Quality of Life through Quality of Information
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INCA – Individual Nomad Clinical Assistant – supporting nurses with mobile devices

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Abstract. Introduction: A completely structured nursing record has been deployed in the 8 hospitals of the University hospitals of Geneva. Even with laptops, the access to the records restrains nurses' mobility during their bedside work. It has lead to a strong demand for mobile devices. Problem: There are several papers showing that mobile computers can lead to increase time for data acquisition, increased errors and omissions. Thus, there are important challenges at developing these tools, while respecting the mobile paradigm and the needs for qualitative and efficient acquisition. A simple translation of user interfaces from usual computers is not recommended. Results: After evaluating various user interfaces with users in real conditions, we propose a solution that eases the selection of patients, the navigation into the various screens, and provides a very clear list of tasks to achieve for nurses. Conclusion: The article exposes the difficulties to adapt an existing tool on mobile devices. Despite these difficulties, by organizing smartly the displayed information, we produced a tool with similar functionalities but better adapted to the user.

Keywords. Mobile Health, CIS, Android, Nurses

Introduction

While dematerialization is one of the major advantages of computerization, it is surprisingly often associated with decreased mobility. This apparent contradiction is well observed in clinical settings, with a strong dependence to computers [1]. To some extent, this problem has been addressed since many years with the use of wireless networks and portable computers. However, mobility can still be increased massively with two important evolution of the hardware: decrease in sizes and in costs. Thus, it is now possible to imagine having one mobile device for each provider that fits in a pocket. Adapting an existing application to a new platform can be a delicate task. There are several papers showing that mobile computers can lead to increased time for data acquisition, errors and omissions [2]. To avoid these pitfalls, we have studied very carefully the way we display the information. It was inappropriate to copy the existing

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interface to the mobile device. Instead, we took advantage of the specificity of the mobile device to build an adapted interface. The generated tool facilitates the selection of patients, the navigation across the various screens, and provides a very clear list of tasks to achieve for the nurses. We implemented this tool for the Samsung galaxy tab, a tablet that runs under the Android OS [3].

Simplifying the workflow of the nurses

Every hospital care performed to a patient by a nurse is known as an "intervention". It can be a shower, a drug administration or any other kind of care in the hospital. In the University Hospital of Geneva (HUG) 7096 nursing care interventions are divided in 22 categories Interventions are planned either by physicians or by nurses. They are defined by several parameters such as their type, date of planning, date of start and end. There is no guideline regarding the way nurses have to manage their list of interventions, but most of the time, it follows a common schema (red arrows, Figure 1). At the beginning of their service, nurses print all the interventions to be performed during the day. Then, they perform their care following the instructions given on the list. Every time nurses perform one of these interventions, they take a note indicating that the task has been done properly. When they have some spare time, nurses enter all the gathered information in the system.

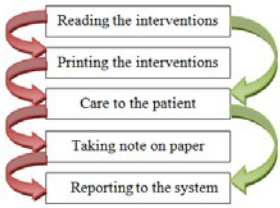

Figure 1. Nurses workflow on a personal computer (red arrow) and on a mobile device (green arrow)

With the introduction of a mobile device, we suppress the need for paper and consequently simplify the workflow by removing costly and annoying steps.

1. METHOD

There are important differences between classical computers and mobile devices that make the adaptation of a program difficult from one platform to the other. We can underline:

- **Different display size**: Whereas personal computers are usually equipped with screens of size between 15 to 22 inches, mobile devices are restricted with screens from 4 to 10 inches. This restriction implies to choose carefully the displayed information and to organize it wisely on the screen. The information of strong value must be identified and favored over the less essential one.
- **Different computational power**: despite huge progress over the past few years, the computational power of mobile devices remains much lower than most of the personal computers. Consequently, in order to ensure a real-time experience for the user, the client code must be optimized and the computational expensive processes have to be restricted to the server side [4].

- **Different way to interact:** Mouse and physical keyboard, commonly employed to interact with the personal computer, are unfamiliar for most of smartphone users. Instead, they interact mainly with fingers. As using one's finger is less precise compared to a mouse pointer, it implies that every element that supports an interaction, such as a checkbox, a button, or an item list, must be of sufficient size to be manipulated [5].
- **Real-time interactions:** Contrarily to the current work organization, with the help of mobile devices, nurses can access information in real-time. This real-time access implies to organize the information dynamically and to present relevant data not only according to the user but also to the time at which the device is used.

2. RESULTS

2.1. Mobile Application Workflow

Nurses are only in charge for the interventions of the patients under their responsibility. Consequently, the tool must offer a simple way to define the context in which nurses are working. In order to define this context, nurses go through a succession of steps displayed on Figure 2

1. **Choice of the unit:** Nurses work only in one unit at the time. Consequently, they have to choose one among those they have access to.
2. **Choice of the room:** In large units, nurses are not responsible for the patients of every room; therefore nurses can select the rooms in which they have to work.
3. **Choice of the patients:** Once the rooms selected, nurses can choose the patient they start to work with. During their work, they can switch between the patients of the selected rooms directly in the intervention view.

