A Feasibility Study of Two Methods for End-User Configuration of A Clinical Event Monitor

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We developed and evaluated a feature that allows users to control what types of clinical information are delivered to them. Using a paper or web-based configuration form, users turn individual alerts and sets of results on or off, and set how they are delivered.

We used usage rates to evaluate this feature. Of 16 residents who had received clinical information from our clinical event monitor, 4 (25%) made at least one change (range 10-25). Of 41 interns, 5 (12.2%) made at least one change (range 5-91). The difference was borderline significant ($p < 0.1$). 5/7 web users changed preferences through a dial-up connection from home. More users used the web-based preference form than the paper form. This difference may be due to the better accessibility of the web-based form.

A survey established that this feature was not as highly utilized as anticipated partly because the initial (default) preference setting was acceptable and partly because the users were too busy to customize their alert settings.

We conclude that user configuration of a system that delivers information using a web-based preference form is feasible and may become important as the volume of information and number of available communication channels increase.

INTRODUCTION

To provide more user control over the delivery of clinical information, a clinical event monitor should allow users to configure each type of message delivery (*e.g.*, on, off, or by which channel). As the number of communication channels (*e.g.*, computer terminal, email, pager, facsimile, hand-held personal computer or personal digital assistant, and cell phone) and volume of information increase, a user may want to control the volume of information in each channel. Most event monitoring systems send messages through only one designated channel. For these one-channel systems, the only option for each message type is on or off. To the best of our knowledge, two systems have been described that use multiple communication channels: the Clinical Event Manager (CEM)[1] at the University of Utah Medical Center and our Clinical Event Monitor (CLEM)[2] at the University of Pittsburgh Medical Center. Table 1 compares these two user-configurable systems.

A basic question one might raise is how to set the delivery channel(s) for each type of clinical information for different types of user environment (*e.g.*, ICU, wards). There are three possible solutions to the question. First, a system designer or a senior clinician dictates the policy for all users. Second, an intelligent agent using a normative approach does the channel selection as proposed by Hogan[3]. The third option is to let users select the communication channels for each type of clinical information.

A potential advantage of a user-configured system is that it delivers only the information desired by the user. Thus users would not be overwhelmed and distracted by unwanted information. Furthermore unnecessary usage of channels would be minimized. In our current approach, users customize CLEM by either filling out a paper preference form or logging onto a web-based preference page.

With user configuration, however, there are the open questions of whether users will customize their system settings and how do we go about encouraging them to do so. In addition, there is the question of whether the traditional paper form is suitable for health-care workers to customize a user-configurable system or are there other alternatives for users to set their preferences?

In this paper, we first describe our user-configurable system, then present usage data and the result of a phone survey of interns, and finally discuss the user-configurable system.

Table 1. User-Configurable Features in CEM and CLEM

Category	CEM	CLEM
Multi-channel delivery	Yes	Yes
Paper preference form	Yes	Yes
Web preference form	No	Yes
Delivery constraint	Yes	No
Time-of-day sensitive*	Yes	No

*Time-of-day sensitive means to get the message only at the certain times via the specified channel.

SYSTEM OVERVIEW

To make configuration as easy as possible, we offer users two ways to configure CLEM. In addition to

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paper form, we provide a web-based preference form that they can fill out directly on any computer with internet access.

An issue was how to maintain both paper and web forms to be consistent with the actual capability of CLEM. Without an automatic method to update both paper and web forms whenever a new type of information is added to the system, inconsistencies would likely develop. The architecture for the automatic updating of preference forms is described below.

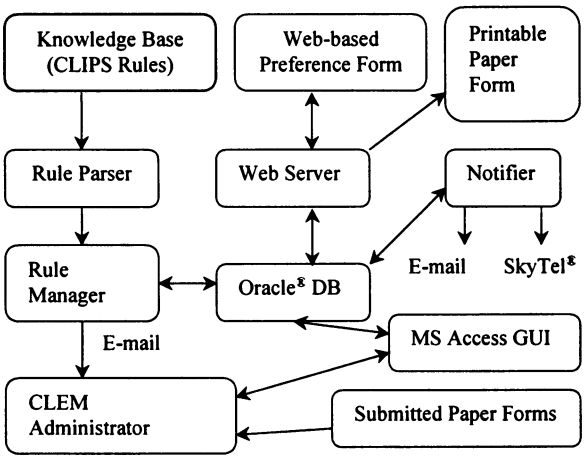

Figure 1. Architecture of User-Configurable System

To automate the updating of paper and web forms, several modules have been developed as shown in Figure 1. The rule parser, which runs off a crontab each night on an UNIX workstation, extracts basic information (e.g., title/category of each information type, expected delivery frequency, default delivery channel(s), and message recipients/procedure) from each CLIPS rule in the knowledge base. Then it sends the information to the rule manager, which then compares the existing types of information in the Oracle® database (DB) with the newly received types from the rule parser. The rule manager updates the database if any difference is observed. For example, if a new type of information is found, the rule manager will then create a new preference for each user using a default delivery channel(s) that is(are) set by the one who initiates the new information type. Similarly, the rule manager also removes obsolete information types from users' preferences. At runtime, the notifier, a multithread server listening to any incoming messages from CLEM, then consults the Oracle® database to get user preferences for message delivery. Basically, the notifier first (1) finds how a type of clinical information is sent to the designated user by looking up the user's preferences, and then (2) delivers the information to the user via his preferred channel(s). The notifier server is discussed in [4].

