Preferences of Interns and Residents for E-mail, Paging, or Traditional Methods for the Delivery of Different Types of Clinical Information

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We elicited from medical house staff their preferences for e-mail and alphanumeric pager as communication channels for the delivery of 18 different types of clinical information about their inpatients. For each type, we calculated the proportion of users who preferred delivery by e-mail, pager, both, or neither (usual delivery).

For 14/18 (78%) types, more users preferred delivery by pager than by the other options. For 2/18 (11%) types, e-mail was preferred. For 2/18 (11%) types, more users preferred redundant delivery using both channels. For no types did more users prefer neither, meaning that the information would be delivered by traditional channels, if any.

We conclude that medical house staff in the inpatient setting prefer to receive many types of clinical information by pager. The reason may be that they otherwise would have to query clinical information systems for these data, which is wasteful of their time and introduces delays into the process of care. Additionally, we found significant inter-user variability, suggesting that it may be useful for the notification services of an enterprise to employ user profiles for the delivery of clinical information.

INTRODUCTION

Medicine is often characterized as an information-intensive field; that is, one in which clinicians and other workers must access and process many types of information, including data about patients and general knowledge about medicine.

Information systems can employ two basic paradigms in support of such workers. These paradigms have come recently to be called *pull* and *push*. *Pull* refers to providing "look-up" capability. *Push* refers to anticipating the information needs of users and providing the information in advance.

Several characteristics of medical practice dictate that designers of information systems use *push* as much as possible. First, clinicians just do not have time to look up all needed information. Additionally, clinicians work much of the time in a data-driven mode; that is, the next action to perform or the next decision for a particular management problem depends on the result of a test (or, more generally, data collected by another party). It is more efficient for an information system to notify a clinician when such data becomes available than for the clinician to poll the system periodically for the data.

Despite this potential of *push* in clinical medicine, there is limited data—and, to our knowledge, no theory—to inform designers of information systems about when to push various types of information and by which communication channel(s). What is known is that a variety of communication channels are acceptable to clinicians for selected types of information (e.g., paper [1, 2], e-mail [3-5], pagers [4, 6], human intermediaries [7], point of care applications such as order entry [8-11], and computer terminals [6]).

One step towards the development of such a theory would be to collect data about the preferences of different types of clinicians for the delivery of different types of data by different communication channels under different conditions. Conceptually, the goal would be to create a series of preference matrices of the form "type of information" versus "communication channel." Such matrices could be the basis for theories about the characteristics of data, users, and context that determine the best use communication channels.

In this paper, we present data that illustrate this approach and serve to populate the e-mail and alphanumeric pager rows of a preference matrix for 18 types of clinical information.

SYSTEMS ENVIRONMENT

In this research, we elicited preferences from users who had received information by pager and e-mail from CLEM, a clinical event monitor that we have described previously [4]. A clinical event monitor is an embedded expert system that evaluates

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information events (e.g., a new potassium result) in the context of other data that it can obtain about a patient, and then communicates its conclusions via some communication channel to a person [5].

Communication Channels

CLEM sends information about a patient to those house staff responsible for the patient. On weekdays from 7:00 a.m. until 2:00 p.m., CLEM sends messages to the intern who has primary responsibility for the patient. After 2:00 p.m., CLEM notifies both the primary and cross-covering interns. CLEM also sends copies of messages to any resident who has included the patient on his or her electronic patient list (house staff who are interested in following the course of a patient often add the patient to an electronic list to facilitate access to information).

CLEM sends messages via e-mail or pager. At the time of this study, CLEM always used e-mail. For eight types of information, it also (redundantly) paged clinicians (at that time, we had developed paged versions of messages only for those types; however, they covered 80% of message volume).

For e-mailing, CLEM uses the Unix program "sendmail" to generate Internet Simple Mail Transfer Protocol messages. The majority of house staff read their e-mails using the Unix "elm" program. E-mail training of users included: (1) an overview of elm use during intern orientation, (2) individual instruction to those users who requested assistance in the use of elm, and (3) pocket instruction cards on the use of elm. Based on our close contact with house staff, we believe that they are competent in the use of e-mail.

