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## **BD – Study report**

### **Impact of pharmacy technicians and automated dispensing cabinets in wards: evaluation by a prospective risk analysis method.**

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## **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 improvement in safety 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 prospective risk analyses is an indirect way to assess safety improvement. These methods commonly used in high-risk industries (i.e. nuclear power, aviation) allow identifying failures in a process and estimate their criticality. They can help compare different process organizations and determine further improvements that can be implemented to continue to increase the safety.

Failure modes, effects and criticality analysis (FMECA) is a well-known proactive risk analysis method, that is more and more used in healthcare setting (see ref 1-3 for previous studies we performed). It requires a reasonable level of resources to rapidly compare the safety of different process organizations.

## **2. Objectives of the study**

The main objective of the study was to compare risk levels in 3 different process organizations:

- 1) traditional ward stock managed by nurses,
- 2) traditional ward stock managed by pharmacy technicians and
- 3) automated dispensing cabinet (ADC) managed by pharmacy technicians.

A secondary objective was to compare the direct costs associated with the 3 organizations.

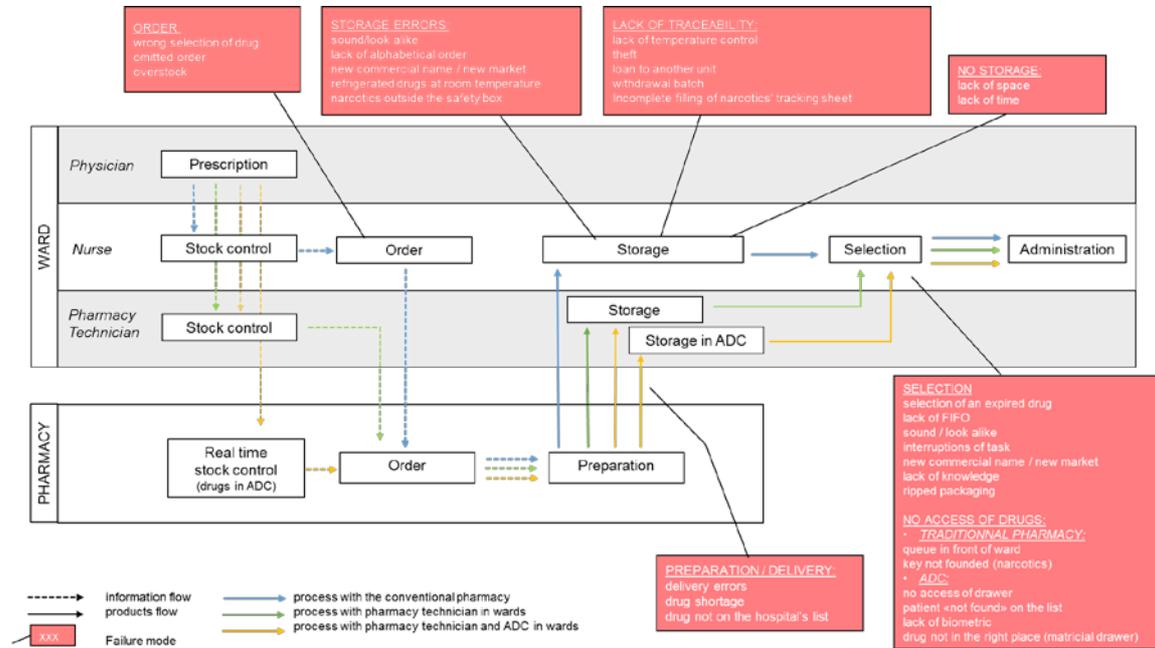
## **3. What did we do?**

According to the FMECA method, an interdisciplinary working group (two pediatric nurses, two rehabilitation nurses, four hospital pharmacists and two pharmacy technicians) was created. The participating nurses were familiar with the use of automated dispensing cabinets, recently installed in their wards. The study was performed according to the following steps:

- 1) Brainstorming to list the possible failures at the different steps of the process ("failure mode");
- 2) Consensual discussion to score criticality ("criticality indexes") of each failure mode for each process organization based on three criteria: the frequency of occurrence, the potential severity for the patient and the detectability. To make this work concrete, the team determined quotations using three model drugs: an intravenous antibiotic (i.e co-amoxicillin), a narcotic (i.e. morphine), and a common oral medication (i.e. acetaminophen). A published standardized grid was used to determine the scores (ref 4);
- 3) Results for the three organizations were compared, acceptability of risks was discussed, additional improvements were proposed and their impact on safety was estimated by a new scoring.
- 4) Direct costs (salaries, investment in equipment) necessary to run each process organization were evaluated and compared to the global criticalities.

