements that can be performed in 8 hour days, 40 hour weeks (e.g., inability for development and testing to occur simultaneously, examples of actual development time from past projects)<sup>1</sup></li> <li>5. Provide formal training to content builders and clinical teams conducted by KM about informatics standards and processes<sup>2</sup></li> <li>6. Require adherence to all timelines. If a timeline cannot be met with current method, it will be considered a “no go” and the established alternative method (see above) should be used<sup>3</sup></li> <li>7. Define timelines that account for formal training, software defects, troubleshooting and human resources<sup>3</sup></li> </ol>	<ul style="list-style-type: none"> <li>• Project team members and leaders lacked an understanding of system functionality, which led to unrealistic requests, disenchantment at unanticipated system constraints, and poor communication and decision-making</li> <li>• Clinical leadership approved decisions to use informatics standards and processes established by KM, but did not understand the significance of actively supporting and enforcing adherence</li> <li>• Timelines were generally adequate to meet the project charter, but did not account for: (a) formal instruction and time needed to comply with informatics standards, and (b) unanticipated software defects</li> </ul>	<ul style="list-style-type: none"> <li>• KM was able to facilitate understanding of informatics standards and processes, and work through unrealistic expectations of system functionality, but it was too late in the project to impact expectations</li> <li>• Subprojects were successful when they had a project charter with concise and finite requirements and expectations</li> </ul>

**Table 1** Continued

Lessons Learned:	Specific Recommendations	Specific Barriers	Specific Facilitators
2. Define an accountable decision-making process	8. Define a consistent decision-making process across the project <sup>1</sup> 9. Define a decision-making process that accounts for individual absences via role-based coverage and redundancy <sup>1</sup> 10. Define an escalation and remediation path to follow when decisions are not made or enforced at the appropriate level <sup>1</sup> 11. Establish specific set of criteria (e.g., a patient safety need) that must demonstrate if a decision deviates from agreed set of standards <sup>1</sup> 12. Expect transparent decision-making, with a spirit of compromise that is aligned with project charter goals <sup>3</sup> 13. Expect leaders to enforce decisions <sup>3</sup> 14. Require documentation of all decisions <sup>3</sup> 15. Establish KM leader with authority to ensure that standards are abided by <sup>3</sup>	<ul style="list-style-type: none"> <li>There was a lack of common understanding of what to expect regarding decision-making, decisions were not enforced, and “unpopular” decisions were tabled, which led to a lack of, or ad-hoc definition and documentation of roles and expected role-based tasks</li> </ul>	
3. Increase team meeting moderation skills	16. Require development of effective meeting moderation skills by meeting leaders <sup>2</sup>	<ul style="list-style-type: none"> <li>IS and Clinical Site Meetings were not collaborative, not solution focused, too big, hard to schedule, lacking appropriate decision-makers, and a “battle of the wills” between members present with unclear competing priorities</li> </ul>	

**Table 1** Continued

Lessons Learned:	Specific Recommendations	Specific Barriers	Specific Facilitators
<p>4. Ensure adequate resources and competency training with online collaborative tools</p>	<p>17. Establish an effective and consistent communication path with software vendor<sup>1</sup></p> <p>18. Require competency training for online collaboration tools, especially for clinicians<sup>2</sup></p> <p>19. Establish an adequate testing environment (i.e., a separate development environment for incremental and iterative system testing on the evolving application)<sup>4</sup></p> <p>20. Use either eRoom(c) or Microsoft Sharepoint(c), but not both<sup>4</sup></p> <p>21. Provide administrative support<sup>4</sup></p> <p>22. Increase availability of conference rooms<sup>4</sup></p> <p>23. Increase conference call quality assurance<sup>4</sup></p> <p>24. Provide sufficient development resources, including personnel, to allow for work to be completed in a timely manner and accommodate redundancy needs<sup>4</sup></p>	<p>There was a lack of administrative assistance, a lack of competency using LiveMeeting and online collaboration tools, unavailable conference rooms, poor conference call sound quality, too many online document sharing tools, lack of KM resources to maintain eRoom, inadequate testing environment, lack of a clear communication path with the software vendor</p>	<p>Useful resources for online collaboration and to minimize travel were Team Coordination System (TCS) for system development bug tracking and change management, eRoom<sup>®</sup> (when kept up to date), LiveMeeting<sup>®</sup>, conference calls, email, laptops, PHS' organization directory</p> <p>Doodle links were a useful and free online tool to schedule the best meeting time among a large group.</p> <p>Useful resources, in general, were project charters, project charter sign-off, meeting minutes, leadership support, and domain experts. Parking validation facilitated the ability of employees to attend face-to-face meetings for collaboration across geographically distributed sites</p>

**Table 1** Continued

Lessons Learned:	Specific Recommendations	Specific Barriers	Specific Facilitators
5. Develop focused, goal-oriented teams and supportive, consultative service based teams	25. Clearly define leadership roles <sup>1</sup> 26. Empower team leaders with decision-making authority <sup>1</sup> 27. Utilize supportive and collaborative “service-focused” teams (e.g., interface team, system testing team) that can provide a service or expertise across subprojects <sup>1</sup> 28. Require team leaders to be accountable to the decision-making process and project goals <sup>3</sup> 29. Expect team members to achieve role-based competencies <sup>3</sup> 30. Utilize focused teams with explicit project goals and requirements <sup>3</sup>	<ul style="list-style-type: none"> <li>Teams were too big and fragmented with unclear shared goals among team members, project leadership, and communication and decision-making processes. This led to a combination of a high workload, lack of documentation of decisions, lack of compliance, and the perception that others are responsible</li> <li>The project was dependent on specific individuals’ knowledge and level of commitment, not role-based competencies and shared goal-oriented actions (i.e., small stable teams were successful in this environment, but work was halted if a team member left)</li> <li>Subprojects that were too big (e.g., integration with the existing electronic medical administration record) struggled with project management challenges; projects that were small (e.g., establishing naming conventions) had no project management</li> </ul>	<ul style="list-style-type: none"> <li>Development of a team to focus on system testing, including, but not limited to: integration testing, regression testing, unit testing, and performance testing.</li> </ul>

**Key of axes to direct implementation of recommendations:**

<sup>1</sup>defined process prior to start of project, <sup>2</sup>training prior to start of project, <sup>3</sup>responsibility throughout project, <sup>4</sup>resources to establish at the beginning of a project and maintain throughout a project

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