Successful Implementation of an Integrated Physician Order Entry Application: A Systems Perspective

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Direct physician order entry is required for effective implementation of an integrated electronic medical record. This effort involves multi-level changes in the whole system of care, from physicians attitudes to interdepartmental relations. This study reports the findings of a follow-up study that quantified dimensions associated with successful implementation identified in a previous study. Results identified several implementation strategies associated with success. These include an interdisciplinary implementation group, involvement of large numbers of regular staff, early and intensive training and support, and 24 hour available assistance as important to success. In addition, attitudes of physicians and their level of involvement were found to be associated with success.

INTRODUCTION

Physician order entry of a fully integrated hospital information system is often thought to be essential to maximize quality management activities, cost control, and clinical decision support. Full acceptance of an electronic medical record by physicians often requires dramatic changes in work patterns and is often met with resistance [1,2,3]. Understanding the factors associated with success involves taking a systems perspective [2,5]. This study is the second in a series of three conducted by the Veteran's Health Administration Information Systems Center at Salt Lake City designed to identify both the individual and institutional level variables associated with successful adoption of an integrated order entry system by physicians.

The Salt Lake City Information Service Center of the Veteran's Administration (SLC ISC) released their order entry system, Order Entry/Results Reporting 2.5 (OE/RR 2.5), to the field in March, 1993. OE/RR 2.5 integrates several clinical packages (e.g., pharmacy and lab) and provides a single environment where clinicians can enter clinical orders and obtain clinically relevant patient information. A new version with a GUI interface is in alpha release currently. Both anticipate supporting full physician order entry.

Physician order entry in these settings is direct ordering by physicians at work stations where orders are captured by receiving departments in a non-ambiguous process. The orders are not text strings that have to later be translated, but are direct communication to services.

The VHA provides an excellent environment in which to conduct such an investigation because the 171 acute care facilities and about 350 outpatient facilities that constitute the VA system operate relatively independently but also share a single information system. This type of organization permits comparisons between different institutions using the same or similar applications.

Three studies were planned to identify factors that discriminate successful from non successful implementation of a physician order entry system in the VHA system. The first study identified salient dimensions of implementation derived from open-ended responses of people directly involved in implementation attempts of OE/RR 2.5 and was published in the 1994 SCAMC proceedings [5]. Respondents were from 6 separate institutions and included randomly selected physician users, administrators, computer support specialists, nurses, and medical record technicians. Participants were asked to provide 3 to 6 facilitating factors and a similar number of perceived barriers to physician order entry in their facility. These items were sorted using a modified Q-sort into categories by independent raters. Table 1 presents these categories collapsed together (many of the barriers were the inverse of the facilitating factors).

The purpose of the study reported here (the second in the series) was to quantify measurement of these dimensions and to assess them directly. These quantified dimensions can then be used to differentiate hospitals that have experienced successful implementation of physician order entry. The third study will follow institutions longitudinally from implementation forward to determine factors predictive of success - a stronger experimental design.

0195-4210/95/$5.00

METHODS

Thirteen hospitals were identified that were either beta sites or implemented OE/RR 2.5 early. These thirteen fell into two categories based on relative success of physician order entry. Success was defined by the percentage of providers directly using OE/RR 2.5 for more than 50% of their orders at each institution as reported by participants of the study. Since all of the facilities were (and are) actually "in process" of developing a physician order system, the period of comparison was defined to end March 1 of 1995.

The percentage of providers using order entry did differ significantly between hospital sets [$F(1,47) = 16.2$; $p = .00$; Means: success = 56.6%; failure = 11%]. There was no significant difference between the two groups in the average time since implementation, in the number of associated packages implemented, or in the percentage of patients cared for by residents.

Questionnaires were mailed to the following individuals from each institution: 1) Medical administration staff, such as Chiefs of Staff and directors of bed services; 2) Administrators, including the director of the Information Resource Management department (IRM) which provides hardware and software support, Nursing, and Medical Records; 3) Support staff, such as the computer support staff from pharmacy and lab who had been assigned to assist with the implementation of OE/RR, and specifically designated coordinators responsible for training and implementing OE/RR 2.5; 3) Users, including ward clerks, physicians, and nurses; and 4) Physician opinion leaders nominated by a random selection of 5 physicians from each institution. Over the 13 hospitals, 131 individuals received a questionnaire. Sixty four percent (n = 83) responded. The response rate did not differ significantly by institution.

Questionnaire content varied according to participant role. Overall, the content of the questionnaires was designed to directly assess the dimensions identified in study one. Table 1 presents those dimensions, the variables used for measurement and who provided the information.