#### 4. What did we find?

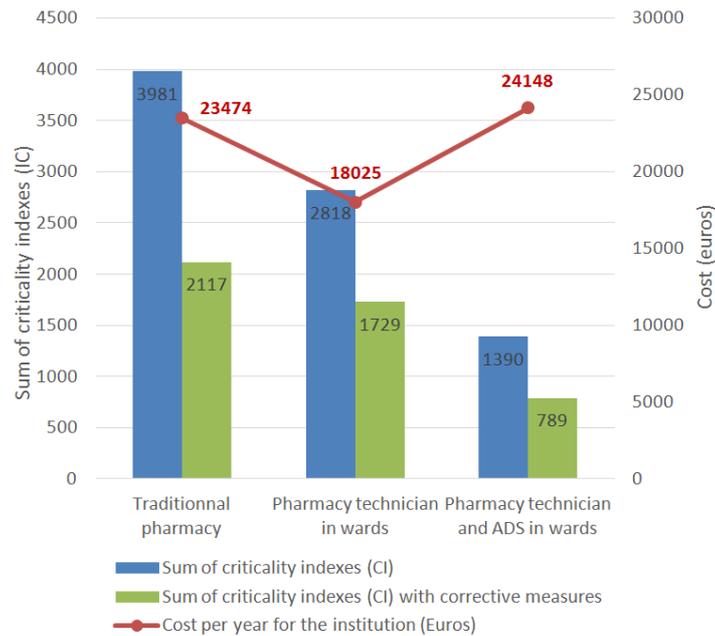
The medication distribution process was divided in four major steps and the team identified 33 failure modes: ordering drugs to the pharmacy (3), delivery from the pharmacy (3), storage (13) and selection (dispensing) of the drugs (14):



The traditional pharmacy managed by nurses had the highest sum of criticality indexes (3981), followed by the pharmacy managed by pharmacy technicians (2818), and then the pharmacy technicians with automated dispensing cabinets (1390). This latter model showed a 65% decrease of the total criticality in comparison with the traditional pharmacy managed by nurses

Eighteen recommendations were made to further secure high-risk failure modes from the 3 process organizations, resulting in a potential additional decrease of the sum of criticality indexes by -46.8% for the traditional ward stock, -38.6% for the pharmacy technicians and -43.2% for pharmacy technicians with the automated dispensing cabinets. The most significant improvement was the integration of an interface with the computerized prescription.

In term of running costs, a ward pharmacy managed by nurses needed an annual expense of 23474 euros, corresponding to the salary necessary for this activity. The same organization with a management by pharmacy technicians allowed a cost reduction (18025 euros/year) due to lower salaries. Finally, the process with an automated dispensing cabinet needed an additional investment of 674 euros/year in comparison with the traditional organization with a management by nurses, considering an 8 years amortization period for the material.



## 5. What can we conclude?

We used a FMECA proactive risk analysis method to estimate the criticality of different drugs wards stock organization models. The application of this method to our institutional situation suggested a strong reduction of risk when automated dispensing cabinets are implemented in the process. The interfacing of the automated dispensing cabinets to the computerized prescription has the potential to bring an additional reduction of the risk level. This connexion has then been prioritized in the evolution of our IT infrastructure.

On the economical point of view, investment costs for the automated dispensing cabinets are almost compensated by the reduction of staff costs consecutive to the task switching from nurses to pharmacy technicians. If additional benefits were added in the balance (i.e. logistics efficiency improvement, reduction of medication errors), an interesting return on investment could be confirmed.

In conclusion, the implementation of automated dispensing cabinets managed by pharmacy technicians increases the safety, for a similar running cost, in comparison to a traditional ward stock managed by nurses.

## 6. References

1. Bonnabry P, Cingria L, Sadeghipour F et al. Use of a systematic risk analysis method to improve security in the pediatric parenteral nutrition production. *Qual Saf Health Care* 2005; 14: 93-98.
2. Bonnabry P, Cingria L, Ackermann M et al. Use a prospective risk analysis method to improve the safety of the cancer chemotherapy process. *Int J Qual Health Care* 2006; 18: 9-16.
3. Bonnabry P, Despond-Gros C, Grauser D et al. A risk analysis method to evaluate the impact of a computerized provider order entry system on patient safety. *J Am Med Inform Assoc* 2008; 15:453-60.
4. William E, Talley R. The use of failure mode effect and criticality analysis in a medication error subcommittee. *Hosp Pharm* 1994;29:331-2, 334-6, 339.

## 5. Annex

The full FMECA analysis is available, with the scores determined for each failure modes.

