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Review

The benefits of automated dispensing machine for hospital pharmacy in Indonesia: situation, implementation, and feasibility

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ABSTRACT

Background: Pharmacy as the main core of hospital is responsible for the quality and safety of medicines. Yet the numbers of medication errors are still high. Automated Dispensing Machine (ADM) is one of the solutions to reduce the dispensing errors in pharmacy. Many countries had studied and proved that the use of ADM gives more benefit than liability. However, ADM is considered as something new, a "nice to have" product.
Aims: This study will explain the benefits of ADM especially in Indonesian hospital pharmacy.
Methods: Systemic Review with PRISMA method uses 5 databases as Scopus, Springerlink, Google Scholar, Science Direct and ProQuest, with keywords Automated Dispensing Machine, Automated Dispensing Device, Automated Dispensing System, Automated Drug Dispensing System, or Robotic Dispensing System. The inclusion criteria are all the studies that showed any impact in minimum of one aspect of ADM in hospital.
Results: There are 13 studies that explained ADM benefits such as increase staff satisfaction for the nurse and pharmacist, reduce dispensing errors about 35% or up to reducing all dispensing errors, time saving until 50% in peak hours and cost analysis and effectiveness. The cost analysis such as inventory stock reduction, increases the cost saving.
Conclusion: In Indonesia, it needs many considerations to implement ADM but it had already installed in 1 Indonesia Hospital. This hospital had proved that ADM can reduce dispensing errors and can solve some pharmacy problem such as the human resources problems and the long waiting time. With the proven benefits of ADM, it is justified for Indonesian hospital to implement ADM and information system in their pharmacy. The effectiveness will perceive the pharmacy and positively affect to all related departments in hospital.

This article is an extension of a selected paper "The benefits of automated dispensing machine as solutions for hospital pharmacy in Indonesia: A systematic review" published in *Proceedings of the International Conference on Applied Science and Health* (No. 1, February 2017).

INTRODUCTION

Pharmacy is a hospital's main core which products are widely used, such as medicines, medical devices, films and reagents. Thus pharmacy becomes the revenue center in hospital [1]. In Indonesia, most of hospitals pharmacies in Indonesia are still using man-power to do their daily

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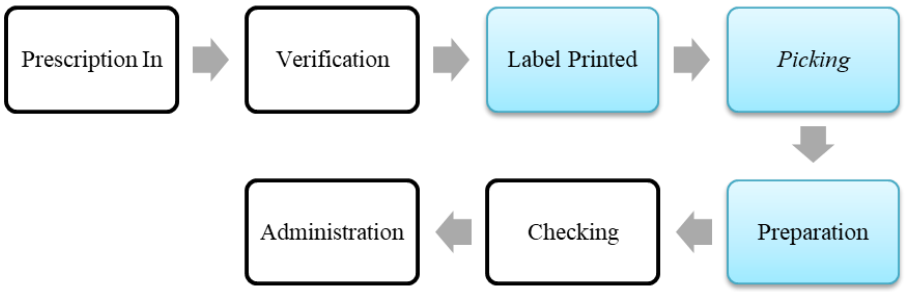

Figure 1. Indonesia pharmacy workflow

activities. According to Indonesia Ministry of Health regulation (Undang-undang No. 35 Year 2014), the pharmacy is responsible for the quality and safety of all medicines in hospital, this includes inventory planning, purchasing, receiving, distributing and evaluating the drug usage by the patient. In the ideal workflow, the pharmacy must get a prescription from the doctor, then continues to verification process, dispensing to hand over or administering the drug and educate the patient also evaluates the drug usage. This processes are not easy to do and error-prone, especially when using only man power; the risk of errors might harm the patient and it some cases it leads to death [2].

Presently, Pharmacy dispenses many drugs to the patients, meaning that dispensing is one of the main and most complex processes. Dispensing includes picking and labelling the drugs. When it is manually done, dispensing error can happen any time, without anyone noticing until the patient is experiencing the harmful effect [2, 3]. There were 134,431 dispensing errors cases annually in England and Wales [3]. Another study showed there were 24% dispensing errors in community pharmacy and 12.5% in hospital outpatient pharmacy [2]. According to Anacleto, Perini, Rosa, & César, 2007 the dispensing errors are responsible for 11% from 50% of medication errors. The most common dispensing errors are wrong drug, wrong dose, wrong label, and wrong quantity [3].

Hospitals are now focusing to improve patient safety and dispensing errors is one of the main concerns. There are some technologies to reduce the dispensing errors such as software, barcoding, automated dispensing machine (ADM). ADM is one of the ultimate solutions for pharmacy to help dispensing automatically and it will become the long-term care solution. ADM uses barcode to identify the drugs, hence, it greatly reduces dispensing errors [5]. ADM use barcode as the drugs identification and must integrated with hospital software.

