Cognitive Analysis of Physicians’ Medication Ordering Activity

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Abstract

Computerized Physician Order Entry (CPOE) addresses critical functions in healthcare systems. As the name clearly indicates, these systems focus on order entry. With regard to medication orders, such systems generally force physicians to enter exhaustively documented orders. But a cognitive analysis of the physician’s medication ordering task shows that order entry is the last (and least) important step of the entire cognitive therapeutic decision making task. We performed a comparative analysis of these complex cognitive tasks in two working environments, computer-based and paper-based. The results showed that information gathering, selection and interpretation are critical cognitive functions to support the therapeutic decision making. Thus the most important requirement from the physician’s perspective would be an efficient display of relevant information provided first in the form of a summarized view of the patient’s current treatment, followed by in a more detailed focused display of those items pertinent to the current situation. The CPOE system examined obviously failed to provide the physicians this critical summarized view. Following these results, consistent with users’ complaints, the Company decided to engage in a significant re-engineering process of their application.

Keywords:
Medication ordering; Cognitive aspects; CPO; Usability engineering Human factors

1. Introduction

Medication ordering, dispensing and administration are key functions in healthcare, particularly in hospital settings. Survey studies of this process have identified concerns about patient safety and medical errors [1]. In this context, the automation of the medication process supported by CPOE systems has been widely considered “the right thing to do” [2] in order to standardize the entire workflow. The objectives of such systems are:

- to support the physician’s decision making by integrating guidelines in the systems to prevent Adverse Drug Events and medication overuse;
- to get the physician to enter his orders himself and sign them instead of dictating them to the nurse;
to constrain the physician to enter exhaustively documented and legible orders to (i) reduce medication errors due to ill documented orders and (ii) get orders precise enough to automatically inform the pharmacy for the dispensing task, allow the pharmacist to control the medication orders, and to automatically populate the nurses’ Medication Administration Record (MAR).

With this kind of solution, the additional workload attached with the improvement of the quality of the process falls mostly on the physician, due to the requirement for exhaustively documented orders. In parallel, the design of CPOE systems has been focused strongly on this critical function of orders documentation, aiming at rigorously documented and exhaustive orders.

Indeed, most of the systematic survey studies have proven effective in reducing medication errors [3], assisting nursing tasks and improving patient safety [4]. But implementation of such systems remains difficult [5], physicians being particularly reluctant to use these applications to enter their orders. The discrepancy between the physicians’ actual work processes and the model of work implemented in the systems has been cited to explain implementation failures [6, 7]. In this context, cognitive analysis of the physicians’ medication ordering task could shed considerable light on the sources of physicians reluctance to use CPOE systems. From the physician’s viewpoint, medication order entry is the last step (and probably subjectively the least important one) of a decision making process taking place in a dynamic environment [8]. When a physician takes responsibility for a patient, the healthcare process he has to manage takes place over a given period of time. During this period the patient’s physiological status inevitably evolves, thus creating a dynamic environment in which the therapeutic decision making takes place.

At each encounter with the patient, the physician needs a rapid, summary display of relevant information in order to support and update his current representation of the patient’s physiological status. As a consequence, information gathering, selection and interpretation are critical cognitive functions supporting the therapeutic decision making which ultimately results in a medication order. Thus, the most important requirement concerning the physician’s cognitive activity for therapeutic decision making and medication ordering would be an efficient display of relevant information.

From this point of view, paper based systems seem to be more usable and efficient than CPOE systems. Our hypothesis is that this weakness of CPOE systems contributes to physicians’ reluctance to use these systems. In this paper, we describe a comparative analysis of physicians’ activity with paper based and computer based systems for therapeutic decision making, focusing on cognitive tasks such as information gathering and information interpretation. This cognitive analysis was combined with a usability evaluation of information display in the CPOE application. As a result of this study, we were able to make recommendations that led to partial re-engineering of the system’s Human-Computer Interaction (HCI).

2. Materials and Methods

2.1. Activity analysis

We used standard methods from cognitive ergonomics:
- Semi-structured and structured interviews of physicians,
- Participant observations of physicians performing medication ordering tasks during their medical rounds, parts of these observations being audio-taped,
• Self-confrontation interviews: physicians were asked to comment on and mentally replay the processes involved in therapeutic decision making.

2.2. Usability assessment

• Usability Inspection: Three independent evaluators inspected the application’s Graphic User Interface (GUI) according to a set of ergonomic criteria [9].
• Usability Tests: we performed on-site usability tests using portable labs equipped with a converter, a video recorder and a microphone connected to a laptop which was installed on the medical cart used by physicians during their rounds.

2.3. Context of the study

This study took place in 3 different French hospitals:

• The University Hospital of Lille, which is a 3000 bed hospital. Users’ activity was analysed in the Nephrology and Neurosurgery departments, with paper-based systems.
• The Denain Public Hospital (413 beds). The activity analysis was carried out on three sites mainly: Respirology, Surgery and Convalescence, with paper-based systems.
• The Georges Pompidou University Hospital (HEGP) of 825 beds. The hospital has a complete Patient Care Information System (PCIS) including the MEDASYS DxCare® component. It combines the functions of a CPOE and a patient record, and it is interfaced with a pharmacy system. CPOE functions are available for laboratory, radiology and medication orders and for nurses’ orders. At the time of the study the medication ordering functionalities of the DxC@re® software package was being used on two pilot sites, with a mobile at the bed of the patient. Activity analysis was carried out on these two sites, Nephrology and Immunology.

