Refereed paper

Technological resources and personnel costs required to implement an automated alert system for ambulatory physicians when patients are discharged from hospitals to home

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ABSTRACT

Background With the adoption of electronic medical records by medical group practices, there are opportunities to improve the quality of care for patients discharged from hospitals. However, there is little guidance for medical groups outside integrated hospital systems to automate the flow of patient information during transitions in care.
Objective To describe the technological resources, expertise and time needed to develop an automated system providing information to ambulatory physicians when their patients are discharged from hospitals to home.
Development Within a medical group practice, we developed an automated alert system that provides notification of discharges, reminders of the need for follow-up visits, drugs added during inpatient stays, and recommendations for laboratory monitoring of high-risk drugs. We tracked components of the information system required and the time spent by

team members. We used USA national averages of hourly wages to estimate personnel costs.

Application Critical components of the information system are notifications of hospital discharges through an admission, discharge and transfer registration (ADT) interface, linkage to the group's scheduling system, access to information on pharmacy dispensing and lab tests, and an interface engine. Total personnel cost was $76,314. Nearly half (47%) was for 614 hours by physicians who developed content, provided overall project

management, and reviewed alerts to ensure that only 'actionable' alerts would be sent.

Conclusion Implementing a system to provide information about hospital discharges requires strong internal informatics expertise, cooperation between facilities and ambulatory providers, development of electronic linkages, and extensive commitment of physician time.

Keywords: ambulatory care, health information technology, hospital discharges

What this paper adds

- It is feasible to automate delivery of information about hospital discharges to ambulatory care physicians.
- Electronic linkages between inpatient facilities and ambulatory providers are necessary for programmed information exchange.
- Establishment of a health information technology (HIT) transitional care automated alert system requires substantial commitment of physician time.

Introduction

Inadequate continuity of care is a profound weakness in healthcare delivery, putting patients at particularly high risk following discharges from hospital to the ambulatory setting.[1–3] Discharged patients have usually experienced a significant change in their health status. They leave hospitals and subacute care facilities at vulnerable points in their course of treatment, but frequently face disconnects, with poor communication between hospital and ambulatory care providers. Studies of discharges from hospital to home have found that discharge summaries, medication lists and laboratory test results are frequently not available to ambulatory care providers.[4–10] Investigators have found missing information associated with higher risks of hospital readmission, emergency department visits and adverse events.[1,5,7]

Several approaches for improving patient discharges from hospitals to home have been described in the medical literature,[11–20] most of which require substantial commitments of personnel time[11–12,14,19,20] or focus solely on the hospital side of the transition process.[15–18] There has been less attention paid to the ambulatory care side of the equation. The increased adoption of electronic medical records (EMRs) within ambulatory practices may allow these medical groups to institute systems that increase their access to timely information about patient discharges.[21–23] To determine the technological resources and personnel costs needed to develop an automated system providing

information about patient discharges to ambulatory care providers, we tracked the process of developing and implementing such a system.

Development

Study setting and population

We developed and implemented a health information technology (HIT)-based transitional care intervention within a large medical group practice. The group practice employs 330 clinicians, including 250 physicians at 23 ambulatory clinic sites covering 30 specialties. The group provides care to approximately 180,000 individuals, many of whom are members of an associated health plan with which the group practice shares financial risk. During the course of this study, the practice used the EpicCare Ambulatory EMR®, versions Spring 2007 IU3 and Summer 2009 IU6. A medical informatics team, consisting of operations research analysts and application computer software engineers, maintains and upgrades the EMR. The team is led by the Medical Director for Informatics, a physician with extensive experience in HIT. Patients most often receive inpatient treatment at one major local hospital. For intermediate care, patients are usually admitted to one of nine independent skilled nursing facilities (SNFs) in the area. Prior to implementation of the transitional care intervention,

hospitals and SNFs intermittently sent discharge information to the medical group's providers through fax or paper mail.

Developing and implementing the HIT-based transitional care intervention

We developed an automated system to facilitate the flow of information to the medical group's providers about patients who were discharged home from the major hospital or SNFs. In addition to notifying providers about the patient's discharge, the system was designed to provide information about new drugs added during the inpatient stay, warnings about drug–drug interactions and recommendations of dose changes and laboratory monitoring of high-risk medications, as well as to remind the provider's support staff to schedule a post-hospitalisation office visit. The team that selected the high-risk medications and developed monitoring guidelines consisted of a national advisory committee and local experts, including clinicians and pharmacists from the medical group.[24] Based on these guidelines, we constructed 'blueprints' that contained the message content and criteria for triggering alerts and recommendations. Staff of the medical group's informatics development team used the blueprints to guide the programming process.

