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Return on Investment after Implementation of a Centralized Automated Storage System in a Hospital Pharmacy

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Abstract: An ADS (automated dispensing system) was implemented in our hospital pharmacy in 2008 to optimize and secure the medication process. The main objective of this study was to compare the projected and the real ROI (return on investment), after seven years of use. ROI was calculated annually (from 2008 to 2015), by deducting the cost of investment (ADS buying and implementation, maintenance, repairs and ADS upgrade) from the cost saving (drugs stock reduction and decrease of pharmacy staff dedicated to global dispensing). In 2015, total costs saving (+$1,141,987) were divided between decreasing drug stock value and reduction of pharmacy staff. Total costs of investment (−$978,656) were acquisition, maintenance, repairs and an unplanned upgrade costs. Finally, the real ROI was +$163,331 after seven years of use. In 2008, projected ROI was +$410,786. The real payback period has been increased by approximately two years (six years of use, instead of four years as expected). Despite their cost, ADSs are a worthwhile investment, leading to a ROI within a few years. These economic considerations should be put into perspective with optimization of drugs stock management, greater efficiency of the global dispensing process, securitization of medication process and redeployment of pharmacy staff.

Key words: Centralized automated dispensing system, return on investment, medication process, payback, redeployment of pharmacy staff.

1. Introduction

Dispensing systems, such as ADSs (automated dispensing systems) (centralized and decentralized), have been developed to secure global dispensing at the pharmacy and finally to secure dispensing and administration process [1, 2]. Both systems are complementary. ADSs start to be widely established in hospital medication organization in Europe and especially in UK, and many studies have demonstrated their contribution to decrease iatrogenic injuries by reducing potentially preventable events [3-6]. But high cost of these available technologies must have to be considered regarding to the efficiency.

The great directives of health policy today are focused on safety and security of patient healthcare from admission to hospital discharge (prescription to administration). Medication errors occur during the medication process from ordering, dispensing to administration [7]. French drug administration and others scientific societies claimed that around 22% to 25% of medicate iatrogenic came from dispensing process [8-10]. Dispensing errors generally lead to administration errors as the pharmacy barrier is overpassed.

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In fact, healthy institutional instances promote nominative dispensing which implies a prescribing validation and a tracking dispensing process to limit potential dispensing errors and inappropriate uses especially for expensive drugs. However, in France, global dispensing remains important due to hard and expensive introduction of nominative dispensing management. Due to an important human factor and a lack of strict control, global dispensing may be one of the biggest springs of dispensing errors. Therefore, securitization of global dispensing is required and allows reorganization of staff to activities like unit-dose dispensing.

In accordance with national challenging health policy applied to public hospitals, our hospital voted the purchase of a pharmacy-based ADS and installed it in July 2008. The considering benefits of the implementation were focused on economic saving impact with stock control and turnaround time and also quality of process with safety of dispensing tasks. ROI (return on investment) is commonly used because of its versatility and simplicity to calculate and to interpret the gauge of investment's profitability. Initially, a projected ROI was calculated to justify the investment for the hospital financial department.

The main objective of this study was to compare the originally projected and the real ROI, after seven years of using and an important upgrade of the pharmacy-based ADS. This upgrade was due to the widespread of datamatrix codes on drug boxes in 2013, and recurrent failures and technical problems of the automat.

2. Materials and Methods

2.1 General Setting

The study was conducted in the pharmacy department at a teaching hospital in Paris, France (800 beds) from 2008 to 2015. The mean of hospitalizing days is 6.1. The pharmacy supplies 43 units with a total number of 1,700 references. The hospital is equipped with a patient information system integrating an electronic patient record and a computerized physician order entry system (DxCare®, Medasys). Forty-three secure and automated medication cabinets (Omnicell® Inc.) are available in the 43 units.