Default Preference Setting

Previously, We had surveyed medical house staff about their preferences for the delivery of different types of clinical information described in [5]. Based on the survey, we set default preferences for each type of clinical information.

Generating Preference Forms

The paper preference form is re-created whenever the rule manager finds a change in type of information. The CLEM administrator receives an email from the rule manager advising him of the changes made by the rule manager. To make the paper form accessible, it is formatted in HTML and available at URL *http://clem.cbmi.upmc.edu/pref.html*. We distribute paper preference forms to CLEM users at the beginning of each hospital service rotation.

The web-based form is created via a CGI script at the time that a user connects to the preference web page. Both the web and paper forms look alike. However, the web form displays the user's current preference setting, which is a feature not available on the paper form. Figure 2 shows a screen shot of the web-based preference form. The contents of the preference form include category, type of information, delivery frequency, and four choices of message delivery (*i.e.*, E-Mail, Page, Both, or Neither). Currently, there are total 51 types of clinical information to customize. The left frame of the web page provides: (1) category links to different categories on the form, (2) system functions (*e.g.*, SkyTel directory for CLEM users and a link to password change).

Processing Preference Forms

After filling out a paper form, a user may give it to the department secretary. Either we pick them up from the secretary or the secretary faxes the forms to us. We then change preferences in Oracle® DB via Microsoft Access® GUI through the ODBC connection. Usually this process takes several days.

In contrast, the web-based preference form doesn't require an administrator to change preferences. Moreover, the web form provides interactive service that confirms any changes with the time of user's first submission. Users thus have a chance to correct any errors. The web form updates users' preferences in seconds.

Security Issues

One basic requirement for the web application is that no unauthorized people can modify users' data. Our first security measure is to require users to enter a login name and password to access the web-based preference form. Second, after any change, our

system sends an email summarizing the changes to the account of the user whose preferences have changed. Thus a user is informed of any changes via email from the system.

The password initially assigned to each new user is the same as his login name. An user can change his password on the preference web page. In case an user forgets his password, the web page also provides instant password-delivery service that sends the user's password to his email account or his SkyTel® pager based on his login name and channel option.

Training

To train/educate the interns and residents in the use of the preference feature, we distributed a user's manual at the first intern rotation in July 1998 and also left several copies in the department secretary office. We also sent email about the use of both paper and web preference forms to CLEM users at the beginning of each rotation.

METHODS

We studied the use of the preference features by interns and residents from July 1 to December 31, 1998 (the first 6 rotations of the academic year). A user in our 6-month study is defined as a clinician in general internal medicine, who had been on service during any one of the 6 rotations. In addition, the user either had held a pager through the course of a rotation or had submitted a paper or web-based form even without holding a pager.

During the six rotations, our Oracle® DB automatically recorded all Web login information from users (including login time, IP address, and preference change). For those users who used paper preference forms, the Oracle® DB recorded the preference changes made by a CLEM administrator and his login information (including login time, name, and reason for change) in the log tables.

To get opinions from users, we administered by phone a structured questionnaire to users. The purpose of the survey was (1) to determine user's awareness of the existence of preference forms (either paper or web) and (2) to understand why a user did not make any changes if he or she was aware of the forms.

RESULTS

Usage of Preference System

During the six study rotations, there were 57 unique CLEM users (41 interns and 16 residents). Of the 41 interns, 5 changed CLEM preferences (usage rate 12.2%) and 4/16 residents changed preferences (usage rate 25%). Thus, our primary result is that 9/57 (15.8%) users changed their preferences in six months. The difference in rates of use of preference forms for residents (25%) and for interns (12.2%) were of borderline significance ($p<0.1$).

Table 2 lists the average number of preference changes per intern (among the 5 interns who had changed preferences) and per residents (among the 4) in the six months of study. We define one preference change as setting a delivery channel(s) for an information type or turning the information type on or off. In this study, only one intern changed preferences in two login sessions (total 91 changes) during one rotation.

Table 2. Average Number of Preference Changes Per Intern and Resident

	Mean	SD
Interns (5)	27.4 (137/5)	37.0
Residents (4)	18.5 (74/4)	6.4

We also compared the usage of paper and web forms. 7/9 users (77.8%, 5 interns and 4 residents) who changed preferences during the six-month study used the web-based form. Most 5/7 (71.4%) used the non-hospital computers to login to preference web page, *i.e.,* they probably did it from home. Figure 3 shows that 8 unique users (4 interns and 4 residents) changed preferences during their first rotations and one intern changed his preferences during his second rotation.