ADM is relatively new in Indonesia, even though some hospitals have already used it. Many studies said that ADM could give positive impacts to the pharmacy even just make the pharmacy focus on caring the patient. But there was study told that ADM can reduce medication errors especially for dispensing errors, reduce the number of staff and make the services faster than before [6].

Most of countries have been used and proved that ADM was their main solutions to give more benefits for their pharmacy. So this study will explain and give some images of the benefits of ADM especially for Indonesia hospital pharmacy.

METHODS

There are many types of ADM such as the box dispensing machine, cabinet dispensing machine, and unit dose dispensing machine. Each machine has its own function for example cabinet system that can be used in emergency, or intensive care unit. The types of machine will be chosen, depends on where the place is pharmacy want to increase the quality services (*see figure 1 to understand the pharmacy flow*). This *Systematic Review* (SR) will not analyse the difference of the machines otherwise discuss the hall effect of the machine in all departments with some types of machines.

Searching

This SR used PRISMA to make readers more understand with the simplest methods of ADM. The

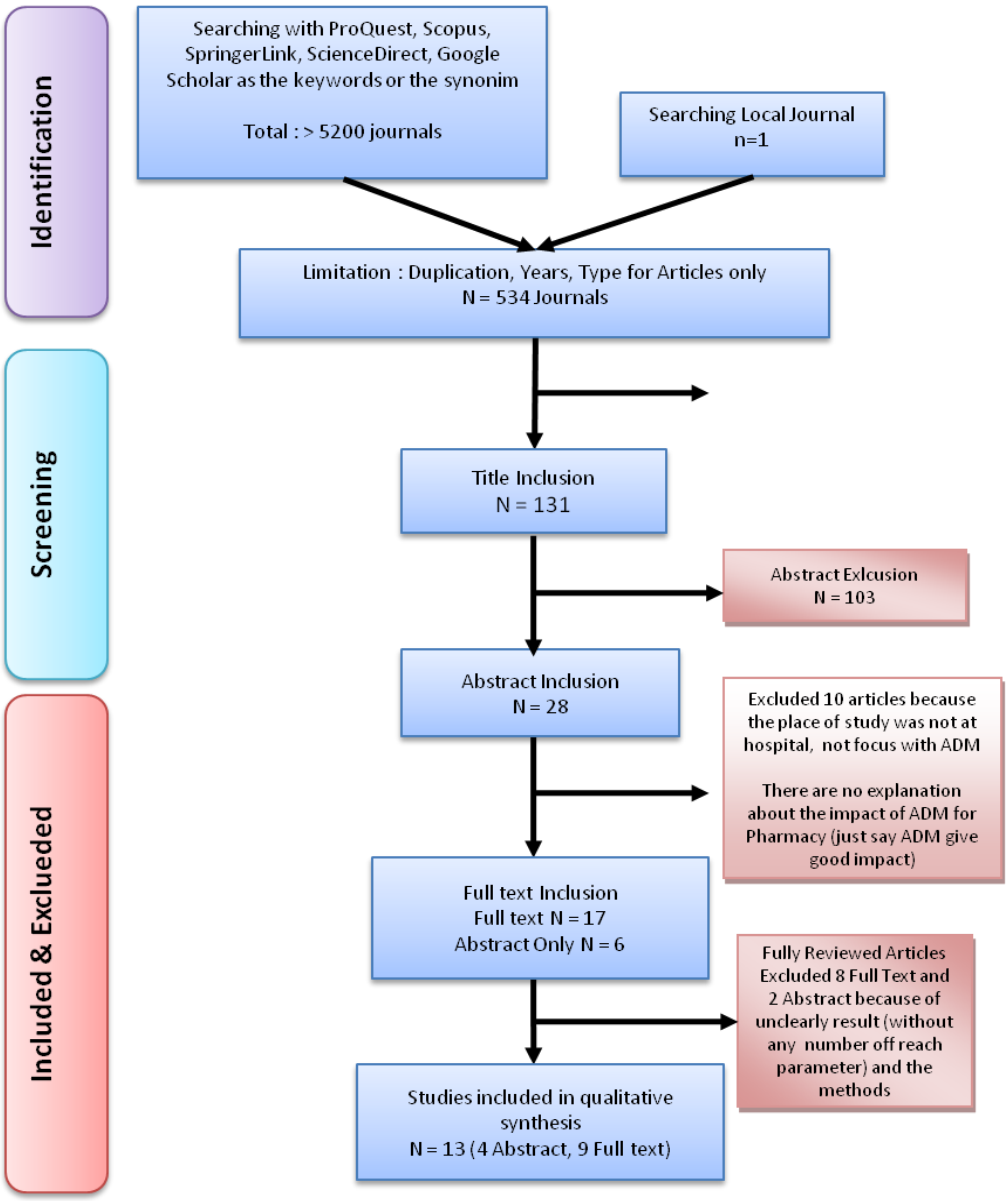

Figure 2. PRISMA methods of the study

sources of the journals are searched via online from Scopus, SpringerLink, ScienceDirect, Google Scholar and ProQuest. The keywords are Automated Dispensing Machine (ADM), Automated Dispensing Device, Automated Dispensing System, Automated Drug Dispensing System (ADDS), or Robotic Dispensing System. Others keywords used to find the local journal and used the synonym to get more variation of the journals. The limitation for this study is free journals that published from 2010 - now. As the result, all journals that fulfilled the criteria are used even only the abstract is available. This study used 2 level filters are the title and abstract.

Inclusion and exclusion criteria

The eligible journals parameter is all the studies that showed any impact of ADM in hospital minimum one aspect such as the financial aspects, workflow efficiency, investment, services speed, etc. All the journals without any impact of the ADM in the hospital explained had excluded. As the final, this study reviewed 13 journals (*see figure 2*).

RESULTS

There are 13 reviewed articles. There are 5 from 13 (2 abstract only) explained ADM for outpatient pharmacy and 8 (2 abstract only) of 13 explained about ADDS (Automated Drug Dispensing System) for intensive care, emergency or wards. Most of those studies, 11 of 13, used observational study such as longitudinal (2 studies), case control (1 study), cross sectional (3 studies), 2 analysis study such as financial perspective. One from 13 used semi experimental study and another 1 study is a systematic review. They compared between before and after implementation of ADM for many perspective in big hospitals (4 studies at more than 1000 beds hospitals, 4 studies at teaching hospital).