For paging, CLEM uses the SkyTel® paging system. SkyTel® pagers can receive messages up to 512 bytes in size. The pagers have a 20-character by 4-line LCD screen and it manages the presentation of messages in 80-character screens that can be paged or scrolled through by the user. The user can configure the beeping properties of a pager both to set the tone (different from his or her other pager if preferred) and to not beep at night. A user can turn the pager off at any time and messages will be stored and forwarded by the SkyTel® Network Operating Center when the unit is again turned on. Similarly, if the battery runs out, messages are stored and forwarded after the battery is replaced.

We designed e-mail and pager versions of messages so they contained similar information. The e-mail and paging systems also did not differ in level of support for any actions necessitated by messages (e.g., neither channel provided a way to place an order). Thus, differences in observed preferences should be attributable to inherent differences among channels such as timeliness of delivery.

Traditional Channels

Several types of information studied were delivered to house staff through non-CLEM channels. For example: radiology reports were placed into patient charts and into an electronic results-review application; the laboratory department paged interns or phoned nurses with critical laboratory results; radiologists paged interns about radiology results; and pharmacists paged interns about selected medication orders.

METHODS

Subjects

All house staff on eight medical ward teams, the oncology service, and the medical intensive care unit (ICU) received CLEM pages and e-mails. Due to a limited supply of pagers, ICU residents (2) shared a single service pager, as did residents on the oncology service (2). Otherwise, each house staff had his or her own pager.

Preference Elicitation

At the end of two rotations (August and September 1997), we administered a four-part survey to house staff finishing the rotation. Two parts of the survey relevant to this paper elicited:

1. Basic information about the respondent, including postgraduate year, usage of e-mail, and usage of pagers.
2. The subject's preferences for the delivery of a sample of 18 of the most common types of information drawn from the set of 33. Subjects indicated whether they preferred delivery by e-mail, 2-way pager, both, or neither.

RESULTS

CLEM Usage

During the study period, the mean number of e-mails per day per user was 4.8 (range 0 - 45) and the mean number of pages per day per user was 2.9 (range 0-36). ICU residents received the largest volume of messages—they received copies of all messages for all patients in the ICU.

Response Rate

During the two study rotations, 62 unique house staff (38 interns and 24 residents) served on at least one of the medical services. All had been issued either personal (55) or service pagers (7) and all had e-mail accounts to which CLEM had sent messages. 39/62 house staff completed the study instrument (response

Table 1. Preferences of house staff for delivery of different types of information

Type of Information	E-mail		Pager		Both[a]		Neither		Total Pager[b]		Total
Impression section from radiology report	3	8.8%	14	41.2%	17	50.0%	0	0.0%	31	91.2%	34
Result of therapeutic drug level testing	1	3.1%	21	65.6%	10	31.3%	0	0.0%	31	96.9%	32
Hematocrit fall of >= 4.0 points	0	0.0%	21	65.6%	11	34.4%	0	0.0%	32	100.0%	32
Positive bacteriology culture	0	0.0%	15	48.4%	16	51.6%	0	0.0%	31	100.0%	31
Medication started that interacts with warfarin	10	32.3%	11	35.5%	9	29.0%	1	3.2%	20	64.5%	31
Serum K <=3.0 or >= 6.0	1	3.1%	18	56.3%	13	40.6%	0	0.0%	31	96.9%	32
3.0 <= serum K <= 3.3 and on Digoxin	0	0.0%	14	51.9%	11	40.7%	2	7.4%	25	92.6%	27
K >=5.3 while on supplemental K	2	9.5%	11	52.4%	8	38.1%	0	0.0%	19	90.5%	21
Patient on digoxin, no serum K measurement	5	21.7%	11	47.8%	6	26.1%	1	4.3%	17	73.9%	23
Serum K >= 5.3 while on K-sparing diuretic	7	29.2%	11	45.8%	6	25.0%	0	0.0%	17	70.8%	24
Thrombocytopenia while on platelet-toxic drug(s)	8	32.0%	9	36.0%	8	32.0%	0	0.0%	17	68.0%	25
Guidelines for monitoring patient newly started on vancomycin	14	56.0%	8	32.0%	3	12.0%	0	0.0%	11	44.0%	25
Guidelines for monitoring patient newly started on amphotericin	14	58.3%	7	29.2%	3	12.5%	0	0.0%	10	41.7%	24
Discontinue telemetry, MI has been ruled out	3	10.7%	19	67.9%	4	14.3%	2	7.1%	23	82.1%	28
Rise in serum creatinine while on nephrotoxic drug(s)	1	3.8%	15	57.7%	10	38.5%	0	0.0%	25	96.2%	26
50% change in creatinine clearance while on renally excreted drug(s)	3	11.5%	13	50.0%	10	38.5%	0	0.0%	23	88.5%	26
Long acting benzodiazepine started in elderly	9	39.1%	10	43.5%	4	17.4%	0	0.0%	14	60.9%	23
Reminder to check gentamicin level	4	17.4%	12	52.2%	7	30.4%	0	0.0%	19	82.6%	23
TOTALS	85	17.5%	240	49.3%	156	32.0%	6	1.2%	396	81.3%	487

