

Implementation of a Computerized Patient Handoff Application

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Abstract

For hospitalized patients, handoffs between providers affect continuity of care and increase the risk of medical errors. Most commercial electronic health record (EHR) systems lack dedicated tools to support patient handoff activities. We developed a collaborative application supporting patient handoff that is fully integrated with our commercial EHR. The application creates user-customizable printed reports with automatic inclusion of a variety of EHR data, including: allergies, medications, 24-hour vital signs, recent common laboratory test results, isolation requirements, and code status. It has achieved widespread voluntary use at our institution (6,100 monthly users; 700 daily reports generated), and we have distributed the application to several other institutions using the same EHR. Though originally designed for resident physicians, today about 50% of the application users are nurses, 40% are physicians/physician assistants/nurse practitioners, and 10% are pharmacists, social workers, and other allied health providers.

Introduction

Patient handoff refers to the social interaction and information exchange that occurs when responsibility for a patient's care transfers from one clinician to another. Handoffs for hospitalized patients have become more frequent with the increased use of cross-coverage and night-float systems. The challenges and dangers associated with patient handoff have received extensive attention from the Joint Commission, and include increased in-hospital complications, delays in diagnostic tests, uncertainty about patients' care plans, and preventable adverse events [1-8]. Although the Joint Commission has recommended a standardized approach to patient handoff as part of its National Patient Safety Goals [9], most commercial electronic health records (EHRs) lack effective tools to support patient handoff activities. As a result, clinicians at many institutions use separate paper or electronic systems that are not part of the EHR. This practice can lead to redundancy, information fragmentation, treatment delays, and medical errors.

We have developed a collaborative application for patient handoff that is fully integrated with our commercial EHR (Sunrise, Allscripts Corp., Chicago, IL). We have made the application available to other hospitals that use the same EHR. This paper describes the design of the patient handoff application, and describes the lessons-learned from its use at two academic medical centers.

Methods

Several methods have been suggested to improve handoff communication in hospitals, including the use of communication frameworks such as SBAR (Situation, Background, Assessment, Recommendation) [10]. As part of its National Patient Safety Goals, the Joint Commission requires that physician handoffs should be "reasonably standardized in order that sufficient patient-specific information is consistently communicated to facilitate continuity of care and patient safety" [9].

One practical method for standardizing the handoff process is the creation and exchange of a handoff document or "signout" note [11]. These notes typically include demographic data (e.g., a patient's name, age, location, code status, and next-of-kin), a brief clinical history of the patient, a list of current medications, recent diagnostic test results, and important "to-do" items for the current and next care provider [12-16]. Signout notes may be

handwritten, or they may be entered completely or in part using a computer application. Although signout notes are widely used in hospitals throughout the U.S., they are generally not part of the educational curriculum for physician trainees and are not traditionally considered to be part of the official medical record [17].

Dedicated tools supporting patient handoff communication and documentation are seldom available in commercial EHRs. Non-EHR systems (e.g., stand-alone applications, word processing programs, pen-and-paper) require clinicians to re-enter data from the electronic chart, a process that is inefficient and prone to transcription errors. Clinician surveys by Bernstein et al. [18] and Van Eaton et al. [19] suggest that integrated patient handoff tools reduce the time residents spent on handoff documentation. Flanagan et al. [20] and Anderson et al. [21] described an electronic handoff application used by the U.S. Veterans Administration, but the system provides only limited integration with the EHR.

Development of the Patient Handoff Application

Our institution includes two large academic medical centers in an urban, medically underserved community. The institution has a fully-deployed commercial EHR. Historically, a variety of paper and electronic processes were used by different groups within each medical center to facilitate patient handoff.

In 2005, a group of physicians, informaticians, and information technology experts began designing a patient handoff application that could be used at both of our institution's academic medical centers. From the outset, a key design requirement was tight integration with our commercial EHR so it would integrate with other aspects of clinicians' documentation workflow. The application was designed to facilitate collaborative work among a range of users, including resident physicians, attending physicians, medical students, nurses and social workers.

The patient handoff application was created as a custom tab within the EHR that was labeled "Handoff." The application was developed using Visual C# (Microsoft Corp., Redmond, WA), and communicated with the EHR using the vendor's included application programming interfaces. The integrated tab provided users with a consistent look-and-feel while enabling the application to leverage core EHR components such as role-

The screenshot displays a patient handoff application integrated into an EHR. At the top, patient information for 'TEST_A' (219L-5) is shown, including allergies (Penicillin), current weight (60 kg), and vital signs. A navigation bar includes tabs for Patient List, Orders, Results, Documents, Flowcharts, Data Vis, Dose Hx, Handoff (selected), Micro-Epi, Dz Mgmt, ABx Sensitivity, and Patie. The main content area is divided into several sections: 'Brief Patient Summary' with a history of updates, 'Active Issues' (Cellulitis of left leg, Benign essential HTN, Diabetes type 2, controlled), 'Primary To-Do List' (follow up cultures, restart home antihypertensives, dose vanc by level while Cr not stable), 'Coverage To-Do List' (NTD, FYI - sundowning and agitated last night), 'Discharge Planning' (Plan to return to SNF when stable), 'Code Status' (DNR), 'Isolation Status' (No specific isolation required), 'Contact Info' (Son (HCP) - John Test), 'Notes/Comments' (6/5/12: Left ankle xray - no evidence fracture), 'Hospital Course' (6/5/12: CXR: clear lungs), and 'Consult Notes'.

