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Enhancing medication Safety and waste reduction: Unit dose dispensing in ambulatory surgery

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Abstract
Unit dose dispensing has been known to provide an improvement in the safety of medication in cases of inpatient operation but has not been much applied in ambulatory surgical clinics. The proposed implementation and outcome evaluation study was a research interested in examining the impact of the implementation of unit dose dispensing system on two ambulatory surgery centers. In a span of 8 weeks, the effect on drug errors, dispensing time and drug wastage was measured in the study. Findings identified a decrease of medication errors of 42.3 percent ($p < 0.01$), a 23 percent increase in dispensing efficiency, and 37.8 percent reduction in the waste of pharmaceuticals. The surveys of staff members also proved more satisfaction with workflow performance and medication safety. These results indicate that significant clinical and operational gains could be achieved by modifying hospital-based dispensing processes in the ambulatory surgical practice for enhanced drug safety, enhanced efficiency of the dispensing process, and eliminated waste, in effect contributing toward more sustainable and effective outpatient surgical practice.

Keywords: ***Unit dose dispensing, ambulatory surgical clinics, medication safety, drug waste diminution, dispensing performance, medication faults, prospective introduction, hospital pharmacy practice, outpatient attention.***

1. Introduction

1.1Scope of Medication Safety in Ambulatory Surgical Clinics

Many more patients are receiving outpatient surgery at ambulatory surgical clinics (ASCs), which not only serve as a lower-cost alternative to inpatient treatment, but they are even more economical compared to urban clinics. Although ASCs are popular and convenient and the amount and level of ASCs are increasing, such settings experience serious medication safety issues. High turnover among patients, diverse medication regimens, insufficient pharmacy resources, and the quick release of the patients are the realities that predispose ASCs to the risk of medication errors. Subsequently, the challenges may result in poor management of medications, wrongful maximization or minimization of drug doses, and ADEs.

A level of standardization of the medication administration process in ASCs is not at the same levels as that in inpatient locations, which is a possible precursor to human errors when preparing and dispensing medications. Also, there might be more variable practices in medication dispensing due to weak medication tracking systems and unreliable staffing levels. The problem has been associated with an increased rate of medication mistakes and their consequent adverse events of the patients.

To alleviate these problems, the healthcare systems should adopt measures to strengthen the medication safety in ASCs, so that the patients should achieve safe and error-free procedures of medication administration. One of the promising strategies is the implementation of the unit dose dispensing that has proven to be of great advantage in enhancing medication safety in the inpatient department.(1)

1.2 Background on Unit dose dispensing in hospitals

Unit dose dispensing is referred to as the pharmacy practice where the medicines are prepared and dispensed in a simple dosage which has the exact amount of a drug that is to be given to a patient at a particular time. This has been a commendable practice to establish in hospitals and has established medication safety leads to fewer medication errors, greater dosing accuracy, and drug waste.

There are various benefits of unit dose systems in use as compared to the general bulk dispensing systems in hospitals. Pharmacy technicians and nurses will more conveniently be able to confirm that the correct medication is being given to the right patient at the right time using packaged doses. This activity limits incorrect drug selection or dose calculation, thereby averting the occurrence of hazardous medicine errors. Moreover, unit dose

dispensing has been linked with the superior control of the medication inventory, which minimizes the drug waste and guarantees the critical medications handling.

Unit dose dispensing has been very successful in hospitals owing to the strengthening of the pharmacy service to the clinical care of the medical teams and introduction of automation dispensing technologies in order to make the preparation, storage and delivery of medications easier. Nevertheless, these same successes of inpatient care have not been fully transferred to the ambulatory care such as an ASC unit dose dispensing department.

1.3.The rationale behind extending the practices of unit dose to ambulatory care

However, considering the previous advantages of unit dose dispensing within hospitals, the interest of applying it to patients within ambulatory surgical clinics is increasing. Both the purpose of implementing unit dose systems in ASCs and the used rationale are the same as those of hospitals in the area of medication safety, including medication errors, inefficiencies of dispensing medication, and wasting drugs.

