ASSESSING THE IMPLEMENTATION PROCESS

Charlene Weir, Ph.D., Cynthia McCarthy, MSN, Sue Gohlinghorst, MSN, Richard Crockett, RN
VA SLC Health Care System

Abstract

A Computerized Patient Record System (CPRS) has many benefits and could improve health care outcomes. Reaping these benefits, however, is dependent on successful implementation of a provider order entry system. The literature supports substantial evidence that even systems that are usable, effective and reliable have not been adopted by the intended users. A successful implementation may be substantially a function of the degree to which the processes of care have changed to adapt to the new system. To ensure successful implementation we suggest monitoring the implementation process itself. The purpose of this paper is to report the methodology we developed for assessing how successfully a provider order entry system is being implemented. We adopt a model of diffusion of information technology developed by Fichman (1994) and expanded by Ash (1997). In this model, diffusion is characterized be three categories, "breadth" (infusion) and "depth" (diffusion) and "quality"(appropriateness of use). In this paper we discuss the typology of diffusion and describe specific measures designed to measure infusion and diffusion of a hospital information system.

BACKGROUND

Provider order entry has many potential benefits such as quicker turn around time for orders, decreased medication errors, online decision support and overall improved quality of care. [1,2,3,4] Reaping these benefits, however, is dependent on successful implementation of the information system. The quality of implementation has been known to impact user satisfaction, adoption and performance of the system [5,6,7]

Implementation of provider order entry systems have been notoriously difficult and involves significant technical, organizational and psychological change [8,9,10,11,12]. In fact, success of provider order entry may be almost exclusively a function of the degree to which the processes of care have changed to adapt to the new system. Monitoring of key indicators of change, then, becomes an essential component of the implementation process.

The purpose of this paper is to report development of "implementation indicators" using Quality Management model to provide continuous monitoring of the outcomes of the implementation itself. Monitoring of the processes of care have long been accepted as part of the model of any continuous quality improvement model and we are taking that approach here [13]. Monitoring indicators of the change process (from a paper record to an electronic record) can be used to assess the quality of the information technology process itself. The statistical foundation of continuous quality management tracking is based on the mathematical definition of "stable processes" [14]. All measured events are probabilistic as they vary around some central tendency. In a stable process, the central tendency is discernable. An unstable process has a steep slope and/ or extreme variability. In this study, we are taking only the first step in identifying stable processes and that is to develop the measurement properties of the indicators.

Implementation of the Computerized Patient Record
The Veterans Administration Hospital in Salt Lake City Utah (SLCVMC) used a phased in approach to implement a Computerized Patient Record system (CPRS). CPRS provides computer order entry and retrieval for medications, progress notes, consults, laboratory, radiology, and dietetics.

Implementation of the Computerized Patient Record System (CPRS) at SLC VAMC was part of a national mandated implementation. Implementation was coordinated at the national level although there was considerable leeway regarding the timeframe and processes locally. At the Salt Lake City VA, implementation of CPRS was conducted in two basic steps, progress note entry and order entry. By policy, progress note entry was initiated first and implemented in a staggered approach across patient care areas starting March 1998. Implementation of order entry began when the graphical user interface component of CPRS was installed into the system in October 1998. Order entry was implemented in a staggered approach beginning on December 1st, 1998. Within a care area, everyone (nurses, clerks, and physicians) were expected to begin using CPRS at the same time (nurses and clerks were instructed <u>not</u> to accept written orders). Electronic note entry was mandated across the hospital (except for the outpatient surgery clinics) as of July 1st, 1999. By this time electronic note entry had been available and encouraged for 18 months.

1067—5027/00/$5.00 © 2000 AMIA, Inc.

Diffusion Model

Implementation of information technology follows the pattern of all diffusion models. We have adopted a typology of diffusion developed by Fichman (1994) and expanded by Ash (1997).[15,16] Ash (1997) recommends measuring both infusion and the extent of diffusion as well. In this paper, we use the terms "depth" and "breadth" to capture these concept. In addition, we have added "implementation quality" to reflect skillful use of the computer system.

Breadth. The first dimension is "*breadth*". Breadth is defined as the degree to which the system is adopted across the organization. In other words, breadth is a measure of the saturation of system use. In terms of provider order entry, breadth would refer to the proportion of providers who are entering their orders in electronically and who are doing electronic notes.

