Origina**l** **Investigations**

Research Paper ■

Implementation of Physician Order Entry: User Satisfaction and Self-reported Usage Patterns

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Abstract Objectives: To evaluate user satisfaction, correlates of satisfaction, and self-reported usage patterns regarding physican order entry (POE) in one hospital.

Design: Surveys were sent to physician and nurse POE users from medical and surgical services.

Results: The users were generally satisfied with POE (mean = 5.07 on a 1 to 7 scale). The physicians were more satisfied than the nurses, and the medical staff were more satisfied than the surgical staff; satisfaction levels were acceptable (more than 3.50) even in the less satisfied groups. Satisfaction was highly correlated with perceptions about POE's effects on productivity, ease of use, and speed. POE features directed at improving the quality of care were less strongly correlated with satisfaction. The physicians valued POE's off-floor accessibility most, and the nurses valued legibility and accuracy of POE orders most. Some features, such as off-floor ordering, were perceived to be highly useful and reported to be frequently used by the physicians; while other features, such as "quick mode" ordering and personal order sets, received little self-reported use.

Conclusions: Survey of POE users showed that satisfaction with POE was good. Satisfaction was more correlated with perceptions about POE's effect on productivity than with POE's effect on quality of care. Physicians and nurses constitute two very different types of users, underscoring the importance of involving both physicians and nonphysicians in POE development. The results suggest that development efforts should focus on improving system speed, adding on-line help, and emphasizing quality benefits of POE.

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One important application of informational technologies in medicine is physician order entry (POE).[1,2] In POE, physicians enter orders directly into the computer. POE has a number of benefits such as ensuring legibility and allowing faster transmission of orders, but perhaps its greatest area of potential is the opportunity in offering physicians online information support.[3] For example, when a physician orders digoxin, the system can check recent results of relevant tests such as serum potassium level, creatinine, and digoxin level, and displays the information on the screen. The system can also perform multiple checks on orders, such as alerting the physician if a patient has a known allergy to the drug being ordered. Providing online information with POE also has the potential to reduce costs: for example, the computer can notify physicians about redundant or low-yield test ordering.[3-5]

Despite the potential benefits of POE, many attempts at implementing it have failed or met with high levels of user resistance.[1,3] For example, implementation of POE at University of Virginia (UVA) Medical Center resulted in widespread discontent among physicians, and led to a boycott of POE by residents until changes were made.[6,7] POE implementation efforts have stumbled for a variety of reasons, including lack of sensitivity to users' suggestions, and the large workflow change that POE brings.[6,7] To be successful, implementers should frequently monitor areas of satisfaction and dissatisfaction among users, and should understand as well as possible how POE is actually used.[8]

This study uses a survey to: 1) evaluate users' overall satisfaction with POE, 2) identify factors associated with satisfaction and dissatisfaction with POE, 3) measure users' perceptions about the frequency they used specific POE features, and 4) measure users' perceptions about the usefulness of specific POE features. This information may have implications for systems development, training, and how POE can be most effectively framed and "marketed" within a hospital.

Methods

POE System and Setting

This study was conducted at Brigham and Women's Hospital (BWH) in Boston, a 720-bed affiliate of Harvard Medical School. A POE system was developed in BWH in 1992,[9] and first implemented in the medical service (200 beds) in May 1993.[10] Surgical and orthopedic services started using POE at the end of 1993. At the time of the study, only medical, surgical, and orthopedic services were using POE; at the present time, all adult inpatient services are using the system. Once introduced, use of POE is mandatory. At BWH, the primary users of POE are the residents and the nurses. The nurses use POE to acknowledge ("take off") all orders entered in by physicians, and to enter verbal or telephone orders from physicians. Monitoring the display screens for new orders has become an integral part of the nursing routine.

In the BWH POE system, most orders are written using menus, and more than 90% are captured in coded form. Most are written using the keyboard, although some devices have mice. As an example of how the ordering process works, to enter an order for a patient on the unit where the patient was, the physician enters his or her password, selects the specific patient from the display list, and selects "Write orders." This takes the physician directly to the main order entry screen from which he or she can enter the various types of orders needed. For a medication order, the physician then enters the medication name and route, and selects a dose and frequency from lists. All orders are subjected to a series of checks, including drug allergies, interaction, and therapeutic substitutions.[3] At the time the present study was conducted, only the first set of decision and information support tools were in place, including basic allergy checking and checking for the most important drug conflicts; the number and range of these tools have been expanded substantially over time.

On average, the POE system processes 17,000 orders a day. Twenty-six percent of all orders are written using order sets and templates. Order sets are pre-written, fixed collections of orders, which can be used in a stereotyped situation (such as post-angiography) and which can be edited or accepted en bloc. Departmental order sets are sanctioned by the clinical departments and are available to all users; each user also has the option to build personal order sets for his or her own use. In contrast to order sets, templates are forms containing a variety of related orders, some with missing parameters; the user selects the desired orders from the form and completes the partial orders as needed. An example is the ordering of chemotherapy, with its associated hydration and premedications.

When POE was first introduced, the nurses were required to attend an hour-log training session. For the physicians, training was not mandatory, but training sessions were held in which the residents were asked to drop in to learn and experiment with the system in the presence of support personnel.

About half of the residents attended these sessions. During the first two weeks of POE implementation, support personnel were on the hospital floor 24 hours a day to assist POE users. Ongoing POE support has been provided by nurse-specialists on an on-call basis. At the time of the study, the system had a minimal amount of on-line help, but there is a "feedback" button that users can press whenever they wish to send a comment, complaint, or suggestion to POE support personnel and developers.

Survey Instrument

A survey was designed to measure user satisfaction and self-reported usage patterns. This is included in the Appendix. Items 1 to 16 on the survey asked respondents to indicate, on a seven-point Likert scale, their general satisfaction with POE, and their assessment of POE's reliability, speed, ease of use, adequacy of training, and impact on productivity and patient care. Items 17 to 25 listed specific features of POE; respondents were asked to indicate whether they use each feature, and if so, to rate its usefulness. Examples of POE features include order sets and "quick mode" ordering (which allow orders to be entered as a line of text rather than through fields or on a form). Items 26 and 27 were open-ended questions in which respondents indicated their most-liked and least-liked features of POE.