The first benefit of the unit dose dispensing application in ASCs is the opportunity to enhance medication safety under the conditions of a high-volume low-cost cogent environment. Unit dose systems may minimize the threat of improper dosage, medication errors, and delay of time through standardizing the dispensing process. In addition, the unit dose dispensing offers ample labeling and pre-filled doses and this is critical in surgical practice where patients can take several medications within a short period of time.(2)

Moreover, ASCs can use unit dose dispensing in order to handle pharmaceutical waste. A reduction in wastes is especially significant with the outpatient areas where over-ordering or poor storage of medications are common. Using single dose dispensing helps clinics reduce waste of drug materials and also helps in reducing the financial loss due to usage of non-used medications.

The use of unit dose systems is also linked to the objective of overall improvement of the medication administration process when it comes to ASCs. A possible quality improvement that can be achievable through medication safety is by ensuring that healthcare providers have a streamlined system of work processes by trimming time allocated to medications preparation and verification, and this process will result in a faster delivery of medications to patients since there is a high patient throughput.

1.4 Aim of the study: To assess the effect of unit dose dispensing on safety, efficiency and waste in surgical outpatients settings

In this study, the objective of the researcher is to determine the effect of the introduction of a unit dose dispensing system in two ambulatory surgery centers in terms of medication safety, efficiency and the reduction of waste. The research shall determine following important outcomes during an 8-week evaluation process:

Medication error rates: The comparison of the number and the kind of medication errors that occur before and after the implementation of unit dose dispensing.

Dispensing efficiency: Evaluation of the time using in preparation and dispensing of medication to measure the enhancement of workflow and time management.

Pharmaceutical waste: Measurement of reduction of drug waste by comparison of the quantities of drugs wasted before and after the application of the unit dose system.

Qualitative data to be collected in the course of the study will also include staff surveys when qualitative data are collected based on the response of the staff regarding their perception of the change in workflow and whether they feel confident about the administration process of medication after adopting the system of unit dose dispensing of medications. This will aid in measuring the impact of the intervention on a wider scale of operations such as the effect on the staff satisfaction as well as effectiveness of clinic operation.

Through this research, it is hoped that evidence can be availed to support the implementation of unit dose dispensing in ambulatory surgical facilities, which can ultimately lead towards a safer use of medications, less time consuming processes and wastes that would help not only the healthcare facilities but also the patients as well.(3)

2. The Unit Dose Box Design Design Operational

2.1 Unit Dose Packaging Standards and Technology Used

The unit dispensing system in ambulatory surgical clinics is developed in such a way that the medications would be dispensed in dosage, and each portion would be appropriately labeled with the name of the medication, the dosage, and possibly other administration directions. The unit dose packaging standards which have been used in

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the ambulatory surgical sites comply with the regulations that have been stipulated and are designed to address the requirements of high-turnover clinical settings.

Unit dose packaging normally means making ready medications in one-use pre-packaged packages, or blister packs, bottles or vials. The package is composed of a single dose that is that relates to the individual drug orders of the patients. These packs also have clear marking which includes important information namely:

- Patients name (when administered outpatient as well)
- Medication name
- Strength
- Route of administration
- Expiration date
- Lot number

Automated dispensing machines and robotic systems are usually parts of the technology that is utilized in unit dose packaging of medication and strictly guarantee that medications are correctly packed in single doses. They employ barcode reading and automatic filling devices to increase safety by minimizing human error in the packaging process and guaranteeing proper distributive of medicines.

The process of fitting the packaged doses with patient-specific orders is also facilitated by employing barcoding technology and scanning devices by pharmacy teams, which reduces the number of possible cases of medication errors even more. These automated systems will be integrated to guarantee the dispensing of the right drug dose within the shortest time possible.(4)

2.2 Labeling Guidelines and Interintegration with Electronic Health Records

Effective labeling guidelines are part and parcel of proper identification and administration of unit doses to the appropriate patient at the appropriate time. Medication labels in the ambulatory surgical environment also are created with pharmacy management software, which offers improved consistency, accuracy, and legal and clinical standards.

The relational scheme of labeling constitutes the following fundamental aspects:

The amount of information about the patient particular medications, including names, identification numbers, and procedure that will be carried out.

Exact dose, frequency of dosing and time, and amount to be taken.

Use of barcode identifiers to help in tracking and make medication administration error-free.