2.2 Description of the Medication Process

Each electronic medication prescription is analysed and validated by a pharmacist. The hospital pharmacy delivers drugs in a global basis. Each day, pharmacy technicians fill the decentralized medication cabinets available in each unit. In 2008, a centralized pharmacy-based ADS, Rowa® system (ARX®), was implemented in the pharmacy (Rowa Extent). The pharmacy staff for medication global dispensing process was then compounded of three pharmacy technicians and two pharmacy technician aides. This ADS was a tandem robot with a duplicate stock. The stock flow process is described in Table 1.

Each ADS had a storage unit (22,000 boxes), a refrigerated unit, a loading unit (ProLog system) to input drugs boxes (using bar-codes) and a dispensing system. The ADS is under control of an ARX® software. ARX® software was interfaced with the drugs stock management software Pharma® (Computer Engineering). Enters and exits of each drug references stored in the ADS are under ARX® software control. They are checked and recorded in ARX® thanks to a bar code scanner. Almost 95% of the drugs are stored in the ADS. Due to weight, high dimension or classification law, we decided not to store some drugs in the ADS, like plasma-derived medicinal products and narcotics drugs.

In 2013, due to the widespread of datamatrix codes on drug boxes and recurrent failures and technical problems, the ADS was upgraded (Fig. 1) (Rowa Vmax). The new robot can read datamatrix but does not have a refrigerated unit, due to technical problem in closing door. Refrigerated drugs are stored outside the ADS.

Table 1 Stock flow process.

Standard different steps of global dispensing process	Online ordering Requests	The hospital is doted of pharmaceutical managing software Pharma®. This software is used to order, to check prescriptions, and to manage medicines. Each unit can order medicines from a pre-established picking list according to their needs with a soft version of Pharma®, which is available on hospital net. All the requests are centralized in pharmacy twice a day for unit care and three times a day for intensive care unit and surgical care. It is used for delivering drugs to cabinets and urgent demands from units.
	Checking the order requests	The established picking list is qualitatively and quantitatively checked by the pharmacist's stakeholders. This validation is automatically injected to ARX® ADS managing software which is interfaced with Pharma® software. From this step, the robot runs the orders.
	Execution of the orders	Exit of drug boxes can be automatically executed by the robot from the validated order lists or from an emergency list for punctual orders. Punctual orders represent emergency needs and daily dose patient list where drug prescriptions are validated after a pharmaceutical control.
	Validation and delivery	Each order is assembled in packs of drug boxes including a delivery slip of the drugs, which is used as a tracking list. Every pack is sealed up and delivered to wards by assistant technicians.
	Global re-supplying	Use of drugs leads to a decrease of the global stock. Stocks under predefined thresholds run a prelist of global order. This prelist is checked and validated by the responsible of orders before sending it to wholesaler for supplying pharmacy in drugs. Drugs loads are realized thanks to Rowa Prolog® Loading system. The robot scans, checks and stores the drug boxes. Then a listing of new stored drugs is edited after each reception.
	Management of lot and expiry date	Expiry date of drugs could be managed using the robot; In case of recall of lot, each delivery could be checked with the concerned lot.

Fig. 1 Pharmacy-based ADS ARX® in 2013.

2.3 Evaluation of ROI (Return on Investment)

In 2013, the hospital chose to upgrade the ADS with a new system to integrate three datamatrix scanners.

In order to assess the profitability of the robot implementation, three ROI were calculated: (1) the real ROI; (2) the projected ROI initially calculated in 2008 (initial projected ROI (before upgrade)); (3) the projected ROI including modification of the old ADS in 2013 (projected ROI with upgrade). This last ROI was the same from 2008 to 2013 and included the upgrade in 2013.

We calculated differences between real ROI and projected ROI when buying the system, for the seventh year of use (2015). The real payback period (i.e., the period of time required to recoup the funds expended in the investment) was then determined, and compared with the expected payback period.

ROI (i.e., balance between cost investment and cost saving) was calculated annually until the seventh year of robot use (from 2008 to 2015), by deducting the cost of investments from the cost savings since ADS implementation:

- Cost investments included ADS buying and implementation, annually maintenance, annually repairs and the ADS buying upgrade in 2013;
- Cost savings were evaluated by the reduction of the drugs stock and the decrease in pharmacy staff dedicated to global dispensing.