In addition to measuring users' satisfaction and self-reported usage patterns, some items in the survey evaluated help-seeking behaviors when users have questions about using POE. The first item in part 2 of the survey was an open-ended question asking users to indicate the POE feature they found most difficult to learn. Then, users indicated the frequency with which they approached different sources for help on POE 1) when they were first learning POE, and 2) at the present time.

The last part of the survey asked users for personal information, and the questions were slightly different for physicians and nurses. In the physician survey, users indicated their gender, service area (medicine, surgery, or orthopedic), position (intern, junior resident, or senior resident), attendance of training sessions, and prior experience with personal computers. In the nurse survey, users indicated their gender, area, shift, hours worked per week, attendance of training sessions, and prior computer experience.

Procedure

Four hundred surveys were distributed to physician and nurse POE users at BWH. Physican surveys were

sent to all medical, surgical, and orthopedic house-staff (interns, junior residents, and senior residents) for the years 1993–1994 and 1994–1995. In all, 200 surveys were sent out to physicians. Although staff physicians and medical students also write orders, they were not included in the sample because house-staff were the primary users of the order entry system. Because there were more housestaff in the medicine departments than the surgical and orthopedic departments, more surveys were sent out to medical housestaff—of the 200 surveys sent out to physicians, 66% (131) were sent to the medical housestaff and 34% (69) were sent to the surgical and orthopedic housestaff.

Surveys were also sent out to nurses. Patient floors where POE was implemented at the time of the study were randomly selected. All the nurses from the selected floors were surveyed. All in all, 200 nurses were included in the survey sample. The sample size of 200 was chosen to balance the physician sample. Of these 200 surveys, 30% (60) were sent to medical nurses, and 70% (140) were sent to surgical nurses.

Surveys were anonymous, but marked so that a second survey could be sent to nonrespondents one month after the initial survey distribution. A maximum of three surveys were sent to each individual in the sample over a one-month period. At the time of survey distribution, POE had been implemented in the medical services for about a year, and in the surgical and orthopedic services for about six months. The survey was distributed at the end of the academic year, when all the survey respondents had at least several months' experience in using POE.

Analysis

The reliability of the items measuring user satisfaction (items 1 to 16) was high (effective reliability = 0.85). In addition to the survey measures of user satisfaction, a binary dissatisfaction score was created: the respondents who gave an overall satisfaction (item 16) rating below the midpoint were considered dissatisfied users (1 = satisfaction ratings from 1 to 3, 0 = satisfaction ratings from 4 to 7). Two-tailed t-tests were used to examine differences in user satisfaction between the physicians and nurses, and between the users in medical and surgical services. Relationships between overall satisfaction and perceptions of different POE features (items 1 to 16 on survey) were examined using correlational analyses. All analyses were performed using the SAS statistical package.[11]

Based on items 17 to 25, indexes for self-reported
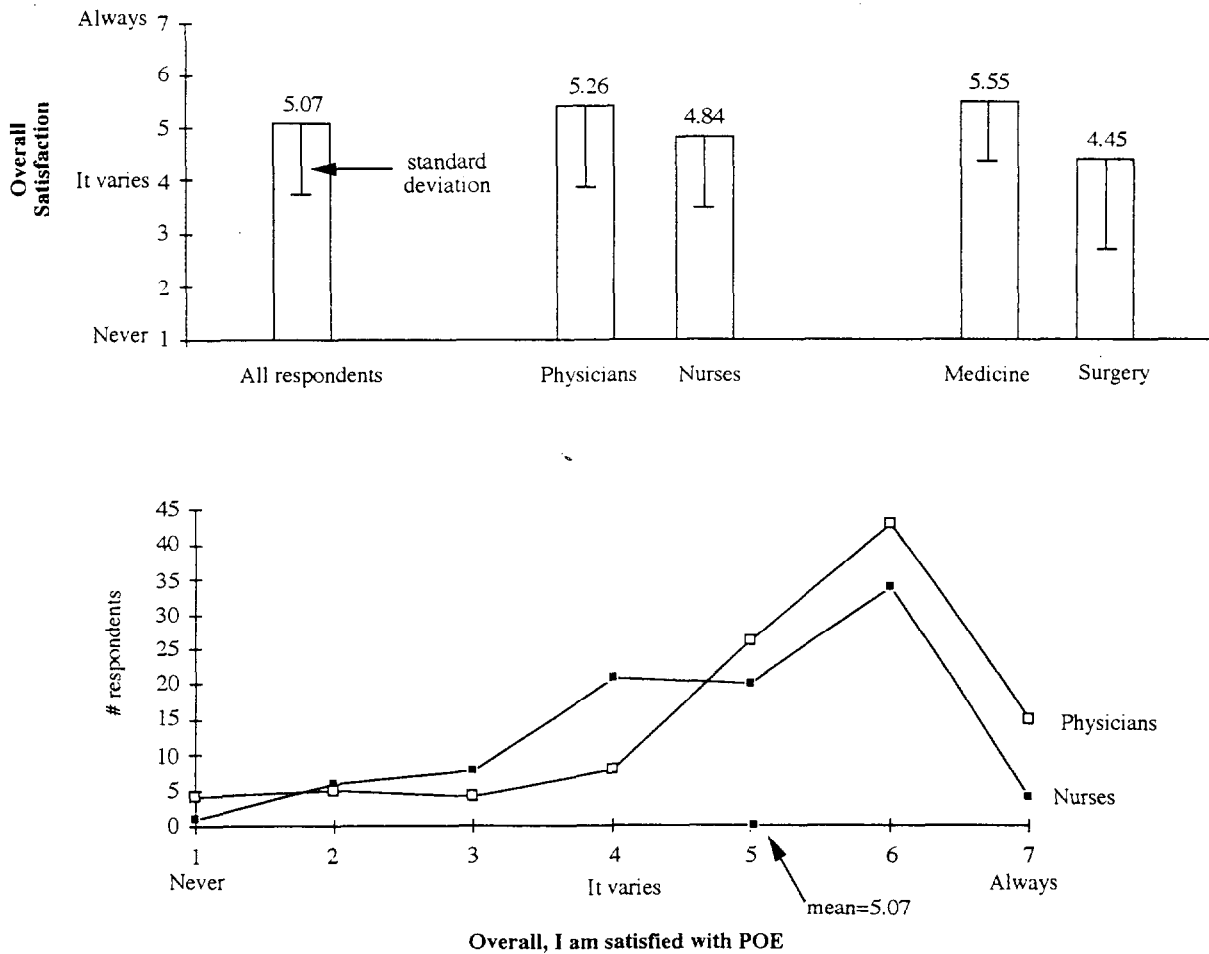
Figure 1 Users' overall satisfaction with physician order entry (POE) for all the survey respondents, by physicians and nurses, and by medicine and surgery. Overall satisfaction was good, and above the midpoint (4) for all groups. Also shown is the frequency distribution of satisfaction ratings for the physicians and nurses. The distribution is positively skewed toward higher satisfaction.