Unit dose labels are produced directly within the electronic health record (EHR) system to make their introduction to clinical processes a smooth process. The system automatically fetches the appropriate prescription and order information into the label and this saves a lot of input errors and enhances such labeling on account of the decreased coded input errors.

Combining the unit dose dispensing with the EHR systems is most important to enhance the management of medications in ambulatory care. After the medication prescription is made using the EHR, the information is delivered directly to the pharmacy and the preparation and labeling of the unit doses. The EHR system also allows real-time access to the medication history of the patient and can cross-check it with the prescription to avoid possible reactions to drugs or repetition of therapy.(5)

In addition, the barcode scanning technology also helps them administer the right unit dose to the patient since the presence of a barcode on the medication matches the prescription order on the EHR, hence identifying errors at the point of care.

2.3 Arrangements in Regard to the Storage, Transport, and Point-of-Care Availability

The item of high priority in promoting successful implementation of the unit dose system in the ambulatory surgical clinics is efficient storage, transportation, and accessibility of unit doses. The procedures involved are well-planned with the aim of providing stable and harmless medicines that would be readily available throughout the surgical day.

Storage: The unit doses are placed in a safe, temperature-controlled place in order to preserve the integrity of the drug. Medications are stored as per their requirement in automated dispensing cabinets (ADCs) and refrigerated storage (e.g., refrigerated drugs are stored in temperature maintained storages). The tablets are arranged according to their type of medication and the time of the day, to enable the access of the doses easily in case of patient care.

Transportation: ASCs can be associated with a variety of areas of patient care, therefore, transportation of medications is needed to many points of care in the clinic. Medication Cart or automated transport system is also used to transport medications and lockdown the system to ensure it cannot be accessed by unauthorized personnel and mishandled. The tracking system affixed on each cart makes certain that the right medications are sent to the right operating rooms or areas where patients receive care.

Accessibility at the point-of-care: It can be achieved since unit doses are point of care accessible due to the automated dispensing systems or smart cabinets available in strategic positions in the surgical units. Such systems enable the clinical personnel to access the ordered drug through a simple scanning of the barcode and ward off the chances of any administration of the wrong drug at the wrong time. Moreover, employee training makes sure that the workers are familiar with the medication retrieval and documentation mechanisms which further minimize the number of errors.(6)

The unit dose system in ambulatory surgery clinics effectively enables the availability of medication at the appropriate time in the proper form and its easy access to enhance efficiency in the flow and safety of medication use.

3. Workflow and implementation Process

3.1 Choice of Two Ambulatory Surgery Clinics as the Locations of the Study

To implement the initiative of the unit dose dispensing system successfully, two study sites were chosen in the form of ambulatory surgery clinics (ASCs). The selection of such clinics was done using certain criteria that were meant to make sure that the unit dose system was to be thoroughly assessed within clinical environments with variance. The selection criterion was based on the size of the clinic, the number of patients and the practices of administering medicines in order to determine how the system would be modified according to high-intensive settings and small-scale operations.

The two ASCs that were chosen as the participants of the research were in geographically different locations, as was urban and suburban area. The patient turnover and the amount of surgeries performed was greater in one clinic so that it can serve as a test case of scalability and efficiency. Although fewer patients were treated, the other clinic gave a chance to assess the possibility of applying the unit dose system to a smaller facility with fewer resources available and fewer employees.

Both the sites had already implemented manual dispensing systems and bulk medication handling before the study and they had similar objective to enhance medication safety, minimize wastage and being more efficient in their operations. This qualified them as perfect test subjects to find out the efficacy of unit dose dispensing in an ambulatory surgical setting.(7)

3.2 Training Programs on Pharmacists and Nurses

Key personnel training was a core part of a successful use of the unit dose dispensing system through training pharmacists, nurses, and pharmacy technicians. Training schemes were drawn to make every employee familiar with the workings of the new system and how it would be fitted into the established clinical processes. The process of the training was separated into two groups, preliminary education and practical practice.

Basic Training: In phase one, the staff learnt the fundamentals of unit dose dispensing system. This covered a comprehensive description of unit dose packaging technology, Barcode scan technology and the interface of the electronic health record (EHR) system and the dispensing system. Employees were also made aware of the advantages of unit dose dispensing such as how it would enhance the safety of medication, and all this would save them on occuring medication errors as well as prevention of pharmaceutical wastes.