ADDS is types of ADM which mostly use for automated dispensing in ward. It doesn't matter about the name even ADDS and ADM used only to represent the inpatient and outpatient department. The result is ADM will give the efficient effect such as the cost saving, reducing error, reduced time services and smooth workflow for inpatient (including intensive and emergency unit) and outpatient department. Another positive impact is especially for the nurse satisfaction and reduced total inventory control cost. One of study showed ADM didn't give any impacts to increase the time for the service because their internal regulation put limited access for only some staff and another staff must wait those staff to use ADM. On the other side, 1 studies also showed that ADM need skilled staff to operate and the pharmacy have to choose kinds of medicines that ADM can dispensed (*see appendix*). Therefore, to maximize ADM hospitals need to integrate with hospital information system and manage all the process including how to make the accurate filling and preparation process and also training the staff about the machine and how to through access to the machine.

Staff satisfaction

From 2 journals which used ADDS as their solutions, all the nurses had satisfied and want to use ADDS as their dispensing system in wards. Totally 91% nurses were very satisfied with ADDS. One journal gives the result that ADM in outpatient, the average of the Pharmacist satisfaction is 8.63± 0,744 and for the nurse satisfaction is 7.78 ± 0.667. According to Gonzalez et al., 2016, his study divided 3 kinds of satisfaction based on the process and the results of ADM (*see table 1*). The greatest result was in patient safety factor from pharmacy (9.75 ± 0.463), it means the pharmacy was satisfied with the ADM because ADM increase the safety [7].

Table 1. The result of satisfaction types for the nurse and pharmacist [7]

Satisfaction	Pharmacist	Nurse
Patient safety	9.75 ± 0.463	8.00 ± 0.7077
Ease of use	9.13 ± 0.641	8.2 ± 0.667
Dispensing speed	7.75 ±0.886	6.33 ± 0.50
Inventory control and integration	> 8.5	7.75 ± 0.707
Average	8.63 ± 0.744	7.78 ± 0.667

Most of nurses and pharmacists actually aware, that they need ADM as their solutions in their job. With the good operational and ease to use, ADM can increase the patient safety, increase the inventory control quality and it had been approve by most nurses and pharmacists.

Reducing incidents or errors

ADM can increase patient safety by reducing dispensing errors and medication errors as final impact. Five studies showed ADDS can reducing the errors, the administration errors by 57% and reduce dispensing errors by 6% [8–12]. For ADM, there are 3 studies that showed ADM has the effect to reduce errors. Even 1 journal only showed the staff satisfaction about the patient safety, but it means the staff approved the ADM reduced the errors and it made them satisfy [7, 13, 14]. Sujatno 2016 showed that in his hospital, ADM could reduce dispensing errors more than 35% (50.33 ± 34.77 to 15.67 ± 6.282). But Beard & Smith, 2013 and Ong et al., 2014 had showed that ADM can make all the dispensing process without any mistakes.

