Use of more than one electronic medical record system within a single health care organization

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Keywords

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Summary

Healthcare organizations vary in the number of electronic medical record (EMR) systems they use. Some use a single EMR for nearly all care they provide, while others use EMRs from more than one vendor. These strategies create a mixture of advantages, risks and costs. Based on our experience in two organizations over a decade, we analyzed use of more than one EMR within our two health care organizations to identify advantages, risks and costs that use of more than one EMR presents. We identified the data and functionality types that pose the greatest challenge to patient safety and efficiency. We present a model to classify patterns of use of more than one EMR within a single healthcare organization, and identified the most important 28 data types and 4 areas of functionality that in our experience present special challenges and safety risks with use of more than one EMR within a single healthcare organization. The use of more than one EMR in a single organization may be the chosen approach for many reasons, but in our organizations the limitations of this approach have also become clear. Those who use and support EMRs realize that to safely and efficiently use more than one EMR, a considerable amount of IT work is necessary. Thorough understanding of the challenges in using more than one EMR is an important prerequisite to minimizing the risks of using more than one EMR to care for patients in a single healthcare organization.

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Introduction

Healthcare organizations vary in the number of electronic medical record (EMR) systems they use. Some use a single EMR for nearly all care they provide, while others use EMRs from more than one vendor. These strategies create a mixture of advantages, patient safety risks and costs. Our organizations use more than one EMR, so we are very interested in how this can be accomplished as safely and efficiently as possible. As the number of organizations using EMRs rises as a result of financial incentives from ARRA [1, 2] and for other reasons, we predict more organizations will consider advantages and drawbacks of dividing the record between two or more EMRs, and might find an analysis of this subject to be useful.

Methods

This manuscript reflects the experience of the authors and their colleagues in 2 organizations using more than one EMR for over a decade each, and what we have learned from consultants, vendors and national colleagues. Our experience includes discussions with multidisciplinary teams within our organizations – such as patient safety, quality improvement, information technology, IT advisory committees, and ad hoc provider groups convened to mitigate risk from using more than one EMR within our organizations.

University of Washington (UW) Medicine and Northwestern respectively have about 0.5 and 0.23 IT employees per hospital bed, and devote about 5.6% and 4.9% of their total budgets to IT. The UW Medicine figures (but not Northwestern) include support for outpatient clinics.

Findings

We define an EMR as a computing system that provides medical record functionality including review and entry of notes and other health information, results management, order entry, decision support, electronic communication and connectivity, patient support, and others as described elsewhere [3]. This definition distinguishes EMRs from computing systems that serve specialized clinical departments, but which do not encompass the full list of functionality. By "more than one EMR" we mean that a patient cared for in the ambulatory and inpatient setting of that health care organization will have electronic record data and functionality described above spread across more than one EMR system, and that practitioners will require access to content or functionality from more than one EMR while delivering care. Thus, there is more than one clinical data repository, and as a result laboratory, radiology, registration, and other departmental systems require multiple pathways (interfaces or other) for data exchange [4].

Patterns of use of multiple EMRs in the same organization

Several patterns of use fit the multiple EMR definition, shown in ▶Figure 1. In organizations with more than one EMR, a common pattern is that one EMR is used for inpatient care and another for outpatient care, as shown in ▶Figure 1b. There are many variations on this pattern in which there is a dominant inpatient or outpatient EMR, with other EMRs used for a smaller volume of inpatient and outpatient care in the same organization. Important considerations driving organizational choice include historical IT infrastructure, safety risks, the volume of care, patient acuity, and the frequency with which patients move from one area to another. For example, the balance of risks and benefits may be different if a large number of severely ill patients move frequently from an area using one EMR to another, than if a small number of patients of low acuity rarely move from the area in which one EMR is used to an area in which another EMR is used.

In addition to understanding the characteristics and mobility of patients, mobility of practitioners and support staff are important to consider. Time spent acquiring and maintaining EMR specific skills may vary depending on whether an individual works in areas with one or more than

one EMR. Since workforce mobility varies greatly within and between units of healthcare organizations, implications of using multiple EMRs will also vary.

