Implementation of automated dispensing cabinets for management of medical devices in an intensive care unit: organisational and financial impact

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ABSTRACT

Background Automated dispensing cabinets (ADCs) have been tested and approved for medication management in hospitals.

Objectives First, to evaluate the logistics and organisational effect of a similar system for management of sterile medical devices in a medical intensive care unit (ICU). Second, to assess the cost savings of this new organisation for the sterile medical devices budget of this department.

Methods The organisational effect was evaluated by comparing (1) the workload of head nurse, nursing auxiliary and pharmacy technician and (2) sterile medical devices emergency orders, 1 year before and after implementation of three ADCs and 100 wireless open-access devices. The hospital's costs (ADC, wireless devices and software) and benefits (stock value and resupplying value before and after implementation) were evaluated.

Results Employment of ADCs led to organisational improvement: the total time saved by the pharmacy and ICU together was 34% of the time spent before introduction. The number of emergency orders decreased from 6% to 1% of total orders after 1 year. €55 000 were saved (stock value + resupplying value) 1 year after introduction of ADCs. These benefits were almost equal to the cost of introducing the system.

Conclusions ADCs could provide an innovative and efficient solution for the management of sterile medical devices in hospitals. Further investigations are needed to complete the financial evaluation, and to develop this system to provide a secure a medical devices circuit.

INTRODUCTION

To improve the management of sterile medical devices (SMDs) in hospitals is important for health security, logistics and financial efficiency. There are an important and still increasing number of devices available on the market, an increasing demand from medical staff and thus a potential impact on hospital budget. In 2013, the French Hospital Federation estimated the cost of medications and medical devices to be 16% of total public hospital expenditure.¹

For many years, computerisation and the use of automated dispensing cabinets (ADCs) for medication management in care units has significantly improved logistics and security. Such a management system can reduce medication errors, rationalises the time spent by nurses and pharmacists on logistics, leading to substantial savings, and thus has a

favourable cost-benefit ratio.^{2–6} After successfully implementing this system for medication management in the medical intensive care unit (ICU) of our hospital, we decided to extend it to the management of SMDs in this same unit. As far as we know, this is the first trial in France.

The primary objective of our study was to evaluate the effect of this new management system on staff workload distribution (pharmacy and ICU) and on SMD availability in the ICU. The secondary objective was to evaluate the economic impact of such a system on SMD stock value and on resupplying costs.

METHODS

ADC implementation

The project was conducted in a 26-bed medical ICU of a teaching hospital, which provides treatment for a range of pathologies (visceral organ dysfunction management, Lyell's syndrome, etc).

- ▶ Three ADC Pyxis Supply Stations (CareFusion, France) were set up for storage of small medical devices. An additional 100 WiFi boxes fixed on opened shelves were set up (to collect large medical devices or devices used in great quantity). An interface with our management software (Copilote, Savart & Michel, France) was established.
- ▶ Access to an ADC required fingerprint identification and personal code. Authorisation to use automated dispensing cabinets (tidying up by nursing auxiliaries and picking up medical devices by nurses and doctors) was given by the pharmacist in charge of medical devices unit or by the head nurse of the intensive care unit. Temporary authorisations could be given for temporary workers.
- ▶ Each stock movement was recorded by the ADC integrated touch screen (the number of items taken was entered on the keypad) or by the WiFi boxes (one pressure for one item). Location of the medical device being searched for was indicated by lights. Depending on the ADC configuration, the three cabinets could open simultaneously when a medical device was needed or the opening might be restricted to one ADC.
- ▶ Alternative names specifically used in this unit have been integrated into the information system of the ADC to help staff members when looking for medical devices.
- ▶ The head nurse of the ICU, together with referring doctor for this unit and referring

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pharmacist for medical devices, assessed needs and updated the list of essential SMDs. Regarding ADCs settings: « minimum », « maximum » and « emergency » thresholds were defined for each reference. Orders could not exceed the maximum threshold without authorisation from all referring personnel. The emergency threshold automatically triggered an intermediate order. The biweekly order to the pharmacy was also automatically triggered and based on the different thresholds. A manual set off of orders was still possible (in case of holidays, for example, the ordering day could be modified) and specific procedures had been set up in case the computer system failed. Automatically generated orders were always checked and confirmed by the intensive care head nurse before being accepted by the pharmacy.