RESULTS

General Overview

Because the number of variables was large in relation to the number of hospitals, composites were made combining variables related to a specific construct. Appropriate (parametric, nonparametric) univariate analysis was performed for each of this composites as well as the remaining single variables. Each of these will be discussed in turn. Means and proportions are presented in Table 2.

Training

The intensity of the training effort was measured by the combination of the number of FTEE a hospital devoted to training plus a weighted sum of the strategies used. One-on-one instruction was weighted more than small groups, which in turn, was weighted more than large lecture groups. A

Table 1: Dimensions Affecting Implementation and Associated Measurement Variables and Sources: (P=Physicians; C=Chiefs of Staff; I=Information Resource Management; M=MAS)

DIMENSIONS	VARIABLES
Functionality	Checklist (I)
Knowledgeable, support from IRM, on-line help	Ratings of support (P,C); Summary of activities (I)
Perception of many potential benefits	Attitude Scales (P,C,I,M)
Ability to customize software	Proportion of Physicians using order sets (P)
Supportive administration, chiefs of staff	Likert Rating (P)
Direct involvement of physicians	Attitude Scales (P)
Good relationship with developers	Attitude Rating (I)
An interdisciplinary, implementation group	Specific questions regarding organization (I)
Good implementation strategies (e.g. starting small, Mandating use)	Specific questions regarding where and how it was implemented (I)
User-friendly interface	Likert Rating (P)
Perceived time cost	Likert Rating (P)
Sufficient number of people hired	Specific questions regarding how many were hired and number used (I)
Adequate Hardware, avail., terminals, etc.	Estimated wait time (P,M) Likert Rating (I)
Comprehensive training and instruction	Self Rating of skills (P) Description of training (I)

one-way ANOVA comparing success hospitals versus non-successful hospitals on this variable was not significant, although the means were in the right direction. One-on-one training was listed by physicians as the most common source of training. Those physicians coming from success hospitals were marginally ($p > .05$ and $< .10$) more likely to have received that training than those coming from less successful hospitals (X^2 (45) $p = .08$). Physicians were asked to rate their skills and abilities in using OE/RR 2.5 and their responses provide an indirect measure of training. Those physicians coming from successful hospitals rated their skills significantly higher than physicians coming from less successful hospitals on a 1(poor) to 7 (excellent) scale. [$F(1,45) = 6.53$; $p = .01$; Means: success = 4.4; failure = 3.0].

Support Intensity

The intensity of support was measured with a weighted sum of the following: 1) A rating of the intensity of support with '1' being a person on call 8 hours a day; 2) A '2' for a designated person that would stay on the floor for 8 hours a day; 3) A 3 would be given for on-line support, e-mail, assistance on the floor, pager, and 24 hour support. This rating was combined with the total number of FTEE involved in implementation. A one-way (success versus failure) ANOVA assessing the difference in the means was marginally significant ($p > .05$ and $< .10$) with successful hospitals appearing to provide more intensive support than less successful hospitals [$F(1,12) = 4.5$; $p = .06$].

In addition, there was a significant difference in the proportion of physicians who reported using customized order sets from the two hospital groups, a measure that also indicates specialized support. Significantly more physicians from success hospitals than from failure hospitals utilized specialized order sets developed at least at the section level (X^2 (45); $p = .02$).

Implementation Strategies

This composite variable is designed to measure the mechanisms of implementation and is a weighted sum of the following: 1) Interdisciplinary implementation team ('0' if not present; '1' if formed after implementation; '2' if formed simultaneously with implementation; and '3' if formed at least 3 months prior to planned implementation); 2) Location of implementation ('0' if started on several floors at once, '2' if started on a large busy ward, '3' if started first on a small, not busy ward); and 3) Mandated implementation ('0' if not mandated, '2' if mandated). A one-way (success versus failure) ANOVA assessing the difference in composite means was significant with successful hospitals having better implementation strategies [$F(1,12) = 5.0$; $p = .05$].

Attitudes of Administration

A scale comprised of three items was constructed assessing general attitudes to an electronic medical record. The scale was moderately reliable across all respondents (alpha = .78). Three one-way ANOVAs comparing attitudes between those in successful versus less successful hospitals for the following groups was performed: 1) Chiefs of Staff, 2) IRM staff, and 3) Medical Records Staff. None of these analyses were significant.

Involved and Interested Physicians

Physicians were asked to estimate the number of actively involved physicians interested in implementation of a computerized medical record at their institution. When these numbers were averaged, there was no significant differences between hospital groups, although the means were in the right direction (success=18.6; failure=5.62). This variable did not control for the overall size of the hospital.