FAILURE MODES	Traditionnal pharmacy managed by nurses (N)						Traditional pharmacy managed by pharmacy technicians (PT)						Automated dispensing cabinet managed by pharmacy technicians (PT with ADC)							
	AB	Mô	ACMP	Mean criticality index	Corrective measures	New mean criticality	AB	Mô	ACMP	Mean criticality index	Corrective measures	New mean criticality	AB	Mô	ACMP	Mean criticality index	Corrective measures	New mean criticality		
<b>Order for the pharmacy</b>	Wrong selection of drug	288	180	108	192	a, b	112	288	180	108	192	a, b	112	288	180	108	192	q	37	
	Omitted order	56	35	21	37			24	15	9	16			16	10	6	11			
	Overstock	24	24	24	24			3	3	3	3			2	2	2	2			
<b>Preparation of order / Delivery</b>	Missing product	288	180	108	192	c, d	128	288	180	108	192	c, d	128	288	180	108	192	c, d	128	
	drug shortage	128	80	48	85			64	40	24	43			64	40	24	43			
	not on the hospital's list	96	60	36	64			32	20	12	21			32	20	12	21			
<b>Storage</b>	Storage errors	sound / look alike	512	320	192	341	e, f	42	48	60	18	42			8	5	3	5		
		lack of alphabetical order	384	-	144	264	g, m	64	96	-	36	66			8	-	3	6		
		new commercial name / new market	336	100	126	187	f, h	64	48	45	18	37			8	5	3	5		
	Lack of traceability	not in the right place in the matricial drawer (ADC)	-	-	-	-			-	-	-	-			14	8	4	9		
		refrigerated drugs at room temperature	40	40	40	40			20	20	20	20			10	10	10	10		
		narcotics outside the safety box	-	30	-	30			-	30	-	30			-	5	-	5		
		lack of temperature control	240	240	240	240	i	10	120	120	120	120	i	10	30	30	30	30		
		theft	225	225	225	225	j, k	120	225	225	225	225	j, k	120	60	60	60	60		
		loan of drugs for another unit	108	12	108	76			108	12	108	76			12	12	12	12		
	No storage	withdrawal batch	50	50	50	50			40	40	40	40			10	10	10	10		
		lack/incomplete filling out of narcotics' tracking sheet	-	24	-	24			-	24	-	24			-	-	-	-		
		lack of space	192	45	72	103	n	54	112	70	42	75			48	30	18	32		
		lack of time	112	20	42	58			16	10	6	11			16	10	6	11		
		queue in front of ward	36	27	18	27			36	27	18	27			36	27	18	27		
		key not founded (narcotics only)	-	25	-	25			-	25	-	25			-	-	-	-		
<b>Selection / Preparation of drugs</b>	No access of drugs	no access of drawer (ADC)	-	-	-			-	-	-	-			48	30	18	32			
		no access of ADC (screen out of order)	-	-	-	-			-	-	-	-			16	10	6	11		
		patient "not found" on the list (ADC)	-	-	-	-			-	-	-	-			32	20	12	21		
	Selection of an expired drug	lack of biometric recognition (ADC)	-	-	-	-			-	-	-	-			16	10	6	11		
		opened oral suspension /solution without an expiration date	192	192	192	192	g, m	144	144	144	144	144	g, m	54	54	54	54			
		ripped packaging	160	160	160	160	g, m	128	128	128	128	128	g, m	84	8	8	8			
	Wrong selection	lack of principle "First In First Out"	128	128	128	128	g, m, n	96	96	96	96	96			64	64	64	64		
		sound / look alike	432	288	192	304	e, f	42	432	288	192	304	e, f	42	144	96	64	101	r	25
		interruptions of task	432	288	192	304	o, p	222	432	288	192	304	o, p	222	144	96	64	101	o, p, r	25
		new commercial name / new market	360	240	160	253	e, f	89	360	240	160	253	e, f	89	144	96	64	101	r	25
	lack of knowledge	288	192	128	203	f, m	133	288	192	128	203	f, m	133	144	96	64	101	f, r	25	
	ripped packaging	216	144	96	152	g, m	128	144	96	64	101	g, m	84	144	96	64	101	r	25	
SUM of criticality indexes (IC)		5323	3349	2850	3981		2117	3592	2618	2019	2818		1729	1908	1320	925	1390		789	
CORRECTIVE MEASURES	a. Use of medication card b. Use of bar code of drugs c. Scanning of all package (pharmacy) and scanning of the delivery box + location d. Autom e. Evalua f. Drug information (pharmacy) g. Having a designated nurse (in charge) h. Generic name order i. Monitoring software										j. Key or entry pass to access the pharmacy k. Nominative order l. Decreasing / limitation of stock m. Reminded procedures n. Decreasing / Limitation of stock / Two-bin inventory system (empty-full) o. Dedicated room p. Identification of the task (colored vest) q. Link ADC - pharmacy software r. Link ADC - prescription									