In this paper, we refer to the user's primary EMR as the one in which a particular clinician spends the greatest clinical time and has the greatest experience and familiarity in using. A secondary EMR is one which the clinician does not have as much experience in using. There are several ways in which an organization may come to use more than one EMR.

- An initial decision is made to implement more than one EMR at the same organization, because, for example, a given vendor may have initially only product for specific venues (inpatient or outpatient) and EMR use in all venues was required by the organization.
- Different clinics or hospital areas may use EMRs tailored to their specific clinical practice.
- As the result of a merger of organizations using different EMRs [5].
- Affiliated private practice groups may choose an alternative EMR that, in their independent authority and opinion best supports their office-based practices.

In each of these cases, because implementing and adopting an EMR is time-consuming and expensive, practitioners may be reluctant to change EMRs to achieve unity, especially if they are satisfied with functionality and the match between the EMR and their clinical workflow.

Using more than a single EMR in one organization is related to the broader topic of information exchange among different healthcare organizations, such as between several hospitals in the same community [6]. However the public likely expects (and in the authors' experience assumes) that more continuity of data exists when a patient moves between locations within the same organization than when the same patient moves between settings of care in different organizations. It is also more likely that those working within the organization will need to learn to use more than one EMR if several are used within the same building or campus, than if they are used in different organizations.

There is a spectrum of EMR use from a single EMR for everything that occurs for the patient, to many different EMRs, one for each episode of care. In the middle is that for most patients, the record is divided; few US patients have all their record in a single location. Few would disagree that one EMR may have technical advantages over another in some areas, nor conversely that there is a benefit to having a single record for documentation and review. The question is how to balance these two competing advantages with their accompanying (potential) disadvantages.

Advantages of more than one EMR

Organizations may choose to use more than one EMR for a variety of reasons. Some EMR vendors have greater experience or skill in tailoring their application to specific specialties or types of care, which confer clinical and financial advantages to the organization. It is difficult for many hospitals and health care organizations to identify a single vendor with applications for each of these domains. New EMR vendors may enter a market niche and specialize in the needs of particular clinical units [7]. The organization, or at least clinicians in those units, may wish to take advantage of this specialization, which may not be matched by the current EMR. Examples include specialties like ophthalmology and dermatology which request specific workflow, documentation, or image capture functions that are not available within "do it all" enterprise solutions versus the highly focused offering. Financial advantages to use an EMR tailored to a setting may add to this interest.

At one end of the spectrum is a best of breed approach [8] in which numerous systems are chosen and interfaced in order to maximize benefits to the highly specific users and their care settings. At the opposite end of the spectrum would be reliance upon a single vendor's solution for all available clinical contexts. (Many vendors purchase applications and work to integrate their component applications over time and while technically residing within the single vendor category, these subsidiary applications often more closely resemble a composite best of breed approach.) Each organization will need to determine where natural lines of separation for clinical systems reside and where functionality available may be adequate from a core vendor's offering limiting integration concerns.

However, special challenges occur when patients and practitioners move from one clinical area to another in which a different EMR is used. We now review many of these challenges and potential solutions to problems created by use of multiple EMRs for the same patient within the same overall organization.

Challenges to using more than one EMR within a single organization

Challenges to using more than one EMR can be grouped into several categories. The primary challenge is mitigating risk to patient safety. Others include ease of viewing the patient's record, user ability to master multiple EMR functionalities and workflows, and institutional costs. ▶Tables 1 and 2 summarize data and functionality to be considered when more than one EMR is used for care of patients in one health care organization. These tables also show what measures (listed in ▶Table 3) UW and Northwestern have taken to address each of these data and functionality areas.

Patient safety

The greatest risk of multiple EMR use is the risk of missing data and any corresponding decision support that impact patient safety. Some of the features of EMRs that are cited as making care safer, such as improving communication, providing access to patient information, and stopping mistakes at the ordering process [9] may be more difficult to achieve if more than one EMR is used without appropriate integration. A secondary but significant risk encompasses increased practitioner time requirement for both patient care and for training which results in loss of income and in provider dissatisfaction with the EMR.