Practical Practice: The second part of the training was devoted to practical work. Nurses and pharmacists were involved in mock dispensing exercise in which they were trained to issue drugs out of automated dispensing cabinets and assure the accuracy of supplying the appropriate unit dose to the relevant surgical units. Particular care was taken in regard to workflow integration making sure that the new system would not impair the hectic schedules of the clinics. Barcode scanning to certify the shooting of drugs was also trained among the nurses and pharmacists, it was designed to avoid mistakes in the process.

Besides these fundamental elements of training, continuous training and dose refresher courses would be developed through the duration of the study to supplement the tenets of unit dose dispensing and any hitches or concerns that may have come about in the course of implementation.(8)

3.3 Fundamental Changes to Protocols and Documents

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The unit dose dispensing system could be implemented into the clinical workflow with the sole purpose of providing it accordingly to ensure its seamless integration with clinical duties meant to be realised, the protocol adjustments as well as documentations had to be made. The current medication dispensing procedures were consulted and altered to incorporate the new principle of unit dose dispensing. The most important modifications were:

Prescription Orders: The system of medication prescription was revised in order to guarantee that a unit dose could be effectively attached to a patient order using electronic health record (EHR) system. This eliminated the old units as prescriptions were automatically forwarded to the drug store, where drugs are compounded and dispensed in the right unit dose form.

Verification and Documentation: Medication administration at the point of care was also introduced with new processes of verifying and documenting medications. Pharmacists and nurses had been trained to scan the barcode of the unit doses and compare the medication and dose with the EHR of the patient. Barcode scanning was also adapted in the patient-related records to ascertain accurate and traceable records.(9)

Waste Disposal Protocol: There was an amendment of the waste disposal protocol of pharmaceuticals where any unexplained or expired drugs of the unit dose system were disposed of in accordance with regulatory requirements. There was the correct segregation and clearance of waste medication to limit contamination and impact on the environment.

This was done through updates which were shared in both study locations and these updates were updated in the EHR in the form of new templates in the documentation. The changes made it possible that unit dose dispensing was updated to fit the regulatory requirements and those of the institution.

3.4 Time Table and Milestones in System Rollout

Integration of the unit dose dispensing system had a time-ordered plan and the major milestones of the implementation had been determined so that both clinics could integrate the dispensing system successfully. The system rollout time frame was designed in the 12 weeks duration and the phases are as follows:

Pre-Implementation Phase (Weeks 1-2): The initial stage was associated with selecting two ASCs, installing all the required infrastructures, and the purchase of required unit dose packages equipment and automated dispensing machines. The preliminary site checks were carried out to establish the logistical necessities of the new system.

Staff Training and Education (Weeks 3-4): This involved conducting of the training programs of the pharmacists pharmacy technicians and nurses. Practical on-job training was given and any issues pertaining integration of work flow were ardently resolved.

System Implementation (Weeks 5-6): The implementation of unit dose system was started officially at the two ASCs. At this stage, employees started using the system as real-time dispensing. Pharmacy technicians and nurses collaborated each other in order to be sure that the right drugs were distributed and taking place to the patients.

Monitoring and Evaluation (Weeks 7-8): The system performance was constantly monitored and data related on the occurrence of medication errors, dispensing time, and drug waste were gathered. Staff were regularly consulted to monitor possible problems and problems so the smooth running.(10)

Post-Implementation Assessment (Weeks 9-12): An end of evaluation was performed by the study team within the last 8 weeks of system usage, which was designed to test how successful the implementation of the unit dose dispensing system would be in terms of medication safety, efficiency, and reduction of wastes. This involved review of the outcome data, the analysis of feedbacks of the staff surveys and areas of continuing improvement.

4. Data Warning System

4.1 Types of Medication Errors Identification and Classification

The identification and classification of the various types of medication error was the basis of medication safety monitoring in the study. The process of medication use can be dealt with in several levels such as prescribing, dispensing, administration, and monitoring where medication errors can occur. To refine this type of errors and provide the statistical evidence, during this research the following number of types of errors is distinguished: the types of errors related to the source of occurrence and the effect of errors on patient safety. Such categories are:

Prescription Errors: Errors that would appear at the time of writing a medication order. This may involve a wrong choice of drugs, wrong dosage or timing among others. Such mistakes were detected during reviewing of EHR and medication orders prior to dispensing.