number of POE features used and perceived usefulness of POE features were generated. The number-of-features-used index reflects the total number of POE features respondents indicated they used, and the perceived-usefulness index is the average of their rated usefulness of features used. Responses to open-ended items were listed and categorized based on the frequency of occurrence.

Results

Survey Sample Demographics

After three rounds of survey distribution, 56% of the physician sample responded. More medical physicians (69%) than surgeons (32%) responded ($p < 0.0001$). A total of 112 surveys were returned from the physician sample. Three rounds of survey dis-

tribution yielded a 47% response rate from the nurses; the response rates were similar in medicine and surgery (medicine = 53%, surgery = 44%, $p = 0.22$). A total of 93 surveys were returned from the nurse sample.

Of the 112 returned physician surveys, 80% were from the medical service and 20% were from the surgical and orthopedic services; 34% of the respondents were female and 66% were male; 40% were interns, 38% were junior residents, and 22% were senior residents. Fifty-four percent of the physician respondents indicated that they had attended a drop-in training session.

Of the 93 nurse respondents, 34% were from the medical service and 66% were from the surgical service. Eighty-nine percent of the nurse respondents were female. Most (51%) worked the day shift (7 AM

Table 1 ■

Correlates of Overall Satisfaction with Physician Order Entry—System and User Characteristics

	Correlation with Satisfaction
Order entry characteristics	
Improves productivity	0.69*
Is easy to use	0.67*
Has negative impact on patient care	−0.65*
Slows me down	−0.65*
Is reliable	0.59*
Improves patient care quality	0.52*
Gives information I need	0.36*
Reduces error	0.32*
I was able to find help when needed	0.31*
I had adequate training	0.21†
User characteristics	
Experience with personal computers	−0.01 (NS)‡
Attended training session	−0.12 (NS)
Usage patterns	
Overall frequency of feature use	0.12 (NS)
Overall perceived feature usefulness	0.4*

*$p < 0.0001$.
†$p < 0.001$.
‡(NS) $p > 0.05$.

to 3 PM), 10% worked evenings (3 PM to 11 PM), and 34% worked nights (11 PM to 7 AM). Most (54%) of the nurse respondents worked an average of four or more days a week. Eighty-three percent of the nurses indicated that they had attended a POE training session.

Self-reported prior experience with personal computers was measured on a scale of 1 to 7, with 7 being a regular/expert user and 1 being a novice. The physicians' (mean = 5.3) self-reported experience was higher than that of the nurses (mean = 3.6, $p < 0.0001$).

User Satisfaction

Overall Level of User Satisfaction

We first examined the users' general satisfaction with POE by examining responses to the survey item "Overall, I am satisfied with the order entry system" (Fig. 1). Overall, the users were satisfied with POE (mean = 5.07 on a seven-point scale). Average ratings on this overall satisfaction measure were above the midpoint for all groups (physicians and nurses; medicine, surgery, and orthopedics), and the distribution of the rating was positively skewed. The physicians were more satisfied than the nurses (physician mean = 5.26, nurse mean = 4.84, $p < 0.04$), and

the users from medical services were more satisfied than the users from surgical services (medicine mean = 5.55, surgery mean = 4.45, $p < 0.0001$).

Correlates of Overall Satisfaction

The item measuring overall satisfaction with POE was strongly correlated with satisfaction with specific POE characteristics (Table 1). Overall satisfaction was significantly correlated with ratings of productivity, ease of use, impact on patient care and quality, speed, reliability, reduction of error, ability to find help, and adequacy of training ($p < 0.001$). Overall satisfaction was most strongly correlated with characteristics related to the *efficiency* of POE, such as impact on productivity (r = 0.69) and ease of use (r = 0.67). Characteristics related to the quality of care, such as reducing error or giving information, were less strongly correlated with overall satisfaction (r = 0.32 and r = 0.36, respectively), although these correlations were still significant.

The users' ratings of perceived usefulness of POE features were averaged to form a general perceived usefulness measure. Overall satisfaction was significantly related to perceived usefulness of POE features (r = 0.40), but not related to the self-reported number of POE features used (r = 0.12). Overall satisfaction was not significantly related to self-reported prior experience with computers (r = 0.01), attendance of training sessions (r = −0.12), or position (r = 0.09).

Table 2 ■

Correlates of User Dissatisfaction with Physician Order Entry System Characteristics

	Correlation with Dissatisfaction
Order entry characteristics	
Has negative impact on patient care	0.52*
Improves productivity	−0.50*
Is easy to use	−0.49*
Slows me down	0.49*
Is reliable	−0.46*
Improves patient care quality	−0.41*
Reduces error	−0.30*
Response time is slow	0.24*
I was able to find help when needed	−0.22†
Gives information I need	−0.19†
Usage patterns	
Overall frequency of feature use	−0.12 (NS)‡
Overall perceived feature usefulness	−0.27*

*$p < 0.005$.
†$p < 0.05$.
‡(NS) $p > 0.05$.