An important patient safety risk is a missed drug allergy or interaction. One of the expected advantages of conversion to an EMR is that a complete patient allergy list and an updated medication list allow for allergy and medication interaction alerts that protect patients and institutions from medication errors [10, 11]. It takes considerable effort to reconcile a patient's medications and allergies at each admission or outpatient visit even in a single EMR. If an entity maintains separate medication and allergy lists in two or more EMRs, the challenge is greatly magnified. These databases are often so structurally different from one EMR to the next that they are difficult or impossible to interface even if the resources exist. Furthermore, standards are not yet completely developed to facilitate this process [12, 13], especially in the case of allergies [14]. Unless the entity can find an efficient way to update each EMR whenever there is a change in patient information, there is a risk that an allergy or interaction may be missed, or that a patient may inadvertently be prescribed a discontinued drug or have a newly prescribed medication discontinued.

A second patient safety risk is missing significant data [15]. An advantage of the EMR is that it presents the provider with the results of ordered tests – lab tests, imaging studies and procedures. To the degree that test results return only to the EMR in which they are ordered, a provider runs the risk of missing a significant result. The practitioner may be unaware that a test was ordered (by a colleague working in a different EMR) or may not see an abnormal result in a timely manner. Tests may be duplicated, at expense to the patient or the system [16]. More significantly, a delay in acting on an abnormal result – or missing it altogether – can adversely impact patient outcome. While interfaces can mitigate these concerns to some degree, they come with their own burdens. All results from each EMR can file to a data repository, but this represents yet a third place to go look for results. Alternatively, results can feed to both EMRs – but this can lead to provider fatigue in seeing each result multiple times, or missing a result if it simply files to the chart without requiring review.

Other examples of information deficits with potential patient safety implications include missing pregnancy or lactation information leading to inappropriate medication ordering, missing recent changes in renal function leading to inappropriate use of IV contrast dye, and incomplete or inaccurate past medical history or family history leading to inaccurate risk assessments.

A third patient safety risk is that patient information does not flow appropriately to the practitioners involved in a patient's care [17]. If a primary care provider designation does not flow between EMRs, a current PCP may not receive important clinical information. This holds true as well for referring providers and other members of a patient's care team. Provider databases are difficult to maintain with accuracy, and multiple EMRs can worsen this problem (▶Table 1). There are risks both in terms of patient care and HIPAA compliance if these databases are not synchronized. This is particularly important during transitions in care, such as when results are still pending at the time of discharge and the final results are never communicated to the PCP.

A fourth patient safety risk involves the impact of multiple EMRs on the practitioner's ability to provide efficient and safe care. First, the provider may not know where certain patient information can be found, or even if it exists. It is time-consuming to reference multiple EMRs, and in each instance the practitioner needs to make a decision to look (or not). The strength of an EMR to present providers with data rather than requiring them to search is thus undermined. Providers may miss significant information, or ignore information that is often duplicative and therefore not closely reviewed.

EMR efficacy is largely dependent on maintaining accurate information in the databases – allergies, medications, problem list, histories, health maintenance requirements are the most common. Many regulatory initiatives (Meaningful Use, Medical Home, PQRS [18]) require regular updating of this information, which is time-consuming and therefore has high stakes for patient safety and efficiency. This work is challenging to perform successfully and consistently in one system, and rapidly becomes unmanageable and frustrating if it needs to be done in multiple systems. Real-time interfaces are not easily achievable or even possible in all cases, resulting in significant costs in rework and provider frustration.

Finally, there is a risk that practitioners become disillusioned with EMR use, perceiving a loss of efficiency and predictability rather than gains in patient safety and communication. Providers have diminished opportunity to become expert in a single system, and are less likely to become truly expert users in multiple systems. The demands on their time for initial and ongoing training, and for additional workflows created to accommodate the multiple EMRs, lead to poor adoption and lack of satisfaction and expense.

Despite measures to simplify data review, the risk that patient data will be missed increases as the number of locations that must be searched rises. The ideal is to minimize search time by bringing data to a single location that is rapidly accessible (A "reasonable" expectation is having a single location to search). An alternative is that all providers are adequately trained to navigate to locations where data are stored for each patient, and that it is clear when such as search is necessary so that time is not wasted on an unnecessary search. A much less desirable alternative is the expectation that all providers will search in all possible locations for data in both EMRs in case there are data to review. Banners indicating that data are present in another EMR may help.