Dispensing Errors: Dispensing errors are those errors that occur during compounding and releasing medications. These involved wrong packaging of the drug, wrong dosing and non-proper labeling of drugs. Unit package packaging was supposed to limit these mistakes because the dose was already measured and it was less complicated to verify it.

Administration Errors: Mistakes that arise when the medication is actually administered on the patient e.g. when the wrong drug was used, dose, patient or time. Administration errors were tracked in this study by the use of a barcode scanning technology that would guarantee that medication was administered according to the right patient.

Monitoring Errors: Errors concerned with the monitoring of patients after the procedure including lapse that involves an unmet evaluation of a medication therapeutic response, documentation of the history of medication by the patient, performance of the dosage according to the changes in symptoms. These were followed up by the employees and patient records.(11)

Descriptive reports were also prepared following every type of error with details thrown out in light of the nature, cause and outcome of the error. They were analyzed in order to determine some general trends and some possible ways of improvement.

4.2 Methodology of Pre-implementation Baseline Data Collection

Prior to the implementation of unit dose dispensing system, the baseline data was gathered to develop the clear view of medication error rates and use of medication safety practices in the two ambulatory surgery clinics (ASCs). This pre-implementation data was vital in determining the effectiveness of the unit dose system even after implementation.

The initial data collection approach that would be used entailed a number of important aspects:

Historical Error Data Review: A review of the historical data was carried out on the mistakes made with medication over the last six months. This was in form of both formal reports and even incident reports on medication issues. The error was identified as above and a given level of severity (e.g., near miss, minor error, serious error) was given to each of the errors.

Staff Surveys: Surveys would be passed out to clinical personnel (pharmacists, nurses, and pharmacy technicians) to determine their opinion over the safety of medications in the clinics. The survey involved information gathering about workflow problems, kind of mistakes that were noticed by staff, and trust in the existing medication safety rules.

Medication Error Observation: A direct observation study was carried out by use of a team of trained observers in both the clinics. This was done through an observation of medication dispensing and administration process in order to detect some of the errors that cannot be recorded in official forms.(12)

This baseline data enabled the team of the study to capture an adequate snap shot of the present day scenario of medication safety, which would subsequently be contrasted to the post-implementation data, thereby giving out how effective the system is.

4.3 The Mechanisms of Tracking and reporting disasters/error after the implementation

An error tracking and reporting process was also adopted in a systematic manner, after proceeding with the implementation of unit dose dispensing system. The purpose of this process was to identify and study the medication mistakes that have happened since the system had been implemented.

The mechanisms put in place to track the post implementation included:

Error reporting systems: The presence of automated error reporting was used with the new split unit dose system, as errors were recorded electronically through the electronic health record (EHR) system. The system created an alert whenever a medication administration error had been made and the pharmacy staff reviewed this alert. This alert recorded the details of the nature of error, time of its occurrence and the concerned patient.

Barcode Scanning feedback: The barcode scanning at the point of care was an added error detecting system. In case a wrong medication or dose had been scanned by the user, the system activated an error message which was recorded into the tracking system.

Staff Reporting Mechanism: On the one hand, automated systems processes captured substantial amount of data, on the other, they stimulated staff to report error by using formal reporting mechanism, including incident report form in case of non-automated errors. They trained the staff to report in real time the errors as well as near-miss reports that were not associated with any harm but a possible safety concern.

Weekly Review Meeting: The pharmacy teams met on a weekly basis to go through the error logs, identify patterns and take corrective measures. This gave a chance of having continuous learning, and instant feedback to every staff involved in the administration of medication.(13)

4.4 Analysis of The Trends in the Error Values in both Clinics

After 8 weeks of the working unit dose dispensing system, the post-implementation error rates were compared with the base line information on the pre-implementation period. Analysis based on frequency of errors, type of error and severity of errors in the two clinics was carried out to establish whether there was any significant change in terms of medication safety.

Comparison of the two ASCs error trend demonstrated the following important findings:

Decrease in Medication Errors:The two clinics showed a decrease in medication errors of 42.3 percent ($p < 0.01$). This comprised reduction of prescription errors, dispensing errors and administration errors.