Correlates of User Dissatisfaction

Overall user satisfaction was good, and only 13% of the respondents rated their satisfaction below the midpoint. Analysis of the binary user dissatisfaction scores showed that 12% of the physician sample and 16% of the nurse sample were dissatisfied; there was no significant difference in dissatisfaction levels between the physicians and the nurses ($p = 0.21$). There were more dissatisifed users from surgical and orthopedic services than from medical services (24% and 5%, respectively, $p = 0.02$). There was a trend toward more dissatisfaction among those who attended training sessions compared with those who did not (17% and 6%, respectively), although the difference was not significant ($p = 0.11$). Self-reported prior experience with computers did not predict dissatisfaction ($p = 0.82$).

Table 3 ■

Responses to the Open-ended Question: "What Do You Like Most about Order Entry?"

Physicians

Most common responses*
   Off floor/remote access, being able to do all ordering in one place
   Computer checks, automatic prompts for default dosages and frequencies

Common responses
   Reviewing up-to-date, current laboratories and medications
   Easy to use
   Templates
   Sign out
   Accurate—avoids illegible writing and standardizes orders
   Extra information about medications
   Do not need charts to write orders

Nurses

Most common responses*
   Typed orders are clear to read, unambiguous, fewer errors

Common responses
   Physicians do more of their own ordering
   Quick review/checking of orders
   Quick turnover to pharmacy—obtain medications quickly
   Can write orders quickly without physician on unit
   Saves time
   Easy to take off orders, even when chart is off the floor
   Easy to recognize pending orders
   Easy to check laboratories
   Less calls/paper to other departments
   Off-floor ordering
   Active medication list
   Organization—nothing is lost or accidentally changed
   Clear accountability—who writes what and when, and who takes it off
   Can review postoperative orders before patient arrives

*The "most common" responses were cited by more than half of the respondents, while the other responses were cited by more than one respondent.

Table 4 ■

Responses to the Open-ended Question: "If There Were One Thing You Could Change about Order Entry, What Would It Be?"

Physicians

Most common responses*
   Speed, slow response time
   Too many screens—too many steps between logon and order entry

Common responses
   Cannot cancel duplicate orders without canceling all orders
   Not user-friendly
   Nurses not accepting verbal/telephone orders
   Allowing laboratories for coverage list
   More help/support
   More flexibility—being able to take orders "verbatim"
   Too many options in order entry
   Asks for too many variables

Nurses

Most common responses*
   Physicians do not put in orders—nurses stuck with doing it
   Entering key many times
   Too many steps to order and take off medications

Common responses
   Constant wait while system recompiles data
   Speed
   Time-consuming
   No direct link to ancillary departments—radiology, blood, electrocardiology, etc.
   Not enough units/printers
   Pharmacy has slow response time
   Inability to differentiate between old and new orders
   More flags for new and pending orders
   More prominent "pending" flags (e.g., in red)
   Discontinuations not well recorded—many conflicting orders

*The "most common" responses were cited by more than half of the respondents, while the other responses were cited by more than one respondent.

Dissatisfaction was most strongly correlated ($r = 0.52$) with perceptions that POE had a negative impact on patient care (Table 2). Dissatisfaction was also strongly correlated with POE features related to efficiency ($r = -0.50$ for "improves productivity," $r = -0.49$ for "ease of use," and $r = 0.49$ for "POE slows me down"). Correlations between dissatisfaction and POE features such as "reduces errors" ($r = -0.30$) and "gives information" ($r = -0.19$) were weaker, but significant ($p < 0.05$). Dissatisfaction was significantly related to perceived usefulness of POE features ($r = -0.27$), but not significantly related to the self-reported number of POE features used ($r = -0.12$).

Open-ended Items

Two open-ended items asked respondents to indicate which features of POE they found most and least satisfactory (Tables 3 and 4). The physicians and the

nurses found different POE features attractive and unattractive. For the physicians, the most frequent response to the survey item "What is the one thing you like the most about order entry?" was off-floor/remote access (Table 3). The physicians often had patients on multiple floors at the same time, and off-floor/remote POE access allowed the physicians to enter all their orders for all their patients at a single location. The physicians also frequently cited system prompts and default options in medication ordering among their favorite POE features. For the nurses, the most valued feature was that it provided easy-to-read, clear, and unambiguous orders (Table 3). In contrast to the physicians, the nurses did not consider remote access to be an important feature because nurses rarely have to leave their floor.

The most frequent responses to the survey item "If there is one thing you could change about order entry to make it better, what would it be?" are listed in Table 4. As expected, the physicians' most frequent response was the system's response time.[3] For the nurses, the most common response was entering orders on POE for physicians. This was probably the case because nurses expected POE's off-floor accessibility to eliminate verbal and telephone orders from physicians. After POE implementation, the nurses still entered 7.8% and 8.6% of all surgical and medical patient orders, respectively. Although we do not have comparable figures from before POE was implemented, an earlier study of medication errors found that the rate of order entered by nurses was 16%.[12] Finally, even though developers made reducing the number of screens a major focus, both the physicians

and the nurses felt that there were still too many steps required to enter or acknowledge orders.

Usage Patterns

Since most POE features were designed for physicians, we examined the physicians' self-reported usage of various POE features (Fig. 2). The physicians reported that the features they used most frequently were off-floor ordering and department order sets; these features were also rated as most useful. The POE features the physicians reported to be less frequently used were "quick mode" ordering, personal order sets, and intensive care unit (ICU) templates. The features perceived to be least useful were giving reasons for radiographs and blood products.

We also arrayed the various POE features arranged by their levels of self-reported usage and perceived usefulness (Fig. 3). Differentiation between high and low self-reported usage features, and high and low perceived usefulness features, was determined by median split. Features in the top left quadrant, such as off-floor ordering, order sets, and preadmission orders, were reported to be highly used and perceived as highly useful, and could be particularly important in contributing to user satisfaction.