Depth. The second dimension is "*depth*". Depth refers to the degree to which work processes have been adapted to using the computer. In other words, how fully has the computer been integrated into work processes. Depth measures vary across the level of analysis ranging from individual users customizing their own work on the computer to care centers tracking their own training and developing their own policies.

Quality. The third dimension is *quality*, or the degree to which the system is used appropriately. Although training may have been conducted thoroughly and processes analyzed completely, the system may not be used in such as way as to minimize impact on patient care. The result is an increase in errors, miscommunications, and adverse events.

METHODS

Automated Data Retrieval

Data collection involved querying the VA's data management system using Fileman. Fileman consists of computer routines written in American National Standards Institute (ANSI) MUMPS programming language. Data was retrieved using Fileman then transferred to a relational database and further queried using Structured Query Language (SQL).

Breadth Measures

Breadth measures consisted of three items. The first is the proportion of electronic orders (all orders are entered in the VISTA system) entered by ordering providers (N=330). The second is the proportion of notes that are electronic and the third is the proportion of outpatient visits with electronic notes. Breadth indicators are listed in Table 1.

Table 1. Breadth Implementation Indicators.

INDICATOR	DESCRIPTION
% Orders by ordering providers	Discriminates between written, policy, verbal & tel.
# of Inpatient Notes	Total Count on any one day
% Visits w/ notes	Number of visits w/notes

Electronic Orders. Before implementation of CPRS the physician would write the order on paper. It was the responsibility of the unit coordinator to enter non-pharmacy orders into the computer system. Medication orders were faxed to pharmacy and entered into the system by a pharmacist. With the implementation of CPRS physicians were instructed (and trained) to enter patient orders directly. Assessing how many of the total orders were entered directly by providers is the important outcome.

Total Inpatient Electronic Notes. In the inpatient setting, electronic note entry occurred simultaneously with electronic order entry. Very few notes were written on a ward once provider order entry started, (excepting DNR notes). We used the total number of electronic notes written in the inpatient area over time as the third indicator of implementation depth. Because each inpatient area "went up" with CPRS at once, the total count of inpatient notes is a relevant figure. Use of paper charts was essentially eliminated shortly after each floors adoption of CPRS.

Ratio of electronic notes to clinic visits. The third indicator is the ratio of electronic notes to visits in the outpatient setting.

Depth Measures

In this study three indicators of depth were used. These items are illustrated in Table 2 below.

Table 2. Depth Implementation Indicators.

INDICATOR	DESCRIPTION
Ind. Customization	Self-report in survey.
Care Center Involvement	Admin. Checklist 1 Track training? 2. Create policies? 3. Send representatives?
# Chart requests	File room scans all requests.

Individual Customization. Self-report use of 12 customization techniques for tailoring CPRS to individual preferences was the indicator of individual

depth (e.g. making own note templates). Forty seven nurses (33%), 26 ordering providers in primary care (94%) and 32 housestaff rated 12 tasks on a 1(do not use) to 3 (use easily without help) scale. Scores were summed across the items for each individual to yield an overall score. For nurses, non respondants and respondants did not differ on age (R=44.5 vs NR=44.8; ns) or length of service (R=12.6 vs NR=12.3; ns).

Care Center Involvement. The six inpatient units were used for this analysis. Each unit was examined for the presence of a current system for training and maintaining computer skills, the presence of representatives working on the informatics committee, and the presence of internal policies regarding the processes of using the computer for provider order entry.

Requests for Paper Charts. When implementation has been fully completed, we would expect requests for paper charts to diminish significantly as clinicians turn to the computer to find information about their patient. The file room keeps an accurate record of the number of chart requests as all records are scanned on leaving the file room and all file requests are done electronically. Their cumulative reports were the source for data analyses.

Quality

To assess the quality of the implementation, three indicators were assessed. These items are listed in Table 3 with a short description.

Table 3. Quality Indicators.

INDICATOR	DESCRIPTION
% unverified orders within 2 hours.	% orders not verified in specified time period. A high level indicates process failure.
# unsigned notes	# unsigned assoc. with alerts.

Percent Unverified Orders. Nurses must note on the chart that they have seen an order and performed the necessary actions associated with putting the order in place. Electronic verification of an order can be done in this system, leaving initials that show the nurse has seen the order. Orders should be verified within two hours of completion in order to assure quality of care.

Percent Unsigned Orders. Often nurses, physicians and medical students will enter orders with the intention of completing the order set, but will fail to sign the orders and thereby "release" them. Large number of unreleased orders (6 hours after entry) can indicate failure to use the system appropriately and could cause adverse patient events.