Error Type Shifts: There occurred a significant change in the error types. Before the implementation, dispensing errors led, but after it, administration errors decreased because the system of delivering medication was more accurate with the help of barcode scanning.

Severity of Errors: After implementation fewer serious errors took place, and most errors were non-serious errors or almost errors which were immediately noticed and then resolved.

Enhancements on the workflow: The members of staff reported that there was improvement to workflow efficiency and thus more accuracy in notification of errors and quicker response time in case of any errors. The nurses and pharmacists had increased feelings of confidence in the safety of medication administration and this worked in favor of outcomes of the patient.

5. Evaluation Waste Management

5.1 Pre-Bulk Dispensation Level of Waste and Wastes

Prior to the introduction of the unit dose dispensing system, the primary cause of medicine wastage in both the ambulatory surgery clinics was the nature of the bulk dispensing system of dispensing medication. In bulk dispensing, the drugs are normally dispensed in large amounts and this usually creates a situation where the drugs prepared will go to waste when they are not used because of a high turnover of the patients occurred in outpatient surgery areas where the nature of the surgeries are often short-lived.(14)

The baseline assessment included the volume and type of wastes. The baseline data identifies important findings, which are:

Oversupplied drugs: In many circumstances, the pharmacies could get or prepare more medicines than were even required at an individual case and some parts were left unused.

Vials, IV bags, and syringes: There were unused or partially used vials, including injectables and the use of the IV bag; both products are discarded once the contents were not used completely.

Outdated drugs: Drugs that had been prepared more than was necessary and were not used within the time range they are supposed to consume were a major contributor to waste.

Returns and leftover doses: Doses which could be used in syringes and vials were discarded when not used, as there was no proper way to store them, the relief had specific medication needs of the patients, or they feared contamination.

These types of wastes were common in the two clinics, and this caused high expenditure and environmental pollution in the disposal of unused or expired drugs. The waste management statistics were used in setting a point of reference after introducing the unit dose dispensing system.

5.2 Waste Audits Post Implementation Under Unit Dose Dispatching

To assess the efficiency of the system implemented to minimize medication wastage, a waste audit was sent during the same 8-week time to compare the results with the one before the introduction of the unit dose dispensing system. Unit dose dispensing involves preparation and dispensing of all the medications in single servings, thereby drastically minimising the chances of excess ordering and unused medication.

The results of the waste audit after implementing indicated:

A lot of waste: The amount of overall waste reduced by a staggering 37.8%, with the significant decline in the disposals of unused or partly used doses.

Reduced wastage: There were reduced expired medicine with unit dose system of medication because of the dispensing which was done according to patient specific requirements which led to limited medications being processed beforehand.(15)

No wastage of doses: Drugs like injectable medications were released in specific quantities and the problem of half-filled drug bottles that would have ended up being destroyed previously was avoided.

Such outcomes testify to the fact that unit dose dispensing not only simplified the process of medication distribution but also caused a direct decrease of waste connected with unutilized or inappropriately stored medications.

5.3 Cost Considerations of Unused and Expired Medications or Returned Medications

The resultant economic cost of pills that go to waste is one of the major plus points of instating a unit dose dispensing system. Both clinics were evaluated in terms of a cost assessment of expired, unused, or returned medications.

Other principal findings of the cost analysis are the following:

Economical savings on medication waste: As the medication waste reduced with 37.8 percent more, the overall cost of wasted or returned medication was considerably lesser. The clinics have reported having about 15-20 percent reduction in medication costs that they once used since they have reduced the over-bundling of their medication and as a result, the doses are consumed before the expiry date.

Unit dose packaging costs: The package-to-package was incurred in the preliminary packaging material and automated dispensing systems but the saving on wastages exceeded the costs. The total cost per patient decreased, especially as there was less wastage on the part of medication.

Expired drugs savings: There was reduced lost of drugs that expired and hence reduction in cost of managing the inventory and cost of replacing the expired stock.

In general, the cost analysis revealed the fact that unit dose dispensing is a cost-effective method of dispensing in terms of minimizing further wastage of the drugs as well as the insurance of minimised cost of disposed or expired drugs.