In contrast, features in the lower left quadrant (high self-reported usage and low perceived usefulness), such as radiographic and blood product reasons, must be monitored because they could be associated with lower user satisfaction, even though the absolute scores of perceived usefulness (3.05 for radiographic reasons
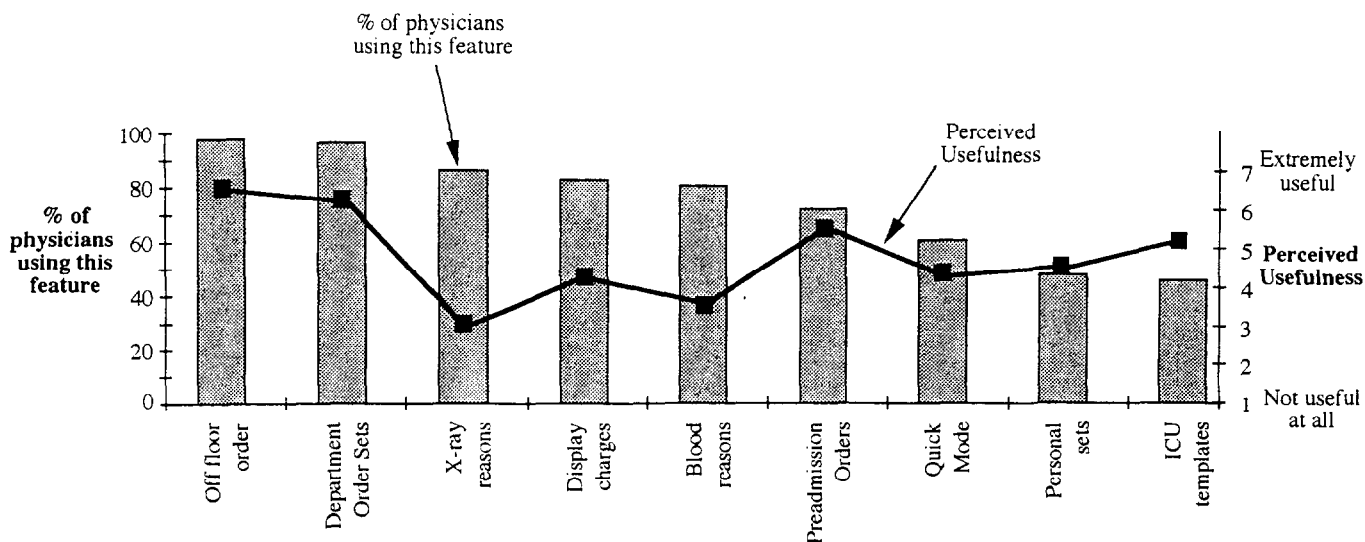
Figure 2 The frequency of usage (bar graph) and perceived usefulness (line graph) of different physician order entry (POE) features. ICU = intensive care unit.

Frequency of use

	High	Low
High (Perceived Usefulness)	Department order sets Off floor ordering Preadmission sets	ICU Templates
Low (Perceived Usefulness)	X-Ray reasons Displaying charges Blood products reasons	"Quick Mode" ordering Personal sets

Figure 3 The various physician order entry (POE) features by frequency of use and perceived usefulness. ICU = intensive care unit.

and 3.51 for blood product reasons) were acceptable. These features were reported to be highly used because they are required by regulators and the hospital. However, this requirement was seldom enforced before POE was implemented.

Features in the top right quadrant, such as ICU templates, were perceived as highly useful but were not reported to be frequently used by physicians. These features have specialized functions: ICU templates would only be used by physicians with patients in those units. Also, the ICU template was implemented in the middle of the year, and many of the respondents had their ICU rotations before it was available. Nevertheless, ICU templates were highly valued by the physicians who used them. Features in the lower right quadrant (low self-reported usage and low perceived usefulness) are most problematic from the developers' point of view. These were features that were not reported to be highly used by many physicians, and not perceived as useful either. It is not clear whether these features, "quick mode" ordering and personal order sets, were not widely used because they were not considered useful, or whether few users recognized their usefulness because they were not widely used.

Other Issues

Training

In response to the open-ended question "What did you find most difficult to learn about POE?," both the physicians and the nurses indicated "moving around the system" (Table 5). For example, the respondents indicated that it was difficult to learn the relationship between screens, menus, and submenus, and how to get from one screen to another. For the nurses, another frequent response to this question was "entering medication orders for physicians." This was also cited by the nurses as the POE feature they would most want to change.

Although the nurses and the physicians both felt that they had adequate POE training (nurse mean = 4.77, physician mean = 4.65, $p = 0.56$), the nurses were more likely to feel that they could benefit from refresher training classes (mean = 4.05) than were the physicians (mean = 2.71, $p = 0.001$). Attendance of training sessions did not significantly relate to user satisfaction ($r = -0.12$) or dissatisfaction ($r = 0.15$). Attendance of training sessions was also unrelated to the self-reported number of POE features used ($r = -0.07$) and perceived usefulness of POE features ($r = -0.08$).

Help-seeking Behaviors

We also evaluated the sources of system support for physicians and nurses 1) when they first started using POE, and 2) at the time the survey was being filled out (Fig. 4). The time differences between initial POE implementation and survey distribution were approximately one year for the medical services and six months for the surgical services. Several trends were apparent. First, the users were more likely to

Table 5 ■

Responses to the Open-ended Question: "What Was Most Difficult to Learn about Physician Order Entry (POE)?"