Figure 1. Patient Handoff application integrated as a tab within commercial electronic health record system.

based access and security auditing. Figure 1 shows the Patient Handoff tab in our EHR. Within the Patient Handoff tab, clinicians could generate and print custom handoff reports for one or more patients. The patients could be selected from existing lists defined by the institution (e.g., patients in the medical ICU) or from lists defined by individual clinicians (e.g., Dr. Jones' personal list of patients). Creation of the handoff report was accomplished by 1) assembling patient data, 2) formatting the data using the Extensible Markup Language (XML), and 3) transforming the XML into a concise formatted report using the Extensible Stylesheet Language (XSL). Patient data incorporated in handoff reports included the following information entered by the clinician:

Format Report Font Size: M Include Cover Sheet Print

TEST, A [649 34 79] 99y F (12/2/12) DNR 2/13/09 (12106)

Summary
99 F, nursing home resident, poorly controlled diabetes, HTN, dementia sent in with fever, found to have LLE cellulitis and AKI, improving on vancomycin (PCN allergy). Sundowning at night.

Notes
6/5/12: Left ankle xray - no evidence fracture
6/5/12: CXR: clear lungs

Discharge Planning
Plan to return to SNF when stable, call daughter to arrange

Consult Notes
--

Allergies
Penicillin-Anaphylaxis

Diet
Regular Diet

Meds: Standing
CARDIO
Furosemide Oral Liq 5mg PO q24h
GI
Ranitidine HCl Oral Liq +R+ 12mg PO q12h-(9,21)
OTHER
Nystatin Topical Oint 1applic TOP q6hr

Vitals
T_{curr}:36.2° T_{max}:37.0° @ 07 Jun 05:00
HR: 147 (130 - 156)
BP: 92/52 (77/44 - 96/51)
RR: 58 (56 - 77) | SpO₂: 100%

I & Os
7A:7P 7P:7A 24h 7A:
DSW 18 12 30 20
DSW 1/4 Normal... 0 25 25 145
Peds Alimentum... 187 0 187 0
Peds Alimentum... 50 225 275 230
Total In 255 262 517 395
Urine: Diaper... 154 167 321 140
Total Out 154 167 321 140
TOTAL NET 101 95 196 255

Labs
138|101|11 - 10.1 06/07/12
4.5|26|0.72 - 114 - x 20.28
12.9 n:7.4-6% 06/07/12
9.6 - (290 M:5.3% E:0.3% 20.28
38.1 B:0.3%

TEST, CASE1 [590 00 08] 12y3m F (1/1/00) 10/15/09 (966d)

Summary
--

Notes
--

Allergies
No Known Allergies

Diet
No diet ordered

Contact Info
--

Primary Team To Do
--

Figure 2. Formatted report of handoff/rounding information suitable for printing.

The Patient Handoff application generated detailed audit logs that we analyzed to track usage statistics. Each user action was recorded, including accessing handoff data for a patient, creating a report, and printing a report. The time, user identifier, user role, patient identifier, and action were included in the audit log.

☒ **NAME** [☒ MRN] ☒ Age ☒ Gender (☒ birthdate) ☒ **CODE STATUS**

☒ Location ☐ Team/Attending ☒ **Isolation**

☐ Surgery ☒ Admit Date (☒ LOS)

☒ Summary	☒ Allergies	☐ Contact Info
☐ Active Issues	☒ Diet	☒ Primary Team To Do
☒ Notes	☒ Meds: Drips ☐ ☒ ☐	☒ Coverage To Do
☒ Discharge Planning	☒ Meds: Standing ☐ ☒ ☐	
☒ Consult Notes	☒ Meds: PRN ☐ ☒ ☐	
	☒ Vitals ☐ °C ☒ °F	
	☒ I & Os ☐ ☒ ☐	
	☒ Labs ☐ 24h ☒ 48 ☐ 72	

Lines between pts (min) - 34 + ☐ Page break between patients

☒ Save Settings ☒ Close

Figure 3. Formatting options for customizing handoff report output.

patient summary, notes/comments, and “to-do” items for both primary and coverage teams. Other data recorded in the EHR were automatically included in the printed reports, including patient demographics, allergies, medications, vital signs, fluid intakes & outputs, results of common laboratory tests (shown in a “fishbone” format), code status, and isolation requirements. An example of a formatted report containing data for test patients is shown in Figure 2.

The handoff report could be customized prior to printing to accommodate the needs of individual clinicians. Figure 3 shows the menu of options available for dynamically modifying the handoff report contents and structure. Among the customizations that could be made were:

1. users could select which data to include based on the intended purpose of the report (e.g., handoff to covering physician, pre-rounding summary, cover sheet with basic demographic data);
2. a cover page containing only basic patient demographics could be included;
3. active medications, grouped by therapeutic class, could be displayed in an expanded or space-saving, condensed form; and
4. the time window for lab results was selectable (e.g., 24 hours, 48 hours).