Organisational impact assessment

Referring pharmacists for SMDs, the head nurse of the ICU and an architect working for Care Fusion Company carried out a management audit review of the SMD circuit between the pharmacy and the ICU. A process map describing the evolution of the organisation before and after implementation was produced:

- We compared the distribution of tasks among pharmacy staff (pharmacy technicians) and ICU staff (head nurse, nursing auxiliaries) before and after introduction of the system.
- We carried out timed observations and staff interviews to compare the time taken for each task (inventory and order to the pharmacy by the head nurse, order preparation by pharmacy technicians, storage of the order by nursing auxiliaries) before and after introduction of the system.
- We compared the medical ICU list of SMDs existing just before introduction of ADCs with the new list after implementation. This gave us the percentage of references SMDs removed after implementation of ADCs.
- We compared rates of emergency orders (number of emergency orders/number of usual orders $\times$ 100) 1 year before and after the introduction of ADCs.

Data were extracted from our management software Copilote (Savart & Michel, France).

Economic evaluation

We determined hospital cost savings generated by the new organisation at the time of implementation (reduction of stock value) and after 12 months (reduction of resupplying costs) by comparing costs (purchase price of ADC, wireless devices and software purchase) and benefits (stock value and resupplying value in euros before and after a year of implementation). The level of activity of the medical ICU and average purchase costs for SMDs were considered to be comparable before and after a year of implementation. Modification of staff costs and maintenance costs were not taken into consideration in this evaluation.

Data were extracted from our management software Copilote (Savart & Michel, France).

RESULTS

Organisational impact assessment

Task redistribution and time spent on SMD management

Activity of the head nurse was the main change: with the introduction of ADCs, manual inventory and manual order entry in our management software by the head nurse of the ICU were rarely needed.

Use of ADCs in the ICU reduced by 34% the total time spent on SMD circuit management (438 min a week before against 290 min after introduction of ADCs):

- A comparison of process maps before and after introduction of ADCs shows that even with two orders a week (instead of one before the implementation of ADCs) the new system dramatically reduced the workload of the head nurse: before ADCs 140 min a week (for one order a week) were necessary for inventory needs, to enter the order in the management software and confirm the order, against 5 min per order per week (two orders a week) with ADCs—that is, a 93% reduction of time spent on this task.
- Time devoted to preparation of the two weekly orders by pharmacy technicians decreased by 19%: 148 min were needed each week before the implementation against 120 min a week after introduction of ADCs.
- On the contrary, time devoted to tidying up SMDs in the ICU increased by 7% (150 min a week before ADCs and 160 min a week after ADCs implementation).
- A comparison of processes before and after implementation of ADCs is shown in [figure 1](#).

Modification of SMD reference list

With the re-evaluation of needs at the beginning of the process, the reference list of SMDs was reduced, with 17% of references being removed: 243 of the 293 references were kept after introduction of ADCs (173 small volume medical devices stored in ADCs and 70 voluminous medical devices stored on open shelves). Items withdrawn were mainly dressings (the range of sizes was reduced for many dressings, bandages and needles); flow controllers were also removed. This was done to harmonise practice in the unit.

Introduction of ADCs also led to a reduction in the stock of medical devices, with an average of 5 days of stock after implementation against an average of 12 days before.

Rate of emergency orders

After the introduction of ADCs, we observed a dramatic reduction in the rate of emergency orders, which comprised 1% of orders after (108 lines of emergency orders for 11 008 lines of orders) and 6% (378 lines of emergency orders for 6312 orders) before the implementation.

Economic evaluation

Implementation of ADCs, wireless devices and computer interface cost €79 000.

Benefits generated by this new organisation represented 70% of the cost of the implementation of the system and were distributed as follow:

- Quantitative and qualitative reduction of stock at the time of implementation led to a first cost saving of €15 000, with no drift at the 12-month assessment;
- €40 000 was saved on orders during the 12 months after the implementation compared with the cost of the previous year's orders, representing 16% of the annual expenditure for SMDs in stock for this unit (€240 000). Savings were made for all SMDs ([figure 2](#)), but particularly for dressings, gloves and infusion devices (savings of 28%, 9% and 9%, respectively).