Time-saving

As the result from the staff satisfaction parameter, they agree that ADM and ADDS help them to serve faster. ADDS can reduce the time in emergency case, peak hour and for preparation process. ADDS also can increase the service-speed and can spare more work-time about 2 hours a day [9, 16, 17]. But Roman et al., 2016 has another opinion, in

emergency case ADM could service faster than the normal situation. Beard & Smith, 2013 mention that ADM can reduce 50% of the time with almost zero errors. As the saving-time effect from ADM, the pharmacist and the nurse have more time to spend it with patients.

Cost analysis and effectiveness

There are 6 studies about the effectiveness of ADM or ADDS which showed as saving the total number of staff, space and total number of stock. ADM compared by manual process, ADM can save up to US$ 1,894,429 (for 10 years) if reach 75% dispensed volumes from ADM[18].The more medicines dispense from the ADM, the more effective the pharmacy will be[14]. Beard & Smith, 2013 explained that ADM can reduced 4 staff, reduced the inventory stock about £250,000, increase the saving cost £500,000.

ADDS can save approximately US$ 148,229 for 5 years [19]. Another study showed also the cost-effectiveness about US$ 80,000 annually. Mostly in US, the ADDS are rented for the hospitals, with the rent cost about US$27,000 annually [9].However one study showed that ADDS can give the impact for the patient cost. The patient cost reduced 20.3% and can increase number of drugs for stocked about 11.4% with the less needed [16].

DISCUSSION

Situation in Indonesia

In Indonesia, there is only one hospital already reported use ADM, outpatient pharmacy of Bethesda Hospital Yogyakarta [13]. The ADM need to integrated with the hospital software system to maximize its potential as what Beard & Smith, 2013 results. The integration between ADM and Hospital Information System (HIS) can make the zero result of errors.

There are some challenges for Indonesia to implement ADM: the low cost of labor with the big population and the low economic rate. All the ADM are made from foreign country such as Italy, Germany, Japan, etc. so the prices usually expensive.

Nowadays, it is very difficult to get the well-trained staff even easier to recruit any new staff. As long as pharmacy still using human power, the errors incidents will be higher than use technology [14]. So the human resource problem for hospitals is still high and ADM can solve the problem with its benefits.

ADM can reduce the total staff needed in pharmacy, increase the inventory control, reduce the errors, increase the time service and increase the staff satisfaction. All the benefits can calculate as the money or cost savings or cost-effectiveness. With those benefits, Indonesian hospitals must considere to implement ADM as their solutions in their pharmacy departments. Claire Chapuis et al., 2015 said that it is very profitable and improve efficiency with the ADM. The only one barrier is the resistance of staff to changing.

ADM implementation in Indonesia

Bethesda hospital has implemented ADM in outpatient department since 2014. Bethesda faced three main problems, the human resource problem, medication errors and very long waiting time before implemented ADM. They had tried many ways to solve the errors problem such as human training, organizing the stocks, using information system and barcode system, but in reality, it just reduced some errors while dispensing errors were still high and the staff workload still very high. After ADM installed, the staff were very satisfy and the dispensing errors incidents had reduced drastically.

Bethesda hospital used 20% and 80% role, to make the priority system for ADM stocked medicines. Most of Indonesia medicines are finished as strips (aluminum foil) or blisters and packaged into 1 box with lot of number (e.g. 10 strips in 1 box), so Bethesda Hospital need to repackaged and put into the box and they called *smart pack.* Those *smart pack* containing certain number of medicine. It will be possible if there will be 3 smart packs with the same medicine but different number.

They also promoted ADM to the physicians as the prescriber. They put any options of the medicines with different number that stocked in ADM in electronic prescribing, so the physicians can choose the kinds and number of medicines to prescribed, which will be dispense with ADM. As the result they got the dispensing errors reduction about 35%. With the combination between ADM and electronic prescribing, they got 69.78% reduction of

dispensing errors, but the reduction not as much as the Beard & Smith, 2013; Ong et al., 2014 studies. It because they still printed the label outside the machine.

According to Bethesda Hospital experience, the biggest issue for hospital pharmacy is the variation of total medicines requested from the physician. Sometimes, the patient also does not want to take hall the total number of medicines in prescription, they would like to buy half from the total amount of medicines. From that reason, the pharmacist should make priority, which medicines will be save inside ADM. They can do a research to find the 3 top of total number from each medicines that the physicians often prescribed as the priority to keep inside the machine. The more medicines are going out from the ADM, the less error will be happen.