Physicians

Most common responses*
 "Getting around" between options
 "Which menu controls what orders and how to get there"
 Relationship between screens not intuitive

Common responses
 Too many menus
 Laboratory orders
 Templates
 Finding out the most efficient, fastest way to do things
 Different types of commands—mixture of single character, alt-key, return
 Knowing what keys/keystrokes to use
 Canceling and discontinuing orders

Nurses

Most common responses*
 Entering (verbal) medication orders

Common responses
 Moving around the system; remembering the sequence of steps
 Knowing how to access information
 Correcting errors, making changes to orders
 Discontinuing a medication
 Function of different alt-keys
 Basic computer technique and terminology

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*The "most common" responses were cited by more than half of the respondents, while the other responses were cited by more than one respondent.

need help and to look for help about POE when the system was first implemented than they are at the present time. Second, the nurses sought more system support than did the physicians. Third, the users sought help most often from their peers. The nurses were most likely to seek help from other nurses, and the physicians were most likely to seek help from other physicians.

Discussion

This study has four main results. First, the users generally were satisfied with POE. The physicians were more satisfied than the nurses, and the medical doctors and nurses were more satisfied than the surgical doctors and nurses. Second, characteristics related to efficiency were more strongly associated with user satisfaction than were the characteristics related to quality of patient care. Third, POE features perceived as most frequently used and most useful were somewhat different than expected. Specifically, in contrast to expectations, "quick mode" ordering and personal order sets were not reported to be widely

used. Fourth, neither attendance of training sessions nor users' self-reported prior computer experience was associated with satisfaction.

POE had only been in place for about a year at BWH, but overall satisfaction with POE was high. Although past efforts at implementing POE had met with strong user resistance,[6,7] users at BWH generally appeared to have accepted POE. The finding that the physicians were more satisfied than the nurses was somewhat surprising, as POE shifted part of the ordering workload from the nurses back to the physicians. For example, we found,[13] as have others,[2] that physicians spent more time ordering after the implementation of POE. In a time–motion study, which included self-reporting and observations, we found that POE increased the time medical interns required to write orders twofold, or by 44 minutes a day, although they recovered about half of this time because administrative tasks were made easier. (An analysis of actual time spent on the computer suggests that the actual time spent ordering may be less than the self-reported data.)[13] However, physicians' satisfaction may be higher than nurses' because much of POE development to date has been targeted at physicians, with many projects more important to nursing, such as the medication administration record, to follow soon. Also, POE benefits such as off-floor ordering and providing information to make better decisions may be more salient to physicians than to nurses.

The finding that the medical physicians were more satisfied than the surgical physicians was not as surprising. The medical physicians had had more experience with POE at the time the survey was administered, and in the time–motion study, we found that the surgeons spent 73 minutes longer writing orders per day, and did not appear to recover any of this time.[13] We have since implemented strategies to decrease this time. For example, we have developed a streamlined method for writing single orders (which account for 66% of all order sessions), enhanced the discharge and transfer process, created an ICU template, and developed a process for efficiently managing multiple patients on warfarin or patient-controlled analgesia.[14] A subsequent study will determine the effects of these speed-enhancement strategies.

Besides increased time spent on ordering, there may be other reasons why some users think that POE decreases the quality of patient care. For example, users may attribute causes of various patient care problems to POE, even though POE simply magnified practice issues that were present before POE implementation. Also, some users feel that POE de-

creased direct communication between physicians and nurses, which may contribute to miscommunication of information. Further, because POE training for physicians was voluntary while use of POE was mandatory, certain physicians may be unaware of various system tools and options available on POE.

The results also showed that users placed more emphasis on POE characteristics related to efficiency as opposed to POE characteristics related to quality. Sviokla[15] differentiates between an "efficiency technology," which reinforces current ways of working and performing ongoing tasks, and a "transformational technology," which changes the nature of the work. POE is a transformational technology. Rather than making pre-POE order entry processes faster, POE changes the process of how physicians make decisions about orders by providing online information feedback and suggestions.[1,7,13] Essentially, POE requires physicians and nurses to have different work

patterns and to "behave differently."[6,7] The differentiation between efficiency and transformational technologies is an important one. When a transformational technology that changes work processes is "framed" or perceived as an efficiency technology that simply reinforces current processes, successful implementation of the technology may be undermined.[15]