DISCUSSION

ADC implementation brought about numerous improvements compared with a completely manual management or a double

Figure 1 Comparison of sterile medical devices' circuit (distribution and time devoted to each task) before and after the implementation of automated dispensing cabinets.

bin system, which has advantages but also limitations.^{7 8} First, space saving with optimised storage is real in contrast with the double bin system, for example, which requires having a double quantity of stock. Second, this management system was time saving. Electronic ordering seems to be the key element of this improvement: it dramatically reduced the time devoted to weekly inventories and orders (–93%) by the head nurse of the ICU, and was the major portion of time saved. This improvement allowed nurses and head nurses to concentrate on their core business. Although we did not conduct a satisfaction survey, feedback from the head nurse, nursing auxiliaries and pharmacy technicians was positive, and consistent with previous reports.^{3 9}

Another organisational improvement was in stock management: 50 references were suppressed (reduction of the range of

products for some items), and emergency orders were considerably reduced during the year after implementation of ADCs. This could be explained by two factors: re-evaluation of needs was carried out by the head nurse and the pharmacist at the start of the implementation process, and traceability of stock movements was improved as each movement of stock is now automatically recorded by the ADC computer system. As for management of medication with ADCs, having a small stock of medical devices improves the rotation of devices and thus avoids the presence of out-of-date medical devices.^{4 5} Further evaluations are needed to confirm this.

In our medical ICU the organisational improvement seen with the introduction of ADCs is in agreement with results seen for medication management. For example, the medical centre of the

Figure 2 Percentage weight of the different sterile medical devices categories in resupplying savings realised 1 year after the implementation of automated dispensing cabinets in the intensive care unit.

University of California in San Francisco reported a reduction by 83% of the number of new medication orders after the implementation of automated supply cabinets (surgical unit), and a substantial reduction in the time spent by pharmacy technicians in preparing those orders.³ In addition to savings achieved by reducing the time spent in preparing orders, savings were also made on the time devoted to picking up medications when needed for a patient. For example, in France, a study on ADC implementation for medication management in a medical ICU (10 beds) indicated that nurses saved almost 1521 h a year with this system (savings on time devoted to picking up medications when needed for patients).⁴ Although this aspect should be further investigated, we assume that we could obtain comparable savings with our organisation since storage units are more convenient.

Our experience shows that savings realised on resupplying costs comprise the major part of savings generated by the implementation of ADCs for SMD management. Considering that savings are well balanced between all medical devices categories, an explanation could be a better awareness by the different participants in the medical devices circuit of the processes and responsibilities. An improved confidence in stock availability might also explain the reduction of overstorage. This reduction of annual resupplying costs is of particular interest since these are savings that can carry on for many years. For this first approach to the subject, we did not take into consideration staff costs and maintenance costs, but we assume that this would lead to an even greater reduction of costs since we noted a marked reduction in time spent by the head nurse and pharmacy technicians in managing the medical devices circuit with no significant increase of the nursing auxiliaries' workload.

A strict comparison with the economy of the medical field would not be relevant; however, trends seem to follow the same direction—that is, cost savings in storage and supply. A study conducted in an ICU of the University Hospital Center of Grenoble (France) showed a reduction of €15 000 in the stock value of medications (56% of initial stock value) and savings represented €9000 a year with reduction in out-of-date medications.¹⁰ Less important savings were seen on initial stock value (about 29%) in the ICU of Broussais Hospital (France).⁴ However, it is important to consider that most studies found that the major portion of savings generated by ADCs were in staff costs: US\$1 000 000 saved over a 5-year period was reported in the USA,³ whereas a French cost–benefit study indicated an amount of €71 586 saved over a 5-year period.¹⁰ That point should be further investigated in our case.

An important concern that has not been fully assessed in this study is how effective this system might be in making the SMD circuit secure. Since there are rarely medical prescriptions for medical devices, this aspect is far more difficult to assess than for medication. In our organisation, order preparation and ADCs filling were realised by different staff members (pharmacy technicians and nursing auxiliaries, respectively), which allowed the establishment of a double-checking process for these critical steps. Moreover, the system is set up to give the exact location of each medical device. All these aspects combined, we assume that it should contribute to reducing the risk of mix-up between multiple devices, as has occurred in the management of medications.^{2–5 11} However, further studies should investigate this aspect through specific indicators.^{12 13}

Finally, although the choice of an ICU to launch this pilot study on ADCs for the management of medical devices was not insignificant (procedures are well established in this medical

ICU, with a staff already at ease with ADC since this system is already used for management of medications), the introduction of ADCs for SMD management in this unit was shown to be logistically and financially favourable.