Viewing and integrating data

Clinicians grow accustomed to viewing data with the user interface most familiar to them. There may be a general layout to the electronic record, such as tabs to separate laboratory, radiology, pathology, and other results. However sometimes exceptions occur in which some results are not available in the expected location, requiring the user to search for results in a different section of the application or in another (sometimes legacy) application. An example is that chemistry results before a certain date are found somewhere other than the laboratory tab, such as when a PSA result posted after 2003 is on one tab of one EMR, while a PSA between 1995 and 2003 is in another tab. An oncologist who needs to see all PSAs since 1995 would need to know to check both. Another example is when interfaces send lab results to one EMR but not to another. In this situation, a complete list of lab results would be seen in one EMR, yet a partial list would be seen in the other resulting in confusion among caregivers.

These exceptions may exist for many different types of data. As a result it may require experience and training to completely review information for a particular patient. Unless the path to data is easily mastered in all EMRs, there is an additional time cost either for training, or for time spent searching for data, or there is a risk that some data will not be seen.

Instead of requiring users to learn to search for data in more than one EMR one can make it possible for clinicians to see all data they need using only the EMR with which they are most familiar. This can be accomplished by transmitting all data from one to another, creating interfaces from source systems to both EMRs, or by constructing views of data using technical approaches other than interfaces (e.g., live database views from one EMR embedded within a different EMR). Another option is to create a third application and its attendant database used solely for reviewing results, which presents the user with a view of all patients' data regardless of its source. In practice users would need to remember to access this third system to view data, but would use their primary EMR for entry of

data, handling messages and for other tasks. This duplication creates an additional storage burden, and may lead to complexities for Health Information Management and Release of Information functions including Health Information Exchange participation.

EMR functionality and workflow

EMRs provide a number of functionalities that present challenges if they exist in multiple EMR environments. As an example, EMRs have message box functionality which allows expedited performance of a number of administrative and clinical tasks. By message box we mean screens and functions in the EMR where new results, messages, unsigned orders and documents and other information from many patients are brought to a single location for review and action by the user. Tasks that may be possible within the message box include:

- Draw attention to new results, with indication that they are normal, abnormal, or critical
- View and acknowledge viewing results (lab, radiology, other)
- Forward results or messages to another clinician or team member for action
- Open the chart to see more information (e.g. trend, chart notes) to determine what action to take
- Send results to patient with annotation
- See orders needing signature, or co-signature, including need for medication refills
- List notes that are incomplete so you can easily find them and remember to finish them
- List of notes that others want you to see, edit, acknowledge
- View reminders to complete discharge summaries
- Send messages between healthcare team members and to/from patients

Strategies for managing message boxes in more than one EMR include the following:

- Use message boxes in more than one EMR. The advantage is that you retain all message box functionality, but this requires regularly (hourly, daily, or some other interval) checking more than one. This strategy may include policies that limit what is sent to either one so there is no duplication.
- Use one message box and be alerted when there are items in the other one. The usefulness of this strategy depends on alert frequency and importance: if there is always an alert for items of little importance, the alerts may be ignored risking missing important items.
- Have a third message box that brings items from both into one place and then either allows you to handle tasks there or links you to the other vendor message box when you click. However it may be difficult to recreate all functionality found in vendor message boxes.

Perhaps the most important use of EMRs, and the one that may be most problematic when more than one EMR is used, is communication between providers who share care of a patient. Sending documents or messages across the boundary of different EMR systems presents a challenge when performed within a given EMR message center. It requires more than just transmitting the message – it should also be possible that when the message is removed from one system, it is also removed from the other. Otherwise, the list of notes or messages to be reviewed will grow quickly, and the review process will become much more burdensome. It is difficult to communicate between EMRs initially, and difficult to synchronize message management between two systems.

A second area of functionality that presents challenges when more than one EMR is used is maintenance of the medication list and other data listed in ▶Table 1. New medication orders and refills, medication list review and reconciliation are more challenging with 2 EMRs and may require entirely separate manual review of the EMR medication lists, and comparison with the patient's records or recollection. Advantages of automated management of the medication process may be in part lost when a second EMR is used.