3. Results

We present the savings costs (departmental reorganization technicians) and the investments costs (robot and maintenance) per year in Fig. 2. The saving cost due to decrease drug stock was taken into account the first year.

Total costs savings were +$1,141,987, divided between decreasing drug stock value (+$75,084) observed the first year after implementation of the robot, and reduction of pharmacy staff in the dispensing area (+$1,066,903). Before the implementation of the robot, the pharmacy staff for medication dispensing process was compounded of three pharmacy technicians and two pharmacy technician aides. Due to the implementation of robot, activities were reorganized and staff involved was revised. Since 2008, one pharmacy technician and 1.5 pharmacy technician aides were moved to other pharmaceutical activities except in 2013 for the up-grade of the robot. Indeed, during this period, one pharmacy technician aide was necessary to compensate the absence of automatic dispensing system.

Total costs of investments were −$978,656, divided between the acquisition cost (−$483,892), the maintenance cost (−$184,981), the repairs (−$30,784) and an upgrade (−$276,000). The implementation of the ADS included the robot, the technical and computer support, and the first year of maintenance.

Finally, the real ROI (balance between costs investments in one hand and costs savings in the other hand) had been +$163,331 after seven years of use (2015).

In 2008, the initial projected ROI included a total costs saving of +$1,194,325 due to the reduction of pharmacy staff during the seven years and a total cost of investment of −$784,539 (robot acquisition and maintenance). Thus the initial projected ROI for the year 2015 was +$409,786, i.e., an overestimation of $246,455 (Fig. 3). This difference was mainly due to the important and unplanned upgrade of the system during the 5th year of use (2013).

In 2013, the initial projected ROI was recalculated including the upgrade. It included a total costs saving of +$1,141,987 (including the need of pharmacy technician aide for 2013), and a total cost of investment of −$984,024 (robot acquisition, maintenance and upgrade). The projected ROI including the upgrade for 2015 was +$157,963, the difference with real ROI was due to repairs.

As the robot was upgraded, the real payback period has been increased by approximately two years (six years of use, instead of two years as expected) explaining the difference between projected and real ROI observed in 2014 (Fig. 3).

4. Discussion

Despite investment costs, an automated dispensing system contributes to improve the safety and the efficiency of the medication system in term of storage capacity, time and cost saving. After seven years of using robot (from 2008 to 2015), the real ROI was +$163,331. The real payback period has been increased by approximately two years (six years of use, instead of four years as expected). The difference between the real ROI and the initial projected ROI for