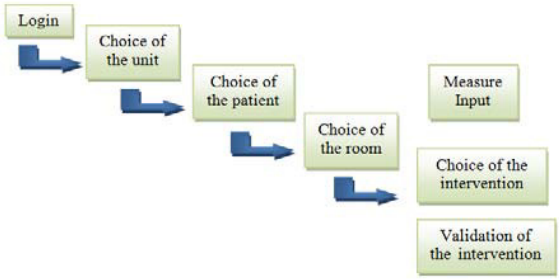

Figure 2. Steps to select the relevant interventions

Once the patients selected, nurses can access the interventions of every patient contained in the list. This list of intervention is ordered and shows each task to perform at a given time. At any time nurses can select the intervention they want to perform and validate it by checking a checkbox.

2.2. Scaling the interface

The current CIS of the HUG contains a module providing a view over the interventions. The interface of this module is tuned for a personal computer and occupies almost the entire available space on the screen. As caregivers are accustomed

with this screen, we want to develop an interface on the mobile device with the highest level of homogeneity.

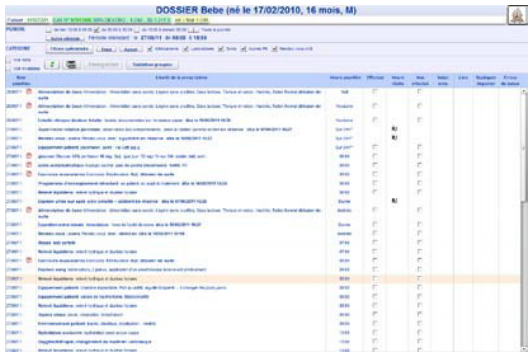

Figure 3. Intervention interface on a personal computer

Figure 4. Intervention interface on a mobile device

The figure 3 shows the intervention management interface on a personal computer. Each line represents a single intervention described by a date, a description, and an hour of execution. The height of the screen allows displaying almost 30 interventions at the same time. Moreover, the sufficient width permits to display the full description of the intervention on a single line.

Such large space is not available on a mobile device. Consequently, the interface has been completely rebuilt to be adapted to the new display (Figure 4). In order to maximize the amount of information presented on the screen we have regrouped some information:

- The concurrent interventions of similar category are regrouped in a common item: As explained in the introduction, there are more than 7000 unique interventions; they are regrouped under 22 top-level categories. Based on the hypothesis that interventions of similar categories planned at the same time can be performed simultaneously by caregivers, we have decided to regroup them. For instance, if a nurse must distribute several drugs at the same hour, these interventions are regrouped under a single item. Regrouping the interventions of similar type not only helps organizing the work in a cleaver way, but also offers a much better overview of the tasks to perform to the caregiver.
- The interventions in reserve are regrouped in a single group: The interventions in reserve are of specific kind. They are not compulsory, but are available in case of need. For instance, it can be an analgesic provided to the patient in case of sharp pain. As these interventions remain always available, displaying them on the screen can take the entire available the space. To avoid such side effect, we regroup all these specific interventions in a single item that remains always on the top of the list. It ensures a

good visibility at anytime. By clicking the reserve button, the user opens a dedicated screen where the details of interventions are displayed. For each reserve the nurse can see the last time it has been administrated and can valid a new administration. Knowing the detail of the last administration is important as it prevents to do an over-use of a drug.

2.3. Real-time advantages

The real-time manipulation of the mobile device allows for adapting dynamically the displayed information, to present it in a smart and efficient way. For instance:

- By default, the first displayed intervention is the one scheduled at the current time: In case some validations are missing, the nurse has still the possibility to return to older interventions. The automatic focus on relevant information minimizes the number of users' manipulations and simplifies the work of the caregiver.
- Ranged interventions are dynamically ordered depending of the time of the day: Ranged interventions have the specificity to be valid over a period, therefore, there is no strict rules regarding how to order them. We decided to position these interventions as close as possible to the current time. Consequently, depending the hour of the day the ranged interventions are presented in different positions. For instance, at 3am a ranged intervention scheduled between 12pm and 6am is presented at 4am. At 4am, this same intervention is presented at 5am. By ordering dynamically the ranged interventions, we prevent the nurse from missing it.

3. CONCLUSION

Mobile computing is the next evolutionary step for nurses' bedside work. The transition to mobile devices has to be handled very carefully as it can become the source of new errors and even of decrease of productivity. Consequently, we have studied the specificities of the mobile platform to respond to it. The resulting program eases the patient selection and enables the validation of nurses' work in real time. The new interface takes into account a smaller display size, the innovative interaction paradigm, and real-time constraints. By organizing smartly the displayed information, we ended with a tool with similar functionalities, but better adapted to the user.

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