Hôpitaux Universitaires Genève

Geneva, February 2017

BD – Study report

Dispensing error rates and impact of interruptions in a simulation setting.

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This study was presented at the 20th Journées franco-suisses de pharmacie hospitalière in Bern and was awarded with the 2nd best poster prize (December 2016). A presentation in an international congress is planned. A publication will be submitted to an international journal.

1. Context

The introduction of information technologies in the medication process aims at improving the safety, the efficiency and the traceability of drug use. Although it is relatively easy to measure indicators demonstrating the impact on the efficiency, the safety improvement is much more difficult to assess. To reach this objective, observational studies in the real life are necessary, which is very time consuming.

The use of a simulation setting is an indirect way to assess safety improvement. In medicine, these methods are more and more used, inspired by models developed in high-reliability industries like aviation. They are very helpful to educate healthcare professionals ("never the first time on a patient") as well as to learn to work together in a team ("crew resource management"). They can also be used in research protocols, to measure the impact of organizational re-engineering on human performance, without any risk for real patients. In a simulation setting, the occurrence of some risks can be artificially increased, to measure their influence on the process reliability, without needing a long observation period in the real life. The behavior of operators can also be easily observed and analyzed, to better understand the interaction between humans and their environment, in normal or special situations.

2. Objectives of the study

The main objective of the study was to measure nurses dispensing error rates with an automated dispensing cabinet and with a traditional ward stock in a simulation setting.

Secondary objectives were:

- to study the influence of task interruptions on dispensing error rates and to compare operator's behavior between the two storage systems;
- to compare the time needed to dispense drugs with the two systems.

3. What did we do?

We created a simulation setting including an automated dispensing cabinet (Pyxis Medstation, BD) and a traditional ward stock (ScanCell, ScanModul System) (Figure 1). The drugs content of the two systems was strictly similar. In the automated dispensing cabinet, all drugs were stored in individualized cubies.

The room was equipped with a phone (for some interruptions) and with a camera (to analyze the reactions to interruptions).

Figure 1 – View on the simulation room

We recruited 18 volunteer nurses to participate to the simulation study. They were asked to dispense 24 hours treatments for 12 patients, representing 78 doses of oral medications. The session was repeated twice, one time with the automated dispensing cabinet and the other with the traditional ward stock (the sequence was randomized) (Figure 2). Nurses dispensed drugs according to a paper-based schedule of administrations. The automated dispensing cabinet was not connected to an electronic prescription and nurses had to manually select the right drugs in a list after having selected the patient on the screen. Nurses were naive to the use of automated dispensing cabinets and a short 5 minutes individual training session was organized prior to the experience.

In each of the sessions, nurses had to face standardized interruptions during dispensation for 6 patients out of the 12. The nature of the interruptions were the following : noise, transmission of an oral order, phone call, physical intrusion, conversation and noise + conversation.

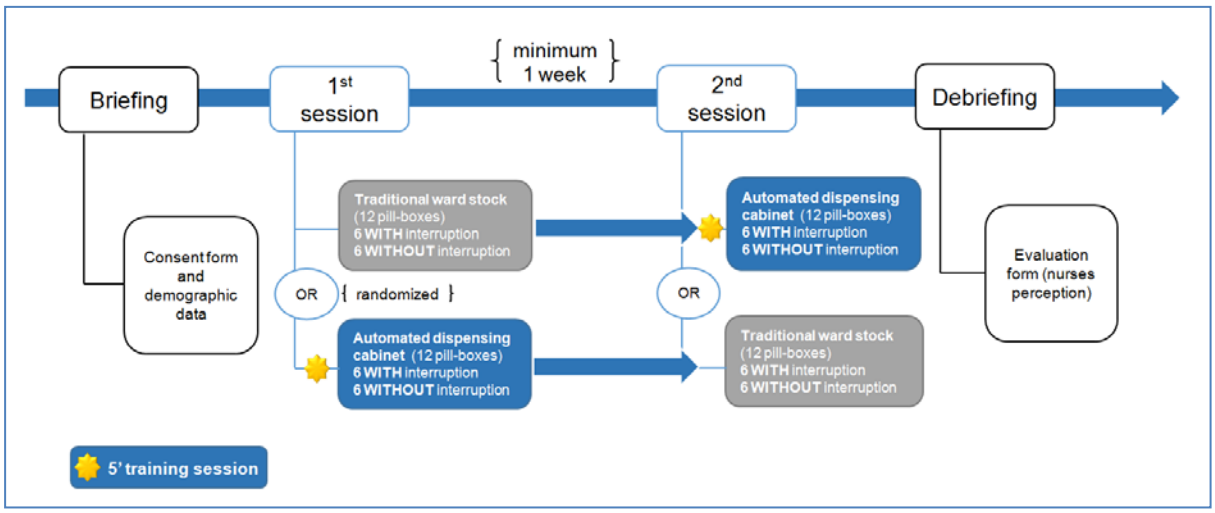

Figure 2 – Study design

At the end of each session, we analyzed the error rate by comparing the real with the expected content of the pill-boxes. The management of interruptions was categorized by video-analysis and the working time for each session was recorded.

4. What did we found?

With the traditional ward stock, a 4.13% error rate was measured, without differences between interrupted and non-interrupted tasks (4.11% vs 4.15%). The two main causes of errors were the selection of the wrong form and the wrong dosage/quantity.