[a]Both means subject wanted message delivered by redundant channels

[b]Total pager is the sum of pager alone and both categories to get the proportion of subjects who wanted that type of message paged.

rate 63%). The response rates for interns (25/39 = 0.64) and residents (14/24 = 0.58) were similar (p = 0.64). Five respondents (all residents) indicated that they had not used the pager during their rotation. Four had been issued a pager, or a group pager, but had elected not to use it, and one had not received any pages due to a system misconfiguration. Because we were interested in eliciting preferences from users who had experienced both pages and e-mails, we excluded these subjects from the primary analysis. A secondary analysis that included these subjects yielded only a minor change in the results, which we will discuss. The response rates for ICU (4/11 = 36%) and non-ICU (35/51 = 67%) house staff were different (p = 0.04).

Usage of E-mail

The usage of e-mail among the 34 clinicians varied widely. Three (9%) used e-mail less than weekly, 10 (30%) daily to weekly, 13 (39%) once or twice a day, and four (12%) more than twice a day (four house staff gave no response).

Preferences for the Communication Channels

Table 1 summarizes the preferences of house staff for the delivery of 18 different types of information. 49.1% of preferences were for pager alone, 32.0% for redundant delivery using both pager and e-mail, 17.3% for e-mail alone, and 1.6% for neither (usual channels). It is noteworthy that the house staff desired to receive 81.1% of the types of information by pager (summing the 'pager alone' and 'both' categories).

For 14/18 (78%) of the types of information, more respondents preferred that pager deliver the information than other options. For 2/18 (11%), the preferred channel was e-mail alone. These two types were practice guidelines about when to monitor serum vancomycin levels and when to monitor serum

creatinine in patients on vancomycin and amphotericin B. These types of information were not as time-sensitive as the other types in this study (i.e., an order for vancomycin triggered a message that suggested that it was NOT necessary to monitor serum vancomycin levels in the general case. Such levels are not typically checked until three days after vancomycin is begun). For 2/18 (11%) types, more respondents preferred redundant communication (both e-mail and pager). These types were *impression sections of radiology reports* and *positive bacteriology cultures*. The length of these reports (10% of the radiology reports exceeded the 512-byte capacity of the 2-way pager and resulted in truncation) and the desire to have a permanent copy are two reasons offered by house staff for wanting an e-mail copy of the report. For none of the types of information did most respondents prefer that CLEM not send the information. This result probably reflects that we had already eliminated information types from our system that did not seem useful to interns based on feedback provided during development of CLEM.

We conducted secondary analyses to determine whether the results were sensitive to (1) including the responses of five house staff who did not have experience with pagers, and (2) resident versus intern status. In the first case, only the preferences for warfarin and benzodiazepine alerts changed (from send by pager to a tie between sending by pager and by e-mail). A comparison of the preferences of interns and residents for delivery showed only a significant preference difference for redundant delivery by pager and e-mail (interns 34.6%, residents 24.8% $p = 0.04$).