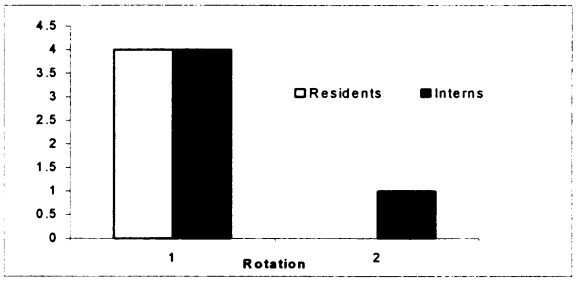

Figure 3. Number of Users who Changed Preferences at their First and Second Rotations

Phone Survey

The subjects of the phone survey were the interns who had not changed preferences using either paper or web from 7/1/98 to 12/31/98. Of 36 interns, 28 (77.7%) responded. In response to the first question in the phone survey, 20/28 (71.4%) interns indicated awareness of preference forms. Of the 20 interns who were aware of the preference feature, 2 told us they had used the web-based form this year and it worked fine. Table 3 shows the responses from the 18 interns who were aware of the preference forms and hadn't made changes. Of 8/28 users who didn't know about the preference feature, the most common reason is because they don't often read email.

DISCUSSION

In this study, we have learned several lessons in building a user-configurable preference system. First, a user-configurable system is feasible. From the usage of our user-configurable system, we found that 5 interns and 4 residents knew how to use the preference feature and made at least one change during their first two rotations even though there was no training provided other than written instructions in email and pager. Some users logged into the web page but didn't make any preference changes.

Table 3: Interns' Responses on NOT Using CLEM Preferences

	Intern Answer	Number	%
1	The default preference setting was acceptable.	6/18	33.34%
2	Too busy to make any preference changes.	5/18	27.78%
3	Don't know how to do it.	5/18	27.78%
4	Don't like CLEM.	2/18	11.1%
5	Don't get many messages from CLEM.	0/18	0%

A good initial or default setting for each type of clinical information is probably useful for an user-configurable system. This initial setting could be determined by a survey from housestaff or by a senior clinician. If an initial setting is acceptable for users, they don't have to spend time in reconfiguring the system. This fact partly explains the low usage rate of our preference feature.

A short training course may be helpful for users who are not familiar with the world wide web or are too impatient to read through the manual, to configure a system. In the phone survey, several interns who did not know how to change their preferences had expressed a desire for a half-hour training class on how to use a configuration system.

We believe that configuration via the web form is a promising way for users to set their preferences on a system. Unlike paper form, a web form provides more flexibility to users since it is available anytime anywhere. According to our result, the usage of the web-based form was more than the paper counterpart. We note that all users who made preference changes from Jan. 1 to March 1 in 1999 used the web-based form exclusively.

A web form is also more efficient than a paper form for maintaining a configurable system. A web-based form updates a user's preferences in seconds compared to the paper form, for which processing could introduce a significant delay and would be more labor intensive. This feature is worth emphasizing since clinicians in our study only spend a month on each rotation. If the delay in preference changes is too long, there is no point for them to make changes.

In addition to our results about feasibility and user acceptance, we also identified the issue of maintaining consistency between a knowledge base and preference forms. In CLEM, we had to develop a rule manager that checked the consistency between forms and knowledge base and made corrections automatically.

The availability and accessibility of a user-configurable system is probably more beneficial for residents than interns. Our conjecture for this finding is that residents might not need all the information since interns are more involved with the day-to-day task of patient care. Furthermore, residents, due to their supervisory role, may receive potentially much more information and therefore have a greater need to turn certain types of information off to reduce the load.

We also found most users made changes to their preferences during their first rotation as shown in Figure 3. This finding suggests that either the changes made in their first rotations satisfied their needs or they were to busy to make any further changes.

We have, however, also found some extensions needed by our preference system. We currently do not have enough granularity in some message types. For example, laboratory results could be further broken down to different sub-categories (such as arterial blood gas and hematology results). However, the trade-off in making more message types available is that it will become increasingly difficult for the users to configure the system, especially when the number of message types gets into the hundreds. It is not trivial to balance user's configuration time and granularity. At the very least, combing an intelligent agent and web-based form could be the solution for handling preferences when there are hundreds of message types.

A second function that we plan to add and evaluate is to configure message delivery as a function of time of day. For example, users can assign a particular date or time not to receive any messages or a certain type of message. Or a user can configure the system to deliver messages at certain time interval during the day. Although SkyTel® pager can be turned off anytime, the messages would be queued up and sent to the pager once it is turned back on.