Another problem pharmacy faced is about the software system and barcode system. Some hospitals just have simple software just for logistic system, but ADM need more complete software such as electronic prescribing and barcode system for each medicines. As the leaders who would like to implement ADM, software and barcode is the first preparation of hospital must have. The leader also must to create the working climate into the technology based to all staffs because some staff could resists for the new technology and do not want to exit from their comfort zone.

Type of data for feasibility study

The implementation of ADM need more management consideration as the financial prospective become the main part to take any decision. The benefits of using ADM should be calculated as the money, but it is not easy to convert all aspects as money value for example the staff satisfaction and the workflow efficient.

First of all the hospitals should think about the standardization of the pharmacy procedure, to keeps the process and the result in good quality and safety as the requirement of accreditation. ADM will record all the dispensing process by computerize and it will make stream-lining the processes. This benefit is the sample of the intangible aspect. Another example is the nurse and pharmacist satisfaction when using ADM. According to the result, the average for both satisfaction is more than eight, it means they are happy when implementing ADM in their department. It should give any positive impact to their work when they are happy. The workload might be reducing and could give impact to their job quality for example incident errors less happen or the service time is faster for their job.

Second, ADM could reduce the dispensing errors incidents. It should become the first priority as ADM implementation consideration. Reducing errors will saving-cost to the hospitals. Hospitals will spend much money to prevent the errors or to solve the impact of errors. The amount of money that they spend for errors can be used for the FS calculation.

Third, the improvement of service time. ADM could saving the time about 2 hours even in inpatient or in peak hour time of outpatient department. The time saving can be converted to the cost-saving and can be used for FS calculation. The converted time-saving become cost-saving can use the human power or staff cost/hour.

The last one is the effectiveness of ADM. From the human resource aspect, ADM can reduced 4 people according to Beard & Smith, 2013. The reduction can be calculated as the cost-saving by using the total cost/month. For the stock efficiency, the average of cost-saving from ADM is about US$ 189,442/year (1 USD = 13,200 IDR, 2,500,634,400,- IDR), or from another study said ADM increase the saving cost about £500,000(1 GBP = 16,800 IDR, 8,400,000,000,- IDR). ADM can give any extra saving money if using ADM in inpatient department, from the result ADM can save US$ 29,645/year or IDR.391,314,000,- per year (1USD = 13,200 IDR). Tsao et al., 2014 also said its profitable when rent ADM while using manual (US$ 80,000 saving vs US$ 27,000 cost). If the hospitals use ADM for inpatient, they can save about IDR.699,600,000 annually.

Now, all the benefits can be calculated and accumulated and must be comparing with the ADM selling price or another additional activity when ADM had been implemented. ADM implementation is also very depending on the leader strategic plan. If the leader didn't put technology as the strategic way to make any improvement for his hospital, it's very difficult to push that hospital to

install the ADM otherwise the FS calculation is ready for them, it might be change his mind.

Limitation and strength

It is very good news for Bethesda hospital that had started to used ADM in Indonesia even just in outpatient pharmacy. Indonesia need another ADM for the inpatient pharmacy (ADDS) to become the sample and as the evidence that ADDS improve the pharmacy process. It's not just for the pharmacy, but for all staff. It can help the nurse workload and their service care to patient. With the ADDS the nurse can safely administrate the medicine and as the result, the total incidents of medication error will reduce.

ADM as the solution is very depends on the leadership, management skill and all the departments support. ADM need some consideration from the leader to make it as the priority for the pharmacy. They need to calculate some analysis to make the real Feasibility Study (FS) of the ADM investment. In this study, the benefits had written so it can help the leader for their FS. In fact, there will be more benefits of ADM rather than the listed in this study, such as the saving space or the opportunities of revenue rising. With the ADM benefit, increase the speed of pharmacy services and reduce the waiting time, can make the patients who do not like to wait, to buy the medicines in hospital.

This study requires more the data such as dispensing errors calculation as the money saving, another improvement in cost calculation. To maximize the function of ADM, it needs trained staff, good managerial concept to review periodically the consumption of medicines inside ADM.

CONCLUSION

Some studies showed ADM could reduce medication errors, increase the staff satisfaction, increase the saving cost and reduce the inventory stock, saving time and make some efficiency such as the reduce the total number of staff and patient cost. With the benefits of ADM, it's very feasible for Indonesian hospital to implement ADM and information system in their pharmacy. The effectiveness not just for the pharmacy, but it would positively change for all related departments in hospital.

CONFLICT OF INTERESTS

None declared.

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