Institutional costs

Users whose work crosses boundaries where another EMR is used will need initial and periodic update training in more than one EMR. Training time ranges from hours to days, and so training costs (including lost time in clinical care) may rise to an important degree. The institution will need to

provide training personnel and resources for more than one EMR. When EMRs undergo substantial upgrades, more training and education of all users using each EMR is needed. The training staff may be the same for both EMRs, but it is likely the size of the training team will need to be increased to support more than one EMR.

User questions, help desk queries, and in-person support will need to be scaled to support separate EMRs. Support staff will need to have expertise in all EMRs supported, either by cross training the individuals or hiring separate staffs with additional operational costs. Upgrades and fixes are required in all EMR environments and have time, resource and training implications across all environments, not just the one currently being upgraded, thus potentially leading to constant impact due to freezes, resource constraints, and training needs.

Technical and policy approaches to mitigating risk

A variety of policy and technical approaches may reduce the risks created by use of more than one EMR. A common approach is to adopt and implement a policy that users must check both EMRs when caring for patients, at each encounter with the patient. Because this may be burdensome, we also use a variety of technical approaches, summarized in ▶Table 2.

UW uses its two major EMRs in a pattern best described in ▶Figure 1c. UW has used integration of a web view [19] into each EMR showing data from the other EMR as the major technical approach. Some data, such as laboratory and radiology results, flow to both EMRs with varying completeness. At Northwestern University, which uses three main EMRs in a pattern shown in ▶Figure 1d, content from the primary ambulatory EMR has been accessible for several years within the inpatient EMR system using a services oriented architecture approach that includes 2 additional ambulatory EMRs used on the Northwestern campus. This effectively creates a local Health Information Exchange chart section for clinical content at Northwestern. The aggregated content is cached but effectively resides natively within the source EMRs. This identical and shared composite view (with drill-down capability exceeding typical Health Information Exchanges) is then embedded within each of the EMR systems on the campus. Clearly, these approaches require local IT sophistication and cooperation among multiple participants in order to be successful. Technical and financial resources devoted to these efforts come from UW and Northwestern and their partners, not EMR vendors.

Discussion

Using more than one EMR in a single organization may be appealing for many reasons, but in our organizations the limitations of this approach have also become clear, and the primary limitation is the risk to patient safety. Those who use and support EMRs realize that to make those EMRs "talk to each other," a considerable amount of IT work is necessary. Approaches such as creating an intermediate results review system that incorporates data from all EMRs are appealing, but extend the number of the EMRs to be used and supported. Since most people spend a good deal of their time in one or another EMR, it is now necessary to look in the third system, and perhaps also in the second. Search time, especially if one is not certain that the search will identify relevant information, reduces time used for other purposes and discourages the practice of checking other systems.

Another perspective to bear in mind when considering use of more than one EMR is that in organizations with multiple EMRs the same pressures that led to the addition of a second EMR can lead to addition of other EMRs, which the marketplace is likely to produce over time. There needs to be some balance between the appeal of these newer systems, and the cost of introducing additional EMRs into a single organization. Despite the challenges we have outlined, the need to better coordinate use of multiple EMRs within a single organization appears to be rising in our communities, as the potentially lost benefits in comparison with a single EMR become clearer with comparison to progress at single EMR sites. While some organizations have adopted a unified, single vendor EMR to replace a multitude of commercial EMRs, the cost for such a switch remains a barrier for many organizations. This must be balanced with the additional expense of training, support, licensing, interface creation and other risk mitigation. These latter costs are incurred over the time in which

multiple EMRs are used and may exceed switch costs. The timing of Meaningful Use and other incentive payments and penalties is an additional complicating factor.

An underlying theme throughout all discussions of a multiple EMR system is the extra work required of providers to get complete information. This extra work may or may not be done, thus creating risk for incomplete or inaccurate information, decreased quality of care and potential risk to patient safety.

