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Participatory design for drug-drug interaction alerts

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Abstract. The utilization of decision support systems, in the point of care, to alert drug-drug interactions has been shown to improve quality of care. Still, the use of these systems has not been as expected, it is believed, because of the difficulties in their knowledge databases; errors in the generation of the alerts and the lack of a suitable design. This study expands on the development of alerts using participatory design techniques based on user centered design process. This work was undertaken in three stages (inquiry, participatory design and usability testing) it showed that the use of these techniques improves satisfaction, effectiveness and efficiency in an alert system for drug-drug interactions, a fact that was evident in specific situations such as the decrease of errors to meet the specified task, the time, the workload optimization and users overall satisfaction in the system.

Keywords. Decision support systems, Drug-drug interaction, User centered design, Usability, Human computer interaction.

Introduction

The clinical decision support systems are a useful tool for improving the quality of care (1), even more in the field of electronic prescribing and especially in the domain of drug-drug interaction (DDI) alerts (2-4). Although this advantage is known, it is not uncommon to find reports indicating a high rate of override of these alerts (5), citing reasons ranging from inadequate construction of the knowledge database (6) and the lack of clinical significance of the alerts (7), and the poor design of the human-computer interfaces (3), therefore any action aimed at improving these aspects would result in improving the rate of the acceptance of this alerts and the patient safety (7). The Hospital Italiano of Buenos Aires (HIBA) developed and implemented a clinical information system with a DDI alert system (8), but the override rate of the delivered alerts was high. Following literature recommendations that stressed the importance of user centric techniques, the decision was made to redesign DDI alert system components. At first we worked on a primary phase of purging and categorizing of the knowledge database recommendations (9), to then move forward in redesigning the human computer interaction of the alerts. This work aims to describe the participatory

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design phase for the development of a new DDI alert based in a user centered design process.

1. Methods

This work took place at HIBA from September 2013 to April 2014. The HIBA is a high complexity university hospital. It has a clinical information system developed "in house" that handles the medical and administrative information (10, 11). This system supports among other features clinical provider order entry (CPOE) (10). In this context, three clinical pharmacologists depurated and optimize the pharmacological knowledge database (done in-house, based on international evidence) (12) to serve as a substrate for the development of the project. Later a team of 3 physicians specialized in medical informatics and two usability experts worked in a user centered design process, following the steps of the ISO 9241-210 (13). The project was raised in iterative stages:

***Stage 1: Inquiry**:* consisted of interviews and contextual observations (14) dealt with topics relating to the processes of prescribing drugs in situations where drug interactions were presented. From the analysis of these interviews low-fidelity prototypes were generated, as a way to confront the ideas that emerged from the interviews with the design of DDI alerts interfaces. Participants' profiles: physicians that worked in ambulatory care and inpatient settings and 4 years of experience using the system. Semi-structured questionnaire was given to the users to guide them through dynamic clinical scenarios that were developed based on real clinical cases (15).

Stage 2: Participatory Design**:* Participatory design stage was conducted using the low-fidelity prototypes. Participating physicians guided the development of a new prototype, closer to the user feedback. Two cycles of prototyping and testing were conducted. The focus was qualitative, seeking the domain saturation. The opinions and thoughts of physicians were obtained and recorded using Think Aloud technique (16). Profiles were similar as those who were involve in Stage 1. The script used in the test was also based on real cases. At this stage, two prototypes were used, the 1st one, made in Balsamiq® (17) was printed on paper and showed to users, 2nd one also made in Balsamiq® was exported and used in order to reproduce the prescription process as closely as possible. ***Stage 2: Usability Testing**:* For the usability testing, high fidelity prototype were developed in Axure® (18), and presented to a new sample of users. This instance was used to measure ***effectiveness, which was understood from two variables, the first referring about if they override the warning or took it into account and acted upon and the second was whether they could complete the process of prescribing. ***Efficiency*****,** which measured the progression in the number of clicks and the time needed to accomplish the task and ***satisfaction*** that was assessed using a SUS - system usability scale questionnaire (19). The whole process was iterative, where each step is based on a process of prototyping cycles, seeking to reach domain saturation, in order to define a final prototype at each stage to proceed to the subsequent step.

2. Results

All of the 24 physicians from three different fields (ambulatory care, inpatient critical care and inpatient none critical care) took part in the 3 stages we conducted.

***Stage 1**:* 6 doctors participated in the first stage; the interviews in this stage were the basis for structuring the prototypes (Figure 1). What emerged from these interviews is that the IDD is a common concern among physicians. Several participants made comments that coincide with those published in the literature, such as the difficulty of finding good resources for detecting interactions, poor interface design, high false positive rates, and the fatigue this alerts causing. We then took advantage of the views expressed by users to create and give structure to the prototypes that would be used in the following steps. They also expressed the desirability or necessity for alerts that provide information and guidance concerning the conduct to follow.