DISCUSSION

For the types of information studied, there was a moderately strong preference for *pager only* as the desired communication channel, although a significant minority of users preferred redundant delivery by pager and e-mail. In general, there was significant variability among users with at least a substantial minority preferring pager, e-mail, both, and neither for many of the types of information.

We believe that the preference for paging is explained mainly by the timeliness of delivery; however, other factors such as the ability of the pager to store messages for later retrieval while they were writing progress notes were also identified by users as advantages of this channel. Users highlighted two types of information as most important to them—radiology impressions and culture reports. In our institution, without paging, a user waiting for such results typically checks existing information systems periodically until the result was posted.

E-mail was rarely the preferred mode of delivery. One reason given by users was that they read e-mail at home at the end of the day, when either they already knew the information or it was inconvenient or too late to act on the information. Even were they to change their habits and frequently check e-mail while on the wards, this approach would not reproduce a key distinguishing attribute of paging—that the user is absolved of the responsibility to check periodically for the arrival of results. In the two cases in which most users preferred e-mail delivery, the time-sensitivity of the information was low. E-mail was, however, desirable as an adjunct to page when page was inadequate to communicate the entire message or the message was long and complex and the user desired to store a copy of it for reference.

We were surprised by the small numbers of "neither" responses. For every type of information that we included in the study, most users desired to receive the information by pager or by e-mail. This is especially noteworthy because there were multiple traditional communication channels (results review and paper reports) for some of these types. A possible explanation is sample bias: CLEM had been in operation for 5 months before this study, and we had edited the knowledge base to refine or exclude information types that the house staff did not want, as determined by their feedback. Another factor is that some of the alerts (e.g., drug-lab interactions) were not available by any other means. However, several types of information otherwise available by existing *pull* modalities were also desired by *push* suggesting that the being sent information when it becomes available is valued by these users.

It is worth emphasizing the significant inter-user variability in preferences. Some of this variability is attributable to the different requirements of residents and interns, and of different settings (e.g., ICU and medical floors). An implication of this variability is that, should a user configurable delivery system be desirable, that the granularity of representation of preferences might have to be at the level of the individual user and alert, and might have to include other context.

A methodological limitation of this study is that subjects actually received paged versions of messages for only eight types of information, yet we asked their preferences for 10 additional types that they may have only received by e-mail. This limitation was a result of the immaturity of the paging component of CLEM at the time of the

research. Thus, our analysis is based on an assumption that house staff who have experience receiving information type A by pager can judge whether they would like information type B by pager.

A second methodological limitation of this study is that when CLEM sent messages by both channels, users likely received the page version first; thus, the subsequent e-mail was less likely to provide useful information and might have biased the study against e-mail. Thus, our analysis assumes that house staff can imagine receiving, for example, an alert about abnormal potassium only by e-mail versus only by pager well enough to provide accurate preference information.

Although in our study, paging is the preferred delivery channel for most users and for most types of information, we must be cautious in generalizing this result to other settings, as it may be sensitive to volume of messages as well as the nature of inpatient work. For example, if the volume of paging were to increase by an order of magnitude, house staff preferences might change to e-mail for some messages just to reduce the number of pages they receive. The results may also be sensitive to particulars of our information system environment. For example, user preferences might change if existing methods for disseminating such information were better (e.g., they might prefer *neither* for radiology results if a better alternative for obtaining these results were in place).

FUTURE DIRECTIONS

As a result of the variability of preferences found in this study, we built a preferences database and have offered our users since January the ability to maintain personal preference matrices. At present, we are collecting data about the way that their preferences change as a function of time and setting.

CONCLUSION

Push is a key modality for satisfying the information needs of users in medicine. Our data suggest that medical house staff want significantly more information pushed than is currently the practice. Substantial additional research is needed. We can expect the need for such research to become more acute as information technology provides an increasing number of communication channels through which information can be pushed.

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