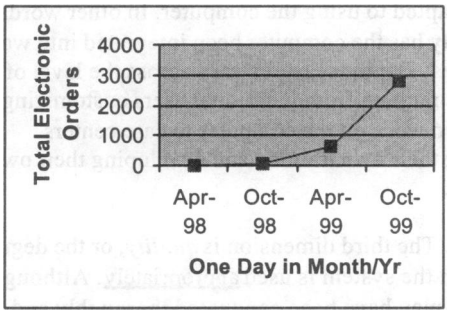
Unsigned Notes. Notes can be typed in or dictated but until they are signed they are not released as an official part of the medical record. Unsigned notes are not made available to other providers and can produce a significant lag in communication. Usually unsigned notes indicate that users are not attending to their notifications.

RESULTS

Breadth Indicators

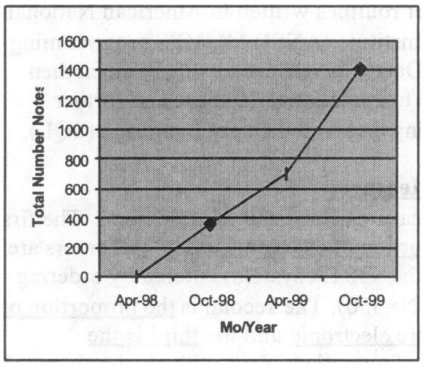
Proportion of Orders that were Electronic. Figure 1 below illustrates these numbers for selected days over a two year time period. (Leveling would indicate that the process has become stable).

Figure 1. Proportion of Electronic Orders.



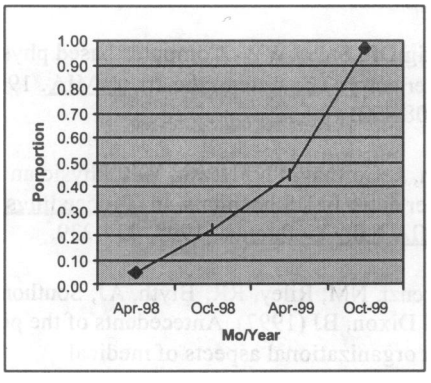
Total Number of Inpatient Notes. Figure 2 illustrates the increase in the number of notes on selected days across a two year period. The rate of increase is steep, indicating a change process. As in the number of electronic orders, we are not able to discern that the process is stable around a mean.

Figure 2. Inpatient Notes on Selected Days.



Ratio of Outpatient Visits to # Electronic Notes. Figure 3 illustrates the proportion of primary care visits with electronic notes on selected days. Although we are reaching nearly 100%, the process itself is not yet stable.

Figure 3. Proportion Outpatient Visits w/Notes.



Depth Measures

Individual Customization. The average score on the 12 skill items was **22** (possible: 12 to 36) with 70% of the users responding with a total score below 23.

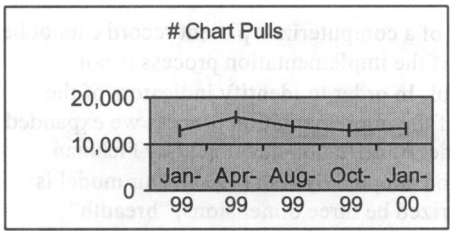
Care Center Involvement. The grey boxes (with + signs) in Figure 4 indicate compliance with the evaluation criteria. Of the six inpatient units, only one met all three criteria for full implementation. This ward had taken over the monitoring of training requirements, had developed policies regarding provider order entry (e.g. the only ward to remove all paper charts from the nursing station), and they had representatives who attended informatics meetings.

Figure 4. Ward Implementation Depth.

UNIT	TRAINING	POLICY	REP.
A UNIT	+	-	-
B UNIT	+	+	+
C UNIT	-	-	+
D UNIT	-	-	+
E UNIT	-	-	+
F UNIT	-	-	-

Requests for Paper Charts. Figure 5 illustrates the total number of pulls per selected month. As can be seen by the graph, there has been no substantial change over the year period.

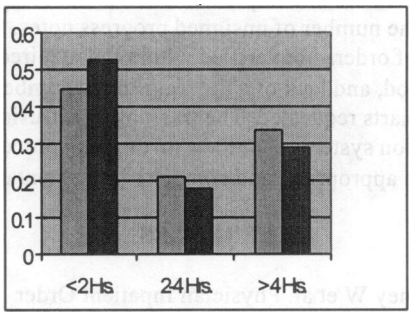
Figure 5. Paper Chart Requests by Month.