Even though POE is a transformational technology, the present study suggests that the users perceived POE as an efficiency technology. The strongest correlates of POE satisfaction were efficiency characteristics such as productivity, ease of use, and speed. The characteristics of POE that played a more significant role in changing the way the physicians made decisions about orders, such as reducing error and giving needed information, were weaker correlates of satisfaction. In other words, although the technology itself was transformational, and patients and
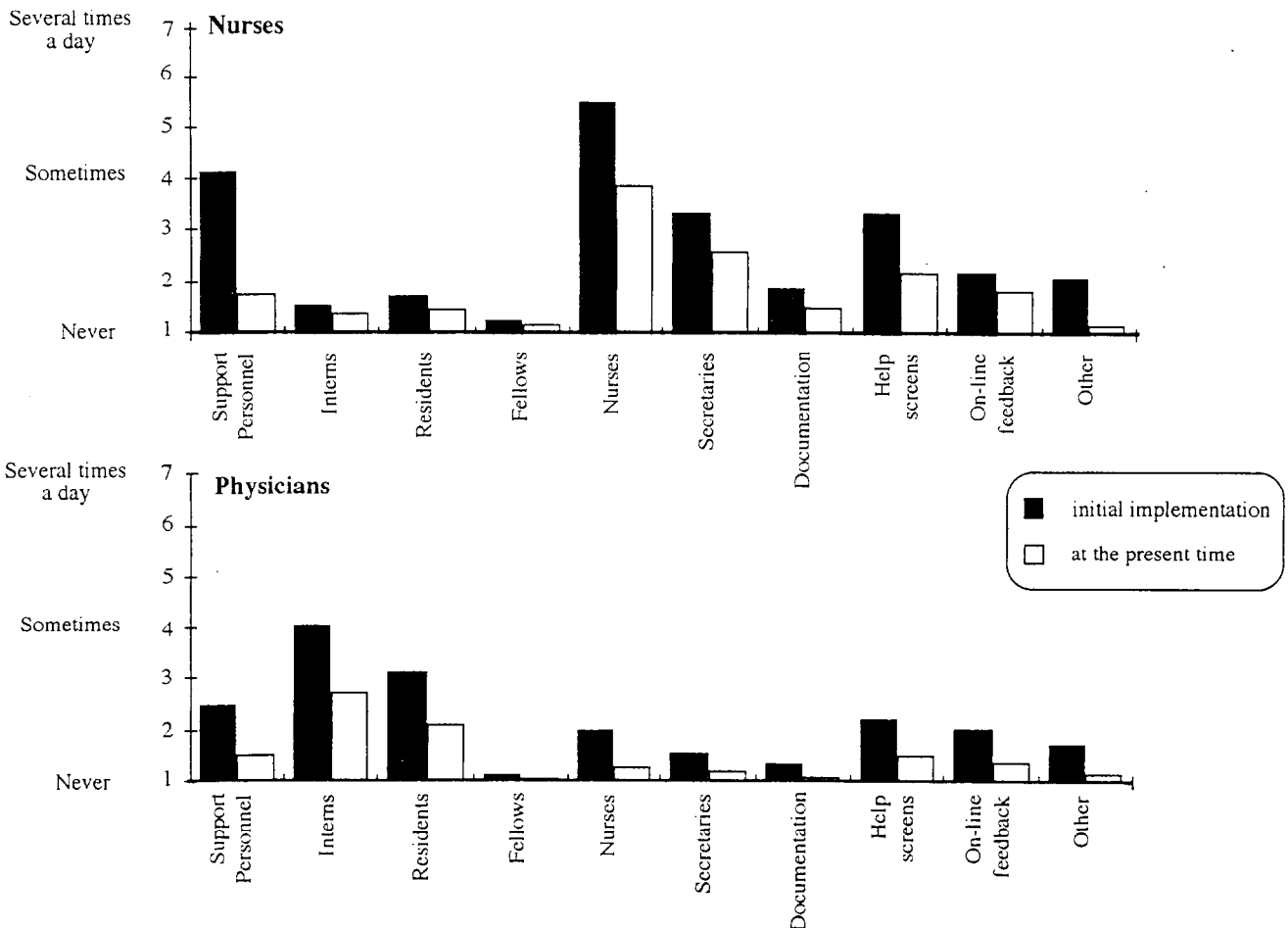
Figure 4 Respondents' ratings of how often they sought help from various sources, both when they first started using physician order entry (POE) and at the present time—demonstrating that users sought more help when they were first learning POE; also, nurses sought most help from other nurses, and physicians sought most help from other physicians.

the hospital benefited substantively from improved quality and reduced costs, the users' satisfaction of the technology was primarily predicted by efficiency concerns. One explanation of this is that efficiency factors are always noticeable whenever a physician or a nurse is using the system. If the system is running slowly, or if it takes too many screens to construct a desired order, the user notices it right away and associates it directly with POE. The transformational factors, while more important, sometimes occur subtly; the presentation of a suggested dose and relevant laboratory result may change the physician's order parameters before he or she had fully formulated them. The cost savings, and the errors that are prevented, may not be directly associated with the POE process by the user. Another explanation may be the fact that during the time of the study, only some of the quality and cost improvement measures were in place,[3] such as all orders were legible, the writer could be identified, and a number of checking systems such as drug allergy checking were in place. Many others have been introduced subsequently and a large number of additional improvements are planned. Although we expect order entry to substantially decrease the number of medication errors and adverse drug events, we are currently carrying out a randomized trial to prove these quality benefits. Thus, rather than suggesting that physicians do not care about the quality of patient care, perhaps the results suggest that they care about efficiency factors in day-to-day practice, whereas quality benefits are appreciated more on a long-term basis; or, current and potential benefits of POE related to improving quality[12,16-18] have not been made sufficiently apparent to the users. Better dissemination of information regarding quality-improvement benefits of POE to users might facilitate its implementation.

Two features expected to be important determinants of successful implementation, "quick mode" entry and personal order sets, were not perceived as frequently used and were not highly valued. For example, "quick mode" ordering, which allowed users to enter orders in a free-text form rather than from the standardized menu-driven options, was designed to alleviate anticipated concerns about system response time.[3] Although response time did emerge as the most common complaint about POE for physicians, "quick mode" ordering was perceived as one of the least frequently used POE features, and was also perceived as not useful by physicians. This was unexpected because "quick mode" was designed to decrease the time physicians need to spend on ordering by reducing the menus users have to go

through. Some of the plausible reasons for this finding are that a large proportion of physicians may not have been aware that "quick mode" ordering existed, or may not have been adequately trained in using it; training sessions showed it briefly but emphasized the form-based order mode. It is possible that users who learned to use the form-based mode first became comfortable with it and had no overriding reason to change to "quick mode." Alternatively, users may have missed the system guidance (for example, menus, dose lists, and relevant laboratory results) when using "quick mode." Similarly, personal order sets have been thought by some to be critical to successful implementation of POE, but we found that users preferred departmental order sets. Departmental order sets are already entered and have the important advantage of facilitating standardization of care. It should be noted that 850 personal order sets have been created, compared with 150 departmental order sets. However, each departmental order set is used many more times than each personal set.

Another finding was that the physicians and the nurses constituted two very different types of users. They valued different things about POE (the physicians valued off-floor access and the nurses valued clear and legible orders) and complained about different things (the physicians about slow response time and the nurses about having to enter medication orders for physicians). This suggests that training and marketing strategies should be different for these different groups. For physicians, POE could be framed as a technology that allows them more flexibility, while for nurses, POE could be framed as a technology that facilitates accuracy. This result also underscores the importance of involving nonphysician caregivers in the development of POE.

The survey results suggest that POE implementation has gone reasonably well. Some of the key success factors in implementing POE at this hospital include substantial physician involvement and leadership in application development, a constant focus on speed and convenience factors, implementing systems as they currently exist rather than changing process at the time of POE implementation, strong support from administrative and clinical leadership, and the willingness to identify user needs (as in this survey) and be flexible in modifying the application. The information from this survey has been used as a guide to the development of POE in a variety of ways. A main finding was the importance of speed to users, and we have introduced a number of workflow-specific improvements mentioned earlier. In addition, online help is currently being developed and added to the system. We have also made an effort to emphasize

the quality and cost benefits of the system in a variety of settings, but particularly in housestaff conferences.