In our view the main issue is a tradeoff between locally customized EMR that allows maximizing efficiency at the local (e.g., specialty clinic) level, at the expense of cost and efficiency when patients and practitioners travel outside that local setting. A Congestive Heart Failure clinic, for example, may have a team well integrated into their local EMR, with detailed information on the referring providers, up-to-date medications, case manager contacts, etc. Thus for patients and providers who stay in one place, the multiple EMR model makes more sense than when patients travel across multiple settings. As patients have multiple comorbidities and multiple specialists with multiple hospitalizations, then the multiple EMR model poses greater barriers to facilitating communication (or requires very large IT resources invested to overcome these barriers, which may not occur in practice).

There is optimism that national initiatives to exchange information *between* organizations will help with exchange of information *within* organizations, and opinion that fundamental change in clinical computing system design will occur [20]. However, the pace at which these initiatives progress [21] may be slower than the pace at which commercial EMRs are added. Thorough understanding of the challenges in using more than one EMR is an important prerequisite to minimizing the risk of this strategy.

Clinical Relevance Statement

Use of more than one EMR within a single organization is becoming more common, and carries benefits and risks to those delivering care and to their patients. This strategy has important implications for clinical care efficiency and safety not previously analyzed in peer-reviewed journals. It is extremely relevant to clinicians practicing in organizations with multiple EMRs and to those supporting clinical computing within those organizations.

Conflicts of interests

The authors receive no income, honoraria or support from EMR vendors and have no other conflicts of interest to declare.

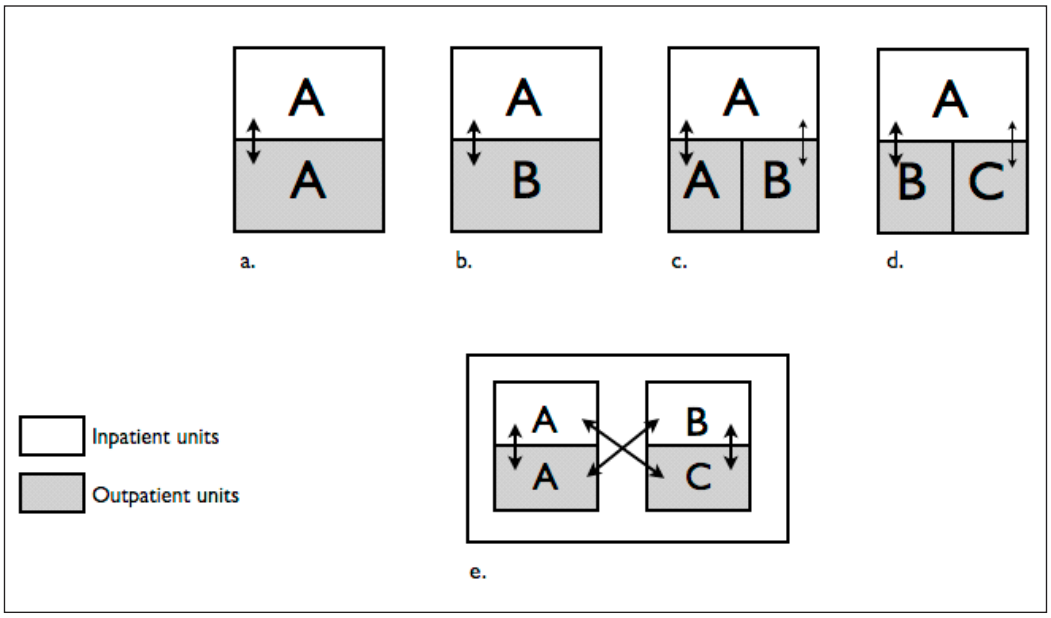

Fig. 1 Patterns of EMR use within a single healthcare organization. Size of arrows indicates volume of patient movement: In **a**, one EMR is used for inpatient and outpatient care. In **b**, there is one EMR used for inpatient care and one used for outpatient care. In **c**, there is one EMR used for inpatients and two used in the outpatient setting; more patients are hospitalized and discharged from outpatient clinics using EMR A than B. In **d**, there are multiple EMRs used in clinics, all different from the inpatient EMR. In **e**, two hospitals each with its own clinics are joined in a single organization, one with a single EMR used in both inpatient and outpatient care, and the other with different EMRs in the hospital and clinics. Patients are admitted and discharged across the two hospitals.