With the automated dispensing cabinet, we observed a non-significant reduction of the error rate (3.28%). Selection of the wrong substance (INN) totally disappeared in comparison with the traditional ward stock. A higher number of errors occurred in case of interruptions (3.88% vs 2.64%), but the difference was not statistically significant.

The impact of an interfacing to the electronic prescription was estimated. The direct link between the prescription and the storage areas prevent the nurses to select the wrong pharmaceutical form and can totally remove this type of errors. An impact on the dosage errors can also be postulated, but only the selection of the right dosage of a multi-dosage product will be secured and not the removal of the right quantities of pills. We estimated two scenarios, without and with a full removal of dosage errors. The error rate with a connection to the electronic prescription is expected to be between 0.71% and 1.85%, which is significantly lower than during manual dispensing (Figure 3).

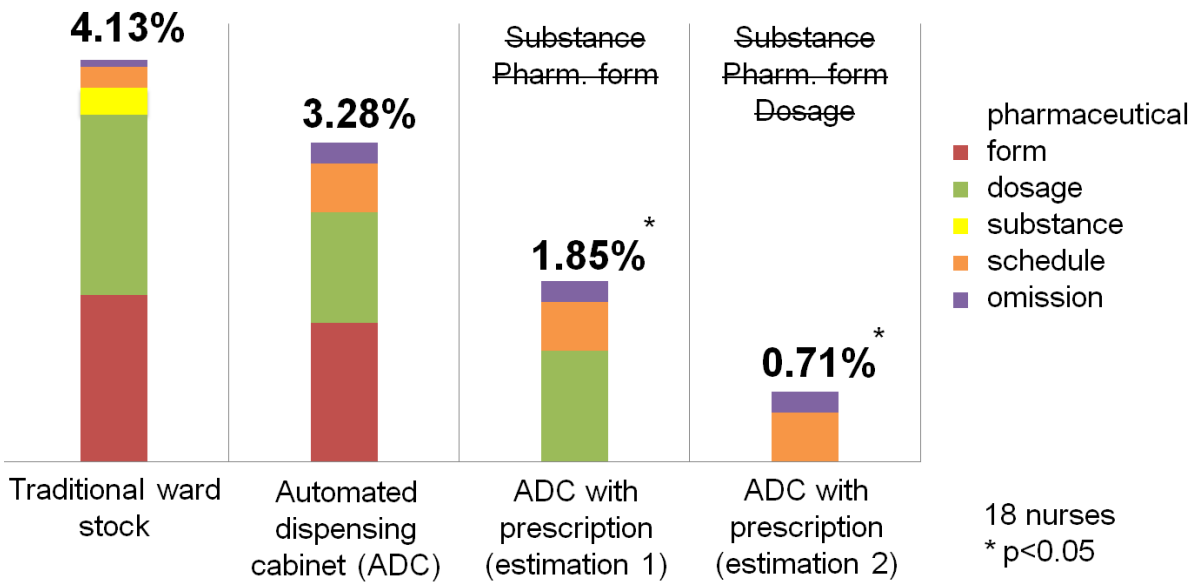

Figure 3 – Error rates

Regarding the management of interruptions, variability was observed depending mostly on the type of interruptions as well as the individuals. Figure 4 summarizes the main types of behavior for the major types of interruptions. Nurse's reactions were almost similar in the two contexts except in case of a physical intrusion by a second person, wishing to rapidly withdraw a drug from the stock. In the traditional ward stock, the dominant attitude was to suspend the dispensing task to let the second nurse pick her drug. With the automated dispensing cabinet most nurses continue their dispensing task and ask to their colleague to wait.

	Traditional ward stock	Automated dispensing cabinet
Noise	No interruption (continue the work)	
	67%	83%
Phone call	Task-switching (answer to the phone)	
	88%	83%
Conversation	Multi-task (discussion with the colleague)	
	69%	89%
Physical intrusion	Suspending task (let their place)	No interruption (don't stop dispensing)
	46%	50%

Figure 4 – Management of interruptions – main behavior

Regarding the working time, a mean of 58 doses were dispensed in 30 minutes with the automated dispensing cabinet and 54 with the traditional ward stock. The difference was not statistically significant and we can conclude to similar speeds. It is important to notice that nurses were using an automated dispensing cabinet for the first time and we can hypothesize an increasing speed with a routine daily use of the automated system.

5. What can we conclude?

We used a simulation setting to measure nurses dispensing error rates with an automated dispensing cabinet and with a traditional ward stock. The results of our study highlighted the high frequency (~ 4%) of dispensing error in traditional ward stock organization reflecting the limited reliability of humans in repetitive tasks. The implementation of an automated dispensing cabinet allowed a significant reduction of error rates when it is connected to an electronic prescription to ensure the right link between the drugs prescribed and dispensed. In the absence of an interfacing with the prescription many wrong form errors still occur illustrating some gaps in nurse's knowledge of the different pharmaceutical forms.

The management of interruptions vary in function of their type. Nurse's behavior was almost the same in the two stock organizations, except in case of a physical intrusion. In this situation, users of an automated dispensing cabinet tend to finish their task before the let their colleague withdraw a drug.

Although it is often believed that the dispensing time is longer with an automated dispensing cabinet, our study measured similar speeds. With a daily practice we can hypothesize a faster dispensing with the automated dispensing cabinet than with the traditional ward stock.