Quality Measures

Proportion Nurse Verification. The time between order release and nurse verification is illustrated in Figure 6. The orders are divided into three groups, the proportion verified within 2 hours is on the far left. Time 1 is the day of April 6, 1998 (blue) and Time 2 is October 4, 1999 (red).

Figure 6. Proportion orders verified in time frames.



Proportion Notes Unsigned. On the four selected days of analyses (4/6/98, 10/5/98, 4/5/99 and 10/5/99) the proportion of unsigned electronic notes is less than one percent and do not substantially vary, indicating a stable process. See Table 4.

Table 4. Proportion of Unsigned Notes.

Date	Proportion of Unsigned Notes
4/6/98	0.003690037
10/5/98	0.083474337
4/5/99	0.299531981
10/5/99	0.56565445

DISCUSSION

Benefits of a computerized patient record cannot be realized if the implementation process is not successful. In order to identify indicators of the effects of the implementation process we expanded on a model of diffusion developed by Fichman (1994) and adopted by Ash (1997). Our model is characterized be three dimensions, "breadth" (infusion) and "depth" (diffusion) and "quality" (appropriateness of use).

At the time of analysis we had technically completed the implementation process. Even though formal statistical analysis was not done, visual inspection of the steep slope indicates significant evidence that the process was still ongoing and further implementation strategies were needed. A leveling of the lines on the graph would denote that the implementation had reached a stable stage and implementation was complete.

Other indicators that implementation is not complete include the number of unsigned progress notes, the number of orders not verified within the required time period, and lack of a decrease in the number of patient charts requested. The tracking of diffusion of information systems should be an ongoing process to ensure an appropriate and complete implementation.

REFERENCES

1. Tierney W et al. Physician Inpatient Order Writing on Microcomputer Workstations: Effects on Resource Utilization. JAMIA 1993; 269:379-383.

2. McDonald C, Hui S, Smith D. Reminders to Physicians From an Introspective Computer Medical Record. Ann Int Med 1984;100:130-138.

3. Bates Dw, Kuperman G, Teich JM. Computerized Physician Order Entry and Quality of Care. Qual Man Health Care 1994;2:18-27.

4. Rind DM et al. Effect of computer-based alerts on the treatment and outcomes of hospitalized patients. Arch Intern Med. 1994; 154: 1511-1511.

5. Ginzberg, M. J. (1981). Key recurrent issues in the MIS Implementation Process, MIS Quarterly. 5(3): 47-49.

6. Zmud RW, Cox JRF. The implementation process: a change approach. MIS Quarterly. 1979;June:35-43.

7. Massaro TA. Introducing physician order entry at a major academic medical center: 1. Impact on organizational culture and behavior. Acad. Med. 1993;68:20-25.

8. Sittig DF, Stead WW. Computer-based physician order entry: The state of the art. JAMIA. 1994; 1:108-123.

9. Ash, J, Gorman, PN, Hersh, WR. Physician order entry in US hospitals. In: Proceedings for AMIA Fall Conference, 1998, 234-239.

10. Lorenzi, NM, Riley, RR, Blyth, AJ, Southon, G. and Dixon, BJ (1997). Antecedents of the people and organizational aspects of medical Informatics: A review of the literature. JAMIA. 4(2): 79-93).

11. Rogers, EM. The "critical mass" in the diffusion of interactive technologies in organizations. In Kraemer KL,Cash JL Jr. (eds): Survey Research Methods, volume 3.Boston: Harvard Business School, 1991.

12. Lee F, Teich JM, Spurr CD,Bates DW. Implementation of physician order entry: User satisfaciton and self-reported usage patterns. JAMIA. 1996;3:42-55.

13. Gitlow, H, Gitlow, S. Oppenheim, A. Oppenheim, R. Tools and Methods for the Improvement of Quality. 1989. Boston: Irwin Press.

14. Wheeler and Chambers, Understanding statistical process control. Knoxville, Tenn, 1986.

15. Finchman, RG. Alternative measures of organizational innovativeness: A conceptual and empirical analysis. Presented at the1994 Annual Diffusion Interest Group Information Technology Workshop, Vancouver, BC, December 17, 1994.

16. Ash, J. Organizational factors that influence information technology diffusion in academic health sciences centers. JAMIA, 1997. 4:102-111.