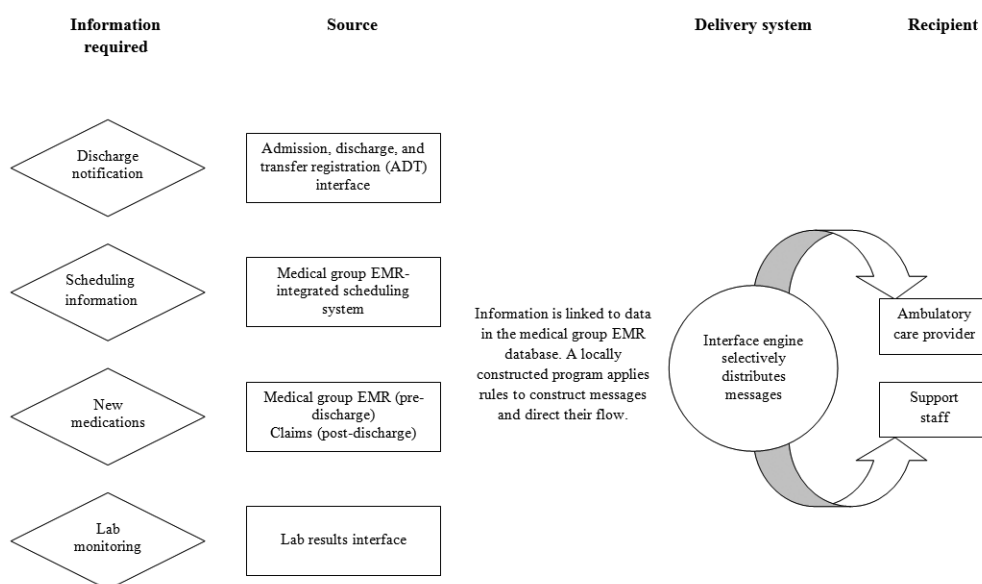The required information elements are shown in Figure 1.

Notification of discharges

The team sought notification from the hospital of new discharges within one day but accepted notification of SNF discharges within five days.

Scheduling information

The intervention was designed to send recommendations for scheduling an office visit to the provider's support staff. To ensure that these recommendations were not sent when such a visit was already scheduled, the system needed access to the medical group's scheduling information.

New medications

To enable timely identification of all new medications patients were taking after discharge, the system required information on the pre-hospital medications and all medications dispensed after discharge.

Laboratory tests

To provide appropriate recommendations about monitoring of high-risk medications, the system needed information on completion of laboratory tests, both prior to and during hospitalisation.

Tracking resources and personnel costs

We tracked the time and effort of each team member through weekly reports that summarised hours for a

Figure 1 Required information sources for the automated alert system

set of predefined activities. Tracking began when the team reviewed the guidelines in preparation for designing the intervention.

To produce summary cost estimates that would be of use to groups considering local development of such an intervention, we did not focus on facility-specific costs. We combined the reported hours for each individual with USA national average hourly wages for the appropriate personnel category, obtained from the Bureau of Labor Statistics, National Compensation Survey.[25] Table 1 summarises hours per activity category and personnel type.

Application

The information technology (IT) team was able to identify or develop sources within the existing IT system for the required information (Figure 1). Several of the sources were products of linkages between the medical group, the primary hospital, outside laboratories, and the health plan.

Notification of discharges

The medical group linked an interface engine to the major hospital's admission, discharge, transfer (ADT) registration system. The medical group provides the names of its providers to the hospital and the hospital transmits information (HL7 ADT messages) including admission and discharge dates for the medical group's patients. These data are automatically placed in fields in the medical group's EMR hospital encounter table. For the SNFs, a similar linkage is still in the planning stage, so we developed a manual system: the discharge planners at the facilities fax their standard discharge forms to a nurse at the medical group who manually enters the information into the EMR.

Scheduling information

The medical group's scheduling system is integrated within its EMR so scheduled visits can be automatically checked to avoid sending unnecessary follow-up appointment reminders.

Table 1 Personnel time and costs for developing and implementing the automated alert system

	Hourly wage ($)	Hours*	Cost* ($)	% of Total cost
Activity category				
Project management		22	1,983	3
Preparing content		169	14,977	20
Designing HIT application		62	5,543	7
Preparing HIT application		268	10,304	13
Developing blueprint		325	14,917	20
Programming		273	17,406	23
Testing		88	5,701	7
Revising		76	3,253	4
Maintaining		26	2,231	3
Personnel category				% of Total time
Internists, general	90.13	614	55,340	47
Operations research analyst	33.93	370	12,561	28
Research assistant†	19.23	202	3,885	16
Registered nurse	32.29	58	1,873	4
Computer software engineer, applications	42.30	40	1,692	3
Database administrator	35.12	17	597	1
Pharmacist	52.47	7	367	1
Total		1,308	76,314	

New medications

Identifying new medications required several sources: medications prescribed prior to the inpatient stays are in the EMR, but information about medications dispensed immediately after discharge is obtained from claims for medication dispensing submitted to the associated health plan. The medical group has access to a database containing up-to-date information on claims because the group is at financial risk for over 60% of their patients in their contractual relationship with the health plan.