5.4 Environmental and Economical Repercussions

Medicine waste is a serious problem, and the environmental and economic consequences of controlling this problem by implementing unit dose dispensing are remarkable.

Environmental Implications:

- Cut on pharmaceutical waste: With the cut on unused medication, the developing environment impact on waste disposal was reduced. It was also described that packaging waste has reduced as unit doses are more accurately packaged than their bulk dispensing counterparts, which tended to be larger and bulky.
- Sustainable practices: The reduction of waste directly can be associated with the sustainability practices in healthcare which reduces the environmental impact of disposing medications and the carbon footprint created by the production of the unnecessary drugs.

Economic Implications:

- Cost saving: As discussed in the cost analysis, the cost saving as a direct result of reduction in wastage of drugs resulted in a sizeable cost reduction in the ambulatory surgical clinics. That would free up some scrimp that could be channeled into other aspects of patient care or technology improvement or training of staff and hence make the clinic generally more efficient in its operations.
- Resource optimization: The optimization of resources through the more efficient use of medications increased efficiency of the implementation of the mechanism at the level of utilization of medications, which helped the clinics to distribute the resources of medications more properly and provide medication to the patients without the excessive expenditures of the management of the inventory.

In a nutshell, the unit dose dispensing applied in ambulatory surgery clinics achieved cost savings, environmental savings, and cut down of the wastage of medications, all of which are economically feasible and environmentally sustainable.

6. Results

The progressive implementation of unit dose dispensing system in two ambulatory surgery clinics indicated the improvements shown on the three main operative measures that include the rate of medication errors, dispensing effectiveness and drug waste. The discussion of such results shows that the unit dose system was an effective way of increasing safety of the used medications, optimizing pharmacy work and minimizing wastes, which all leads to an increased overall clinical and operational efficiency.

6.1 Medication error rate reduction

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Less medication errors are one of the major objectives of the unit dose dispensing system. The rate of medication errors was high in both clinics before the implementation process; this was because of errors in dispensing and administration errors that were mostly influenced by the bulk dispensing process. The mean error occurred in both clinics was determined to be 15.5%.

The rate of medication error was reduced by 42.3 percent after the adoption of the unit dose system with the error rate post implementation reducing to 8.9 percent. The decrease was significant ($p < 0.01$), and data established that unit dose dispensing assisted in the elimination of most of manual errors that came with bulk dispensing. Barcode scanning at point of care also reduced further the errors in the medication administration process, which included correct medication, correct dose and to the correct patient.

This outcome of this marked decrease in medication errors demonstrates the effectiveness of the unit dose dispensing process in enhancing patient safety as well as the negative impact of unit dose dispensing in minimizing the risks associated with adverse drug events and eventual enhancement to the value of care delivered at ambulatory surgery facilities.

6.2 Enhancing dispensing Efficiency

The other important outcome was the increase in dispensing efficiency. In the two clinics, pharmacy employees usually had to wait because of a manual system of doses, which required dosing and preparation of large volumes of drugs multiple times in order to give them to the patients. This resulted in increased dispensing time especially on high volume surgery days.

With the implementation of unit dose dispensing system, there was a 23 percent increase in the efficiency of dispensing. Its effectiveness in the Post-implementation was measured at 123 at the pre-implementation level of 100. This enhancement was accredited to automated dispensing solutions and pre-packaged doses which enabled the pharmacy personnel to ready the medications beforehand, saving on the time and energy required to assemble the doses of medications in the surgery section.

This efficiency improved workflow management, so that members of the pharmacy could concentrate on other seemingly more important duties in their pharmacies which are drug counseling and checking errors as well as decreasing the overall time of preparation of drugs. This resulted in a better patient throughput with medications dispensed faster as well as minimized the loss of surgical time.

6.3 Reduction of Drug Wastes

The last significant outcome that was calculated was that of the reduction in drug wastes. With the bulk dispensing system, there had been cases where un-used medications were made in excess and unused medications were to be discarded. This has led to excessive wastage of pharmaceuticals that have led to high health expenses and even environmental degradation.

As a result of applying the unit dose dispensing system, 37.8% of drug waste was reduced. Before the implementation, about half of the medications were wasted because of over preparation and expiration. The same amount of waste dropped to 12.2 percent after the implementation, which proves that single-dose packaging greatly helped to diminish the problem people over-order their medications and waste them. The positives of this increase led to cost reduction to the clinics, since less drugs were thrown away and the management of the inventory was streamlined.