3. Results

3.1. Paper-based system

10 physicians were interviewed, 20 medical rounds were observed and 6 were audio-taped. In the hospital setting, medical decision making takes place mainly during the physician’s rounds. For each patient, the physician gathers relevant information, focusing on last changes in the current treatment, orders or complementary exams pending, physiological and behavioural reactions of the patient. Most often, the nurse (or a house officer) accompanies the physician on his medical rounds. She summarizes the patient’s case, sorts out the relevant paper files, and hands the physician the proper document if he asks for details. When on his own, the physician seeks himself relevant information in the paper record. Loose sheets allow him to lay out all the necessary information and make easier the information gathering.

Then the physician turns to the actual medication management, and focuses on the patient’s current treatment. To do so he almost always consults the MAR, but very rarely uses the order sheets itself. The MAR (cf. figure 1) is in effect the only document which provides a synthesized global view of the patient’s current treatment. All the information the physician needs to get a complete picture of the current treatment is displayed on a single page. The treatments are summarized with a temporal axis which permits the physician to obtain, at a glance, a global, summarized view of the patients’ current medication. At this stage, all he needs is the list of medications, with an indication of dosage. These observations were confirmed with self-confrontation interviews during which all the physicians spontaneously stressed the necessity of a global synthesised view of the current treatment.
From this representation he may then proceed to a greater level of detail for specific pertinent items. Thus therapeutic decisions invariably follow this two steps process: first a synthesized view of the current treatments, followed by a more detailed focussed examination of medication items pertinent to the current situation.

3.2. Computer-based system

4 physicians were interviewed, 7 medical rounds observed and 5 recorded. In the CPOE situation, the nurse usually does not accompany the physician during his rounds. With the computerised system, the physician is forced to switch among several windows and screens to get all of the relevant information. The system provides him with alarms when new complementary exams or lab results are available, thus efficiently guiding him in his information gathering task. These functions are highly appreciated by all the physicians. However, when the physician turns to medication management, he gets but one screen for the display of current treatments, which come out in the form of a list of overly detailed orders. Some usability problems emerge here. While the MAR is effectively reproduced, it is not readily available to the physicians. Access to the MAR requires three clicks and going through three different screens, and three more clicks and screens to get back to the list of orders and to order entry functions. Moreover, in the application, the information displayed in the MAR would not fill all the physician’s needs in terms of information supporting the decision making.

Physicians are forced by default to use the list of medications ordered in the system (cf. figure 2), in which the display of information is flawed by (1) inclusion of considerable detail (such as the colour of the tablets) which obscures the global view and (2) considerable redundancy.

In addition to this critical loss of summarized global view, the specific program which we examined suffered from further usability problems. We present here two examples of such problems.
The medications are listed chronologically by start date. The physicians in fact are interested primarily in the most recent intervention because they want to know whether they had had the desired effect. As the most recent orders appear at the bottom of the list, the doctors are forced to search through the list of meds with extensive scrolling.

The length of time the patient had been taking the medication proved to be a critical piece of information in the physician’s decision making process. This is absent in the computerised display, forcing the doctors to perform this calculation themselves.

4. Discussion

The cognitive analysis allowed us to identify the users’ needs and demonstrated that the physicians’ medication decision making process relies in two distinct steps for information gathering: (i) a global synthesized view of current treatments, followed by (ii) a detailed focus on specific pertinent items. In the paper-based situation the physician spontaneously refers to the MAR for information gathering instead of referring to the order sheets. The failure of the system to provide ready access to such a summarized view of the patient’s current treatment contributes to resistance to the use of the system. This represents but a particular example of a weakness all too frequent in currently available systems, as noted by many authors [10].

On-site usability tests proved that medication order entry was efficient and fast enough with the DxCare® application. But physicians kept complaining about the “loss of overview” [10] of the patient’s medical case and more particularly of his current treatment. Acknowledging this complaint, perfectly consistent with the cognitive analysis and usability assessment, the Company engaged in a re-engineering program of the application and its HCI.

Figure 3- Suggested display providing global view

Relying on the cognitive analysis of the physicians medication ordering task, we provided the Company with a set of recommendations illustrated in a schematic mock-up (figure 3). This mock-up was designed so that the physician could view all the current treatments on one screen, and, at a glance, identify for each medication its dosage and actual/expected duration. Based on this analysis, a collaborative design process has now been undertaken, involving the Company designers and computer scientists, representatives of the users (particularly the physicians) from all the 38 hospital sites where the application is currently
installed, and usability engineers. Indeed, the re-design process is far from terminated and a number of key functions such as the format of representation of the medication and its dose regimen, and the default order of display of medications must be precisely defined and agreed upon by all the participants in the re-design process. For example, all the physicians ask for a function allowing them to sort the current orders according to the patient’s pathological process each medication cares for. To be reliable, such a sorting would require a more complex data model and an intelligent medication database. For the time being, in order to compensate for the faulty display of relevant information and to answer to the physicians’ complaint, the Company has developed additional sorting functions by therapeutic class and route of administration. A direct access to the nurses’ MAR from the physician’s screens is also under development.

5. Conclusion

All these analyses make it possible to give usability recommendations and general orientations which will guide the later process of re-engineering. In complex work situations which are in the process of computerization, an activity analysis makes it possible to attain a level of comprehension and modeling of the work situation, and this is relevant: (i) to interpret the problems observed as well as users’ requests, (ii) to guide and justify re-engineering decisions.

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7. References


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