Table 1 Patient data that may require integration when more than one EMR is used. Numbers in UW (University of Washington) and Northwestern columns correspond to entries in Table 3.

	Comments	UW	Northwestern
Allergies	encoded form needed to trigger allergy alerts during CPOE. Exchange from one system to another can occur via intermediate mapping such as RxNorm but not straightforward, since multiple component fields may differ.	3	3
Allergic reactions	may be in narrative text rather than encoded.	3	3
Medication lists	frequently updated; less valuable and higher risk if not current. RxNorm may be useful intermediary.	3	3
Lab results	including ordered, pending, corrected status. Consider oldest results, which are important in chronic conditions.	1	1
Problem list	coding schemes may need to be reconciled. Similar but distinct terms may clutter aggregated lists. Updates important.	8	3
Imaging reports	flag for critical results also useful; ability and means of flag display may vary.	1	1, 3
Images	providing web link with shared user and patient context helpful.	3	5
Notes	duplicating entire note collection may not be desireable. Whether or not an unsigned note is viewable by others varies between commercial EMRs.	3	3
Consultation notes	filing system for specialty notes may vary across EMRs leading to reconcilation issues when creating aggregated views.	3 (partial)	3
Scanned records	outside records and correspondence may be scanned into one EMR but not the other.	8	5,8
Code/no code status	review and update for each encounter may be desirable. Updates needed if status changes.	8	5, 8
Advance directives	scanned document and/or summary with notation as to location of scanned document.	8	5, 8
Health maintenance factors	dates of cancer screening and disease specific events, or indication if done elsewhere or declined important to maintain credibility of alerts. Recommendation timers may vary across EMRs.	8	
Immunizations	community or state registry may contribute. Incomplete data reduce likelihood that no result available means immunization not needed.	3	3
Durable power of attorney information	updates important. Scanned copies often needed urgently.	8	5, 8
Blood pressure	historical, current, patient-recorded.	8	3
Height, weight	particularly important for children.	8	3
Alerts (e.g. behavior, infection, research study participation)	some may be appropriate to generate pop-up or other type of alert.	8	3

Table 1 Continued

	Comments	UW	Northwestern
Notification when patient admitted, discharged, seen in ER, expires	may be sent via email without identifiers, or appear in message box.	8	1
Primary care provider	may be one or more person.	1 (partial)	3
Outside primary care provider	in organizations with high volume of outside referrals, name, current address, email or fax number and preference for contact.	3, 8	3
Consultants who provide continuity care	tracking consultants is as important as primary care providers for some patients.	3, 8	3
Referring and other outside physicians	in organizations with high volume of outside referrals, name, current address, email or fax number and preference for contact.	1	5, 8
Whether patient has viewed particular result through web	important for users of all EMRs to know to avoid unneeded communications.	8	5. 8
Delay, if any, in releasing results to patient via web	some organizations may wish for providers to view some result types before patients do. Such rules should be synchronized across EMRs.	8	5, 8
Current patient location (home, inpatient, room number)	especially important in tracking and coordinating care.	8	3
Next of kin	changes should be communicated to users of all EMRs.	8	5, 8
Preferred pharmacy	outpatient and discharge medications should be sent to pharmacy patient prefers. If there is more than one EMR, this preference should be available.	8	5, 8

Table 2 Functionality that poses special challenges when more than one EMR is used.

	Comments	UW	Northwestern
Message box	Can limit use to inpatient or outpatient only. Create view indicating number of unread items.	8	5, 8
Messaging	May be in narrative text rather than encoded.	8	5, 8
Between providers	Includes notes sent for review by another provider.	8	5, 8
Between providers and patients		8	5, 8
Order writing	Transmitting orders written in one EMR to another EMR.	8	1, 5, 8
Medication reconciliation	May be difficult within one EMR. Requiring that it be done in each EMR is problematic.	View only via 3	5, 8 (view only via 3)

Table 3 Technical and policy approaches to simplifying use of more than one EMR in the same organization.