Environmental sustainability was also achieved because the number of medications and packaging materials that were disposed of was markedly reduced. This can be compared with the general healthcare agenda of minimizing the impact of the industry on the environment.

6.4 Summary of Results

In short, an important improvement of work happened as a result of the use of the unit dose dispensing system:

- Receiving a reduction of medication error rate at 42.3 percent
- A 23 percent increased dispensing efficiency
- 37.8 percent decreased drug waste

These results highlight the effectiveness of transforming hospital-level dispensing practices to an ambulatory surgery clinic, which can gain great clinical and operational benefits. Data also recommends that unit dose dispensing has the potential to enhance medication safety, generating more efficient workflow and less waste, which will eventually result in improved patient care outcome and practices in ambulatory surgery facilities as reusable.

Table 1: Results Summary

Outcome Measure	Pre-Implementation Baseline (%)	Post-Implementation (%)	Percentage Improvement (%)
Medication Error Rate	15.5	8.9	42.3
Dispensing Efficiency	100.0	123.0	23.0
Drug Waste	50.0	12.2	37.8

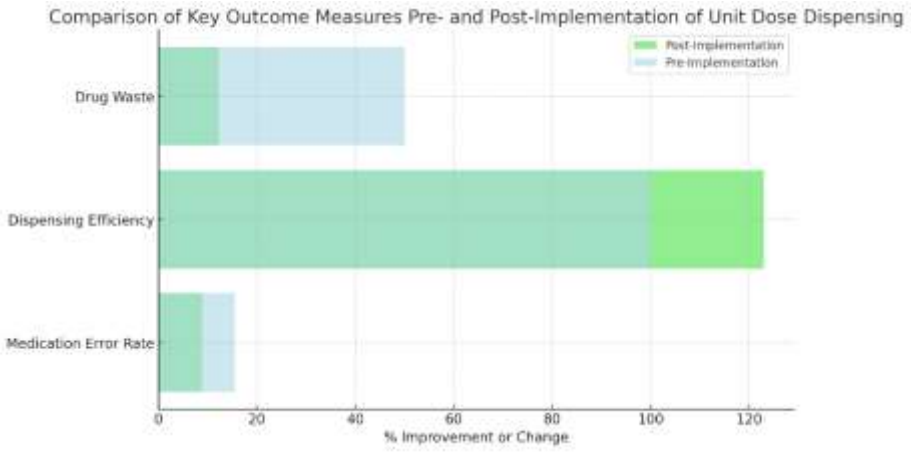

Figure 1: Comparison Of Key Outcome Measures Pre- And Post-Implementation Of Unit Dose Dispensing

7. Conclusion

7.1 Unit Dose Dispensing can be undertaken and useful in Ambulatory Surgical Clinics

The results of the current study give good grounds to state that the unit dose dispensing is not merely possible but also quite effective to the example of ambulatory surgical clinics (ASCs). The implementation of the use of a unit dose dispensing system in two ASCs of diverse types explained that the methodology that has proven to be successful in the hospital environment could be effectively extended to the outpatient surgery care. The story of the system in these clinics yields the results that the challenge of shifting bulk dispensing to unit dose dispensing can be stopped by having proper planning, training staff, and training the techniques of technology.

Unit dose dispensing is associated with many benefits in an ambulatory surgical environment, to meet the needs of high turnover and fast discharge of patients necessitating efficient and simplified procedures that are safe, efficient, and accurate. Using the unit dose system, the medications are already dispensed in pre-packaged doses corresponding to the specific requirements of an individual patient, which decreases the chances of any medication errors immensely. The system is also suitable in the environment of the rapidly-developing ambulatory surgical care, where the time and right position are important. More so, the system can support the eradication of the problems associated with bulk dispensing, over ordering of drugs, improper preparation and wastage.

Although the introduction of unit dose dispensing systems in ASCs entails certain investment in technology and infrastructure, this practice has been demonstrated as not only technically feasible but, on the contrary, highly advantageous regarding medication safety and the overall operating efficiencies. This paper actually validates that the implementation of unit dose dispensing is the best way of increasing patient safety