Laboratory tests

Information about laboratory tests is communicated to the medical group from outside laboratories and the major hospital through electronic lab results interfaces that load results and dates of completion directly into the EMR.

The EPIC EMR is accompanied by a Microsoft SQL Server® database that contains copies of all of the EMR's information and can be programmed by the local clinical site. For the automated alert system, programs were written to extract the required data elements from the database and apply rules from the blueprints to construct alert messages. An additional system component was necessary to ensure automatic distribution of the alerts to the appropriate recipients (e.g. the correct provider for the newly discharged patient and the associated support staff). The team opted to direct alerts to the result interface, where they appear in the recipient's in-basket. The process uses an interface engine which is a locally written application that turns the alerts triggered by the program into messages to specified providers in a form that resembles messages from labs (HL7 ORU messages, structured reports of observations and results).

Initial development of the automated alert system was followed by an iterative test/revision cycle within the EMR's test environment in which we corrected typographical and firing logic errors and assessed basic functionality. Two physicians from the medical group reviewed all messages generated by the system for four months prior to implementation and suggested modifications directed at ensuring that messages would be perceived as necessary, useful and brief.

Once the fully revised system was ready to go live, a memo was sent to the medical group's providers to inform them of the new messages they would be receiving. The group had a history of including locally developed alerts and messages within their EMR system so no further training was necessary. Figures 2 and 3 provide examples of the system's alerts.

The total estimate of costs for personnel involved in developing and implementing the transition intervention is $76,314 (Table 1). The time spent on the project across all personnel types was 1,308 hours. Physicians contributed over 600 hours which represented the largest component of time and costs. Their time includes overall project management, preparing the content, and reviewing and revising the alerts. The operations research analyst spent 370 hours developing

Figure 2 Screen shot displaying an appointment scheduling alert for the ambulatory physician support staff

Figure 3 Screen shot displaying a medication alert for the ambulatory physician

the project's computer programs. The project required substantial coordination which was provided by a research assistant who also developed blueprints based on the guidelines. An EMR database administrator from the medical group contributed data to the discussions of content and provided information about existing data elements to the operations research analyst. The medical group's pharmacist and a registered nurse contributed their perspective to the preparation of content and the review and revision process.

Hours for maintenance during the initial four months were low, despite the fact that the EMR software was upgraded during that time. The resulting revisions to the alert system required very little time from the informatics team.

Discussion

Development and implementation of the automated alert system were made possible by the existence of linkages to the hospital and outside labs, a scheduling system integrated into the medical group's EMR, cooperation from SNFs, real-time access to claims for dispensed drugs, and a locally written interface engine application. It was supported by an EMR that includes a flexible database, allowing local programming. Strong informatics expertise was required, including substantial time from an operations research analyst, an applications software engineer and a database administrator. The staff hours required totalled 1,308, with 47% of those from physicians.

With the continued growth of a movement in the USA toward the use of hospitalists, hospital-based physicians who provide medical care to patients during inpatient stays,[26,27] transitions to ambulatory care are likely to remain difficult and may result too often in readmissions.[4,28,29] Placing more complete information in the hands of ambulatory care physicians has the potential for improving the transition process. To accomplish this, the ambulatory care side of the process may need to become proactive by implementing systems for obtaining the information they require. With the expansion of EMR implementations in ambulatory care,[23,30–32] it is possible to assemble the components required to support more rapid and complete flow of information during discharges of patients. Like the medical group in which this intervention was implemented, many provider groups with EMRs already use interface engines to allow direct receipt of ADT and ORU messages and are using these in some applications. Most hospitals and commercial laboratories are equipped to send such messages. The interface engine that allows this medical group to send messages to targeted recipients was developed locally, but commercially available interface engines can accomplish this. Provider groups in the USA that do not have direct access to pharmacy claims can obtain timely information on pharmacy dispensing for their patients through the Surescripts® e-prescribing network.

The expertise and staff time required to implement an automated alert system may be a stronger limitation than the technological resources. The presence of a physician leader with HIT and health information exchange knowledge was essential to the project, as was the availability of in-house IT staff with design and programming skills and extensive understanding of the local network.

Further research is necessary to determine the effect of HIT-based transitional care interventions on patient outcomes. Such information will enable ambulatory care practices to make informed decisions about the most effective strategies for adopting information management systems.

In conclusion, we found that the implementation of an automated alert system to provide information about patient transitions to ambulatory physicians is feasible for provider groups, but it requires strong internal informatics expertise, cooperation between facilities and ambulatory providers, development of a number of electronic linkages and extensive commitment of physician time.

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