Results

The Patient Handoff application was first made available to users in March 2008. Its use was optional, and gradually most clinical services in the institution began using the application. No formal training was conducted to instruct clinicians on the use of the Patient Handoff application; however, a short instruction guide, referred to locally as a “job aid” was made available. The job aid was used to educate Service Desk personnel about the application, and a copy was included in the EHR training materials for new clinical employees.

Use of the application at each medical center was measured by reviewing audit log data from February, 2013. Table 1 shows the use of the Patient Handoff application by user role. Of 6,311 clinicians accessing the application in February 2013, about 50% were nurses, 40% were physicians/physician assistants/nurse practitioners, and 10% were allied health professionals.

In February 2013, a total of 21,288 handoff reports were printed, which included an average of 8.7 patients each. The time required for the application to generate a report for 10 patients was about 2-3 seconds.

Table 1. Use of the Patient Handoff application by clinician role, February 2013.

Role	Users accessing application	Patients viewed	Application accesses	Reports printed	Average number patients per report
Nurse	3,136	7,323	66,812	9,359	5.8
Physician	2,208	9,110	288,977	2,987	11.8
Physician Assistant	305	3,802	78,471	4,821	10.8
Nurse Practitioner	188	1,670	18,504	1,883	8.6
Social Worker	152	1,816	4,800	582	16.2
Respiratory Therapist	110	756	2,662	454	7.8
Physical/Occupational Therapist	100	966	2,390	453	15.5
Pharmacist	80	756	2,468	702	10.6
Dietician	32	352	484	47	11.9
Total	6,311	26,551	465,568	21,288	8.7

Discussion

Since 2005, our multidisciplinary team (including a core group of 5 clinicians and informaticians) has spent several hundred hours developing and testing the Patient Handoff application. For the project to be successful, two key challenges had to be overcome. The first was the difficulty of integrating the application within our commercial EHR. Initial attempts to use native EHR functionality to create a handoff report acceptable to physicians were unsuccessful, even with assistance from vendor resources. The second challenge was developing a system that would meet the needs of clinicians from a variety of specialties and from two distinct medical centers.

Collaborative use of the application

One of the interesting findings from the analysis of system usage logs was the regular viewing of the Patient Handoff application by nurses and ancillary staff. Many units used the Patient Handoff application to facilitate handoffs for nurses. Anecdotal reports indicated that nurses viewed the Patient Handoff application as a reliable and timely source of information on patient status and plans for treatment or discharge. These observations are comparable to the findings of Sidlow et al. [22], which demonstrated that nurses who were given “view” access to handoff information reported improved ability to develop care plans and increased nursing satisfaction.

Time savings

A trial by Van Eaton et al. found that implementing a computerized tool for physician handoff decreased the rounding time of residents, and enabled them to spend their pre-rounding time more productively [19]. While we

have not conducted a rigorous study of this outcome measure, clinicians have reported a similar experience of time saved because the printed report replaced tedious pre-rounding activities such as gathering and re-writing patient vital signs and laboratory test results.

Improved medication management

One of the most useful features of the patient handoff application was the direct retrieval of active medications from the order entry system. Prior to the implementation of the application, medication lists in signout documents were maintained manually in free-text lists. Analyzing signout notes entered using Microsoft Word (Microsoft Corp., Redmond, WA) at a separate academic medical center, Arora et al. found that 27% of medication chart entries were discrepant with the signout note, and 54% of the discrepancies had moderate or severe harm potential [23]. Because medications in our application were retrieved directly from the active orders in the EHR, there were no such discrepancies. Clinicians also appreciated that the printed report generated by the Patient Handoff application helped remind them to reorder time-limited medications such as barbiturates or opiates.

Including Handoff Information in the Medical Record

The information found in handoff documentation is rich in terms of clinical decision-making. If handoff documentation is maintained within the EHR, pertinent information can be readily accessible to multiple members of the care team. Results from studies by Petersen et al. [24] and Arora et al. [25] suggest that standardization of data collection and integration of handoff information into EHRs could improve communication and reduce medical errors. Foster et al. reported on the use of electronic patient handoff data to support clinical decision support tools and to facilitate error reporting [26]. Hripesak et al. noted that emergency room clinicians frequently access handoff information from patients' previous hospitalizations to identify key events and findings, particularly when a discharge summary document is not available [27]. Furthermore, Stein et al. demonstrated utilization of centralized, electronic handoff documentation throughout the day and night, and across an individual patient's admissions, not just during the usual times associated with end-of-shift patient handoff [28]. Based on these findings, it is somewhat surprising that handoff information is often not considered to be an official part of patients' medical records [29].

Conclusion

Face-to-face discussion during handoffs of patient care can be supported by information technology. We have developed a patient handoff application that is fully integrated with our commercial EHR, and implemented it at two academic medical centers. The application is used monthly by over 6,000 physicians, nurses, and other types of care providers. Primary factors influencing adoption were 1) integration with our commercial EHR, 2) time savings experienced by users, and 3) the ability to generate customizable formatted reports.

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