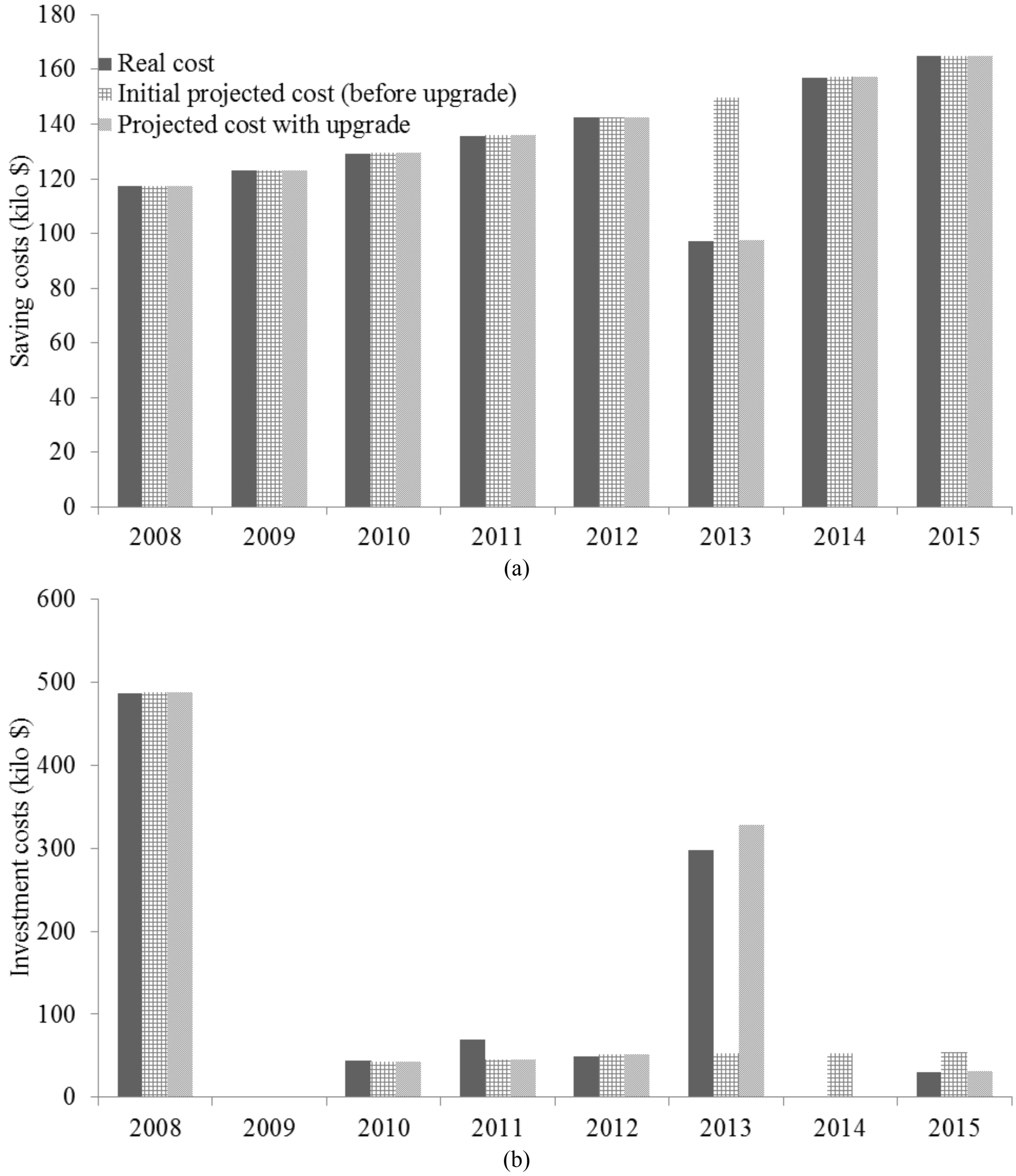

Fig. 2 Real costs, initial projected costs (before upgrade) and projected costs with upgrade divided in: (a) pharmacy staff; (b) robot and maintenance.

the year 2015 was $246,455.

Pharmacy-based ADS improve workflow efficiency with a greater storage capacity [5, 11, 12]. In UK hospital pharmacies, Franklin et al. [11] showed that the implementation of ADS represents a 23% increase in storage capacity in the first site and a 123% increase in the second site, compared to traditional storage [7]. Installing ADS contributes to medication safety [3-6, 11]. ADS ensures that drugs resources are secure, organized, tracked and ready for use. Slee et al. [5] and Fitzpatrick et al. [12] have shown a reduction in dispensing errors from 16% to 50% which increases patient safety. Moreover, as the expiry dates and batch number are recorded in the ADS, stock management and recall of lots are improved. This technology also helps pharmacy staff to reduce or eliminate labor-intensive tasks by automating the management of medications and supplies where they are needed. ADSs have been associated to time savings with significant reduction in median time of picking [7].