Attitude of physicians regarding the value of an electronic medical record did differ between hospital groups as measured by a scale constructed of three items (positive impact, potential savings for system, and decreased errors). Reliability for this scale was high (alpha=.85). [$F(1,44) = 6.7$; $p = .01$; Means: success = 16.7; failure = 13.3]. Physicians response to a question asking if clinicians entering orders themselves took too much time from patient care was also significantly different between hospital groups on a 1 (agree completely) to 7 (disagree completely) scale. Physicians from successful hospitals rated POE as being significantly less time-consuming than those coming from less successful hospitals [$F(1,42) = 5.55$; $p = .02$; Means: success = 4.1; failure = 2.7].

Supportive Developers

Overall developer support was measured on a 1(not at all) to 7(very supportive) Likert scale (1= not at all supportive and 7= very supportive) by IRM staff. There was no difference between hospital groups on this measure and the overall mean was 4.73.

Usability

This variable was measured with a rating on a 1 (very poor interface) to 7 (very easy to use interface). The overall mean was 3.6 and did not differ between hospital groups.

Hardware
This variable was measured by asking for estimated waiting times for terminals plus an overall rating on a Likert scale asking if there were sufficient terminals available. There was no significant differences between groups on this variable. Overall, those hospitals that had implemented POE had provided terminals for every office as well as several in the residents work rooms.

Table 2: Means and proportions overall and by hospital group. Successful (S), Unsuccessful (U) and Overall (O).

VARIABLE	S	U	O
*Implementation Strategies(13)	9.33	6.15	7.74
*Intensity of IRM Support(13)	9.50	3.83	6.67
Training Strategies (13)	5.33	3.17	4.25
Admin. Attitudes (13)	9.50	3.83	6.89
*Physician Attitude (45)	16.7	13.4	15.3
Usability (45)	3.70	3.15	3.50
Developer Support (13)	5.17	4.20	4.73
*Perceived Time Cost (45)	4.08	2.74	3.50

Note: A single asterisk (*) indicates significance at the $p \leq .05$ level. Sample sizes are in parenthesis next to each variable.

DISCUSSION

The results from this study support the finding of our previous study as well as work done by others that a major factor in successful implementation of physician order entry is the pattern of organizational policy development and implementation[3,4,5].

Providers skilled in the use of the computer, specialized IRM support, positive attitudes on the part of clinicians, and effective implementation strategies were all significantly different between hospital groups. All of these variables reflect an intensive organization-wide effort to ensure effective implementation. These findings also suggest that this effort must be done early. Successful hospitals tended to provide 24 hour, one-on-one, personalized support. Although few new FTE were hired, many people were involved in the process in addition to their other regular duties.

In addition, two of the three measures of physician involvement were significantly different between hospital groups. Physicians from successful hospitals rated the system as more valuable and reported that it was less time consuming that those physicians from less successful hospitals. The direction of causality for this finding is hard to interpret. The more favorable attitude on the part of clinicians may be an effect of success, not a cause. People tend to judge an activity more favorably if the outcome was successful than when the outcome was less successful, especially if they were involved in the process [6]. Or the finding may simply reflect the truism that people are more positive about an activity that they know more about.

However, the active support of users has been found in other studies to be a significant causal factor in producing success of many types of implementations [7,8]. Only a prospective longitudinal study would be able to tease out the differences of cause and effect.

Contrary to expectations there was no difference in attitudes regarding the use of an electronic medical record and the importance of POE for administrators at the two hospital groups. One reason for this failure to find a difference may be that overall support was generally high and differences could not be detected (a ceiling effect). The overall mean of the attitude regarding the electronic medical record across both hospital groups was 18.2 on a possible scale of 21.

Other items did not differ between the hospital groups as predicted. For example, there was no difference in wait times or available terminals or judgments regarding the difficulty of having enough terminals, although the means were in the right direction for each of these items. One reason for this lack of differences is that hospitals that do not have enough terminals for POE will not have physicians waiting for one as they will tend to use the written chart. Those who have mandated POE provide the terminals in order to ensure adequate patient care. Hence, the perception may match the actions.

The user interface was not perceived by any of the respondents to be extremely "user friendly", but this perception did not differ between groups. This suggests that a less than ideal interface did not impact implementation significantly. It also may be the case that physicians in the VA were willing to try OE/RR 2.5 as they were aware of the upcoming (now in alpha) OE/RR 3.0 which uses a GUI interface with windows.

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