	Comments	Example
1	Interface with bidirectional data exchange	HL7, batch
2	Use of standard formats to simplify export and import of information from one EMR to another	CCD
3	Web view of data in all EMRs which is accessible from all EMRs	Vendor-supplied or locally developed portals
4	Creation of a new application suite (in addition to the EMRs) to view all patient data from all sources. Use EMR functionality for entry of notes and orders	
5	Context sharing to permit synchronized views of all patient data through source systems, without need to separately log in to each.	CCOW
6	Vendor EMR mediated exchange of information between EMRs	CareEverywhere, Resonance
7	Use of external Health Information Exchange for exchange of information within the institution	RxHub
8	Policy that providers are expected to look in all EMRs for patient data	

References

1. Blumenthal D. Launching HITECH. N Engl J Med 2010; 362: 382–385.
2. Charles D, Furukawa M and Hufstader M. Electronic health record systems and intent to attest to meaningful use among non-federal acute care hospitals in the United States: 2008–2011. ONC Data Brief No. 1 February 2012. Office of the National Coordinator for Health Information Technology.
3. Committee on Data Standards for Patient Safety. Key capabilities of an electronic health record system. Bethesda: The National Academies Press, 2003.
4. Payne TH. Architecture of clinical computing systems. In: Payne TH, (ed). Practical guide to clinical computing systems. Design, operations, and infrastructure. Oxford: Elsevier, 2008.
5. Snyder-Halpern R, Hoyman K. Clinical information system implementation. Challenges across two merged hospitals. Comput Nurs 2000; 18: 157–161.
6. Kuperman GJ. Health-information exchange: why are we doing it, and what are we doing? J Am Med Inform Assoc 2011; 18: 678–682.
7. Clayton PD, Sideli RV, Sengupta S. Open architecture and integrated information at Columbia-Presbyterian Medical Center. MD Computing 1992; 9: 297–303.
8. Hermann SA. Best-of-breed versus integrated systems. Am J Health Syst Pharm 2010 Sep; 67(17): 1406, 1408, 1410.
9. Bates DW and Gawande A. Improving safety with information technology. N Engl J Med 2003; 348: 2526–2534.
10. Bates DW, Leape LL, Cullen DJ, et al. Effect of computerized physician order entry and a team intervention on prevention of serious medication errors. JAMA 1998; 280: 1311–1316.
11. Salanitro AH, Osborn CY, Schnipper JL, et al. Effect of patient- and medication-related factors on inpatient medication reconciliation errors. J Gen Intern Med 2012; 27: 924–932.
12. Nelson SJ, Zeng K, Kilbourne J, Powell T, Moore R. Normalized names for clinical drugs: RxNorm at 6 years. J Am Med Inform Assoc 2011; 18: 441–448.
13. Hamm RA, Knoop SE, Schwarz P, Block AD, Davis WL 4th. Harmonizing clinical terminologies: driving interoperability in healthcare. Stud Health Technol Inform 2007; 129(Pt 1): 660–663.
14. Bouhaddou O, Warnekar P, Parrish F, et al. Exchange of computable patient data between the Department of Veterans Affairs (VA) and the Department of Defense (DoD): terminology mediation strategy. J Am Med Inform Assoc 2008; 15: 174–183.
15. Smith PC, Araya-Guerra R, Bublitz C, et al. Missing clinical information during primary care visits. JAMA 2005; 293: 565–571.
16. Stewart, BA Fernandes S, Rodriguez-Huertas E, Landzberg M. A preliminary look at duplicate testing associated with lack of electronic health record interoperability for transferred patients. J Am Med Inform Assoc 2010; 17: 341–344.
17. Weiner SJ, Barnet B, Cheng TL, Daaleman TP. Processes for effective communication in primary care. Annals of Internal Medicine 2005; 142: 709–714.
18. Federman AD and Keyhani S. Physicians' participation in the physicians' quality reporting initiative and their perceptions of its impact on quality of care. Health Policy 2011; 102: 229–234.
19. Goldberg HI, Tarczy-Hornoch P, Stephens K, Larson EB, LoGerfo JP. Internet access to patients' records. Lancet 1998; 351: 1811.
20. Mandl KD, Kohane IS. Escaping the EHR trap – the future of health IT. N Engl J Med 2012; 366: 2240–2242.
21. David R. State health information exchange boards grapple with a dense thicket of policy questions. Healthc Inform 2012; 29: 18, 20–1.