This study has several limitations. First, there are several concerns regarding the response rates. We may have a response bias in the surveys received; for example, it is possible that the users who were most or least satisfied with POE were more likely to return their surveys, thus our results might not be representative of all the users. Currently, we have no data from the nonrespondents to assess the direction or amount of this bias. Also, our response rates were different between the physicians and the nurses, and between the medical and the surgical staffs. The low response rates among the nurses (47%) and especially the surgical housestaff (32%) raise concerns about the generalizability of the results from these populations.

Also, we asked the survey respondents to provide self-reported data about frequency of use of different POE features instead of obtaining actual frequency-of-use data; these self-report usage data may be inaccurate. For example, although "quick mode" was not perceived as a frequently used feature from the survey reports, actual system usage data showed that "quick mode" accounted for approximately 8% of all orders entered. Further, perceived frequency of use was measured by asking the survey respondents to check features they used, the survey did not ask the respondents how often these features were actually used. While actual, objective usage data would be helpful in compensating for these biases and corroborating our results, much system usage data were not readily available at the time of the study. In the future, self-report measures should be validated by actual usage frequency data collected from the system. However, for purposes of correlating with user satisfaction, users' perceived usage may in fact be as important as or more important than actual usage.

Further, our results drew heavily on the measure of user satisfaction, which was measured by a single survey item. We used a single item to measure satisfaction partly because of efforts to keep the survey short and easy to fill out, and partly because the single item showed consistent relationships with other measures of satisfaction. Although past research has shown that single items used to measure satisfaction can be valid[19,20] a longer survey with more items measuring overall satisfaction would create a more reliable measure of satisfaction.

We conclude that understanding users' attitudes toward POE and how they use POE is vital for successful implementation. In this study, we found that user satisfaction was good; that productivity, speed,

and ease of use were most highly correlated with satisfaction; and that off-floor ordering and legible orders were the most highly valued POE features among the physicians and the nurses, respectively. Understanding and responding to these users' attitudes and usage patterns may facilitate an otherwise difficult implementation process.

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APPENDIX A

Physician Order Entry User Satisfaction and Usage Survey

Part 1

Based on your experience, please indicate whether the following statements about order entry are true. Write a number in the blank beside each statement, based on the following scale:

1	2	3	4	5	6	7
Never			It varies			Always

_____ 1. The order entry system is reliable -- it does its job consistently.

_____ 2. Order entry improves my productivity.

_____ 3. Order entry has a negative impact on patient care.

_____ 4. Order entry reduces patient care errors.

_____ 5. The order entry system is easy to use.

_____ 6. Compared to paper ordering, order entry slows me down.

_____ 7. Order entry gives me the information I need to write better orders.

_____ 8. I feel that I had adequate training on order entry.

_____ 9. Order entry improves the quality of patient care.

_____ 10. System response time on order entry is slow.

_____ 11. When I have a problem with order entry, I just ask someone for help.

_____ 12. I feel that I can benefit from refresher classes on order entry.

_____ 13. When I need help on order entry, I can find it.

_____ 14. Displaying charges for ancillary tests affected the tests I order.

_____ 15. Displaying charges for ancillary tests is annoying.

_____ 16. Overall, I am satisfied with the order entry system.

Questions 17 to 25 ask you about specific features in order entry. Please put a check next to features you use, and indicate whether you find them useful by circling a number on the scale:

		Not useful at all			It varies		Extremely useful	
_____	17. "Quick mode" ordering	1	2	3	4	5	6	7
_____	18. Order sets and templates	1	2	3	4	5	6	7
_____	19. Personal sets	1	2	3	4	5	6	7
_____	20. ICU templates	1	2	3	4	5	6	7
_____	21. Preadmission orders	1	2	3	4	5	6	7
_____	22. Displaying charges for ancillary tests	1	2	3	4	5	6	7
_____	23. Writing orders from off the patient floor	1	2	3	4	5	6	7
_____	24. Choice of reasons for X-rays	1	2	3	4	5	6	7
_____	25. Choice of reasons for blood products	1	2	3	4	5	6	7

26. What is the one thing you like most about order entry?_____

_____

27. If there is one thing you could change about order entry to make it better, what would it be?_____

_____

(please turn over)

Part 2

1. When you first started using the order entry system, what did you find the most difficult to learn?

   _____

2. When you first started using order entry, how often did you go to the following sources for help? (write a number next to each group based on the following scale:)

1	2	3	4	5	6	7
Never			Sometimes			Several times a day

   _____ a. user-support personnel   _____ f. secretaries
   _____ b. interns   _____ g. user documentation
   _____ c. junior and senior residents   _____ h. help screens
   _____ d. fellows   _____ i. on-line feedback
   _____ e. nurses   _____ j. other (please specify): _____

3. Now, how often do you go to the following sources for help with order entry ? (write a number next to each group using the same scale as above:)

   _____ a. user-support personnel   _____ f. secretaries
   _____ b. interns   _____ g. user documentation
   _____ c. junior and senior residents   _____ h. help screens
   _____ d. fellows   _____ i. on-line feedback
   _____ e. nurses   _____ j. other (please specify): _____

Part 3

Your responses are completely anonymous, but we would like to ask you a few questions about who you are:

1. Gender: _____ Female   _____ Male

2. Area: _____ Medical   _____ Surgical   _____ Orthopedic

3. Position (as of 6/6/94): _____ Intern   _____ Junior resident   _____ Senior resident   _____ Fellow

4. Did you attend the drop-in training sessions for order entry? _____ Yes   _____ No

5. How much experience do you have with using personal computers? (circle one number)

1	2	3	4	5	6	7
I never use it			Occasional user			I am a regular and expert user

Thank you very much for your time!