Figure 1. First prototype

Stage 2: Using participatory design techniques, a different sample of physicians generated new interfaces to be tested. The results at this stage were analyzed by non-stringent qualitative techniques, in order to analyze the results and give them some structure. The opinions given at this stage were: alerts were generally well received; the possibility of taking actions from the same alert was positively assessed as a way of not interrupting the workflows and not having to restart the prescription process. Actions integrated as operations were received as a great advantage. Negatives comments: several options offered in an alert were thought complex. These results were considered for the redesign and re-testing until users deemed them appropriate. Perhaps the main result of this stage was the realization that the interface should be action-oriented and not just information. (Figure 2).

Stage 3**: **Effectiveness: of the 24 physicians, 11 ignored the warning (45, 8%) and 13 (54.2 %) took action. The other measure of effectiveness was whether the physicians could finish the prescription process, in which the following results were evident: 13 (54.17 %) physicians completed the task without difficulty, 10 (41.67 %) completed the activity with questions or mild errors, and 1 (4.17%) completed the task with serious errors. There were no instance where the tasks couldn't be completed.

Efficiency measured as the amount of clicks is shown in Table 1, ***Efficiency*** measured as the time used to accomplish the task in Table 2, and ***Satisfaction*** assessed from a SUS questionnaire in Table 3.

This in turn gives an average value of 77.90 per participant on a scale of 0-100 which indicates a value more than adequate, this equals an 83% percentile, which in other words means that the acceptance rate the system is above 80 %.

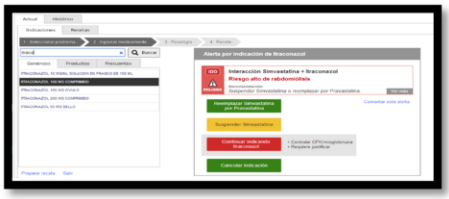

Figure 2. Refined prototype

Table 1. efficiency (amount of clicks) for stage

Action	Performance	Amount of clicks		
		Stage 1	Stage 2	Stage 3
Prescribing process	Complete the task	68	70	65
	Complete with questions or mild errors	71	68	65
	Complete with serious errors	-	-	-
Follow the recommended action	Complete the task	54	60	50
	Complete with questions or mild errors	52	75	70
	Complete with serious errors	-	-	-
Prescription cancelled	Complete the task	13	10	8
	Complete with questions or mild errors	76	75	70
	Complete with serious errors	-	-	-

Table 2: efficiency (time) for stage

Action	Stage 1 (seconds)	Stage 2 (seconds)	Stage 3(seconds)
Prescribing process	16	18	15
Follow the recommended action	11	11	10
Prescription canceled	9	12	10

Table 3: satisfaction with SUS scale score

By question	Score
I think I would like to use this system when prescribing	3,00
The system is unnecessarily complex	3,00
The system is easy to use	2,90
I would need the assistance of an expert to use the system	3,90
The diverse possibilities of the system are well integrated	3,60
There is too much inconsistency in the system	3,40
I believe that most of the clinicians could use the system without problems	2,00
The system is very uncomfortable	3,10
I felt secure using the system	3,10
I would need a lot of instructions to manage the system	3,10

3. Discussion

From the detailed analysis of the metrics considered in the final stages, both the values of effectiveness, efficiency and satisfaction improved until the final prototype. Regarding satisfaction, values higher than 80% demonstrate the importance of involving users in the design of the system. With regard to the acceptance of the recommendations, although a percentage above 50 % is generally considered low impact, this performance is more than acceptable in this particular topic, where similar studies have thrown much higher alert failure rate. Another problem had to do with the creation of clinical cases, they refer to rare problems that doctors do not routinely handle, which is presented as one of the challenges for the design framework. Future lines: final functional prototype testing: the final stage will be held using the final prototype; laboratory testing will be performed from cases generated from the actual incidence based on the frequency of cases recovered in previous analysis.

Limitations: this study was conducted at a single center, so the processes to incorporate external validation should be done. Furthermore, the correlation between the clinical case and physician specialty was not always as desired, some physicians may face situations not commons to their practice, so their actions are not taken with a

strong knowledge of the field, but rather by the influence generated by the alert that leads to select "suspend" rather than doing harm.

4. Conclusion

The incorporation of new participatory design techniques for the development of support tools for DDI was a positive experience because it enabled the development team to access a large number of errors and valid considerations, which could be resolved and improved before passage development

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