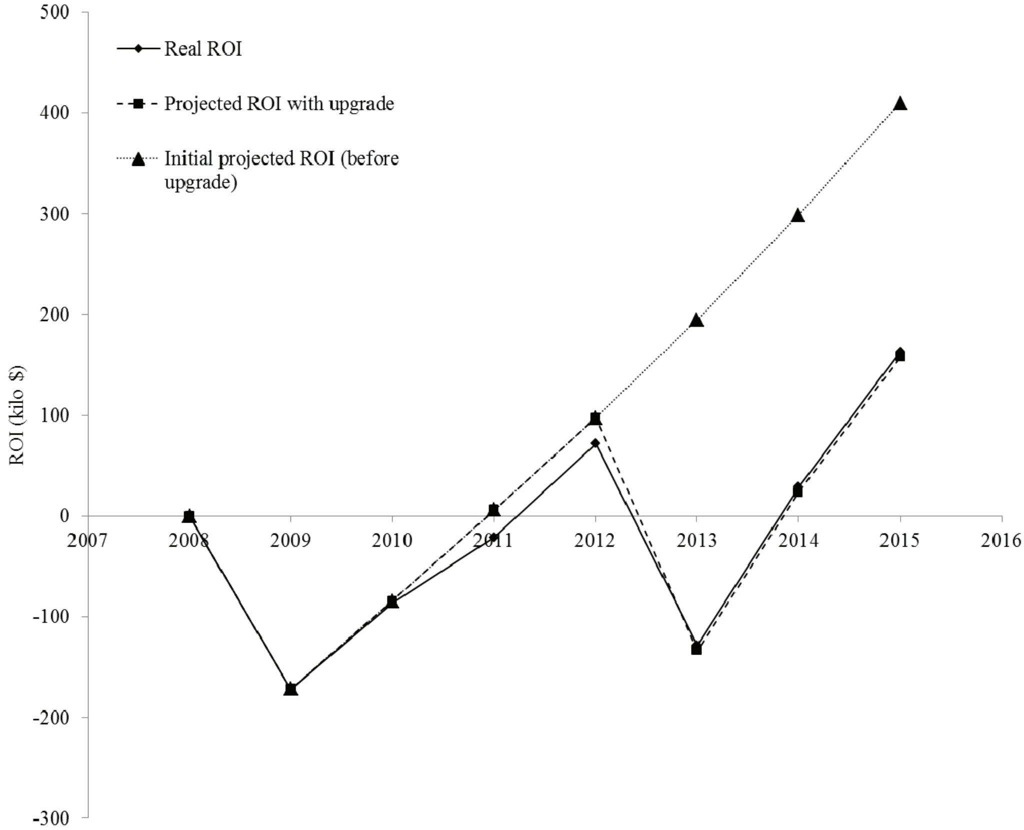

Fig. 3 Real ROI, initial projected ROI (before upgrade) and projected ROI with upgrade.

Medication safety aspects and time savings were similar to our results. In a previous study (data not published), a significant reduction in dispensing errors rates (2.88% for traditional storage (n = 14,526 drug boxes) versus 1.73% for ADS technology (n = 11,193 drug boxes), $p < 0.05$) and in time delivering drugs (17 min ± 10 min for traditional storage versus 9 min ± 7 min for ADS technology, $p < 0.01$) were observed. Finally, ADS induces departmental reorganization with net reduction of pharmacy technicians in the global dispensing process to dispatch them to the unit-dose dispensing process [13, 14]. We moved one pharmacy technician and 1.5 pharmacy technician aides to unit-dose dispensing activity and delivery of chemotherapy drugs to units.

This study has some limitations. The calculation of ROI included the balance between cost investment and cost saving. For the cost saving, we did not include the management of expired drugs with the ADS. Moreover, the drug stock effect of the implementation of the ADS was only evaluated the first year. Moreover, we did not evaluate the benefit of the ADS in term of satisfaction of the pharmacy staff.

Despite their cost, centralized automated storage systems are a worthwhile investment, leading to a return on investment within a few years. When purchasing a robot, economic projections should be calculated with caution, because of technological and regulatory changes that can lead to a premature obsolescence of the system.

5. Conclusions

Despite the initial cost and an unplanned upgrade in 2013, the real ROI was positive, leading to a ROI within a few years. The economic considerations should be put into perspective with the benefits: optimization of drugs stock management, greater efficiency of the global dispensing process, securitization of medication process and redeployment of pharmacy technicians to value-added activities, as unit dose drug daily dispensing system or management of automated secure dispensing cabinets in care units. However, this ADS technology need to be completed with other technologies to secure the medication process. For example, combination with unit dose system and BCMA system could be implemented.

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