To conclude, ADC implementation for management of medical devices appears to be rational, generating time and cost savings. Thus, it could provide a real answer to improving hospital efficiency. Further studies should be conducted to specify the role of ADCs in overall cost savings and to determine how effectively the medical devices circuit can be secured. As for medication circuit management, the effect of the addition of bar code or data matrix readers to this system to secure the circuit should be investigated.^{14 15} Interfacing with patients' medical records should also be investigated in order to expand this system to the management of implantable medical devices, which requires an uncompromised traceability system for the health security of patients.

What this paper adds

What is already known on this subject

- ▶ Automated dispensing cabinets (ADCs) have been tested and approved for medication management in hospitals.
- ▶ They have a favourable cost–benefit ratio.
- ▶ To our knowledge, there are no available data about the use of such a system for management of medical devices.

What this study adds

- ▶ Our study in a medical intensive care unit shows that ADCs are suitable for medical devices, improving the efficiency of medical devices management.
- ▶ This system could be extended to other hospital units and to the management of implantable medical devices to improve safety and traceability.

Contributors EB contributed to the analysis of data and wrote the manuscript. SM, FK and VA were involved in the implementation of automated dispensing cabinets in the intensive care unit. MP and AA were involved in implementation of the project.

Competing interests None declared.

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REFERENCES

- 1 France FHd. Estimation du taux d'évolution budgétaire 2013 pour les établissements publics de santé. Dernière consultation le 18 juillet 2013. 2013.
- 2 Pedersen CA, Schneider PJ, Scheckelhoff DJ. ASHP national survey of pharmacy practice in hospital settings: dispensing and administration—2011. *Am J Health Syst Pharm* 2012;69:768–85.
- 3 Schwarz HO, Brodowy BA. Implementation and evaluation of an automated dispensing system. *Am J Health Syst Pharm* 1995;52:823–8.
- 4 Goudou-Sinha C, Fagon JY, Pineau J, et al. La mise en place d'un automate décentralisé dans une unité de réanimation médicale. *Gestions Hospitalières* 2001;405:264–9.
- 5 Bedouch P, Baudrant M, Detavernier M, et al. La sécurisation du circuit du médicament dans les établissements de santé: données actuelles et expérience du centre hospitalier universitaire de Grenoble. *Ann Pharm Fr* 2009;67:3–15.
- 6 Pedersen CA, Gumpert KF. ASHP national survey on informatics: assessment of the adoption and use of pharmacy informatics in U.S. hospitals—2007. *Am J Health Syst Pharm* 2008;65:2244–64.
- 7 Brun-Fitton A, Boileau JY, Levron-Gouzerh A. Mauvaise utilisation du système plein/vide de dotations en médicaments. Limites d'un système ou conflits intérieurs? *Techniques Hospitalières* 2007;706:55–7.

- 8 Leboucher G. Mise en place et bilan du système plein-vidé à l'hôpital de la Croix-Rousse des Hospices civils de Lyon. *Techniques Hospitalières* 2010;719:35–41.
- 9 Rochais E, Atkinson S, Guilbeault M, *et al.* Nursing perception of the impact of automated dispensing cabinets on patient safety and ergonomics in a teaching health care center. *J Pharm Pract* 2014;27:150–7.
- 10 Kheniene F, Bedouch P, Durand M, *et al.* Impact économique de la mise en place d'un automate de distribution des médicaments dans un service de réanimation. *Annales Françaises d'Anesthésie et de Réanimation* 2008;27:208–15.
- 11 Skibinski KA, White BA, Lin LIK, *et al.* Effects of technological interventions on the safety of a medication-use system. *Am J Health Syst Pharm* 2007;64:90–6.
- 12 [No authors listed]. ASHP Guidelines on the safe use of automated dispensing devices. *Am J Health Syst Pharm* 2010;67:483–90.
- 13 Klibanov OM, Eckel SF. Effects of automated dispensing on inventory control, billing, workload, and potential for medication errors. *Am J Health Syst Pharm* 2003;60:569–72.
- 14 Helmons PJ, Dalton AJ, Daniels CE. Effects of a direct refill program for automated dispensing cabinets on medication-refill errors. *Am J Health Syst Pharm* 2012;69:1659–64.
- 15 Oldland AR, Golightly LK, May SK, *et al.* Electronic inventory systems and barcode technology: impact on pharmacy technical accuracy and error liability. *Hosp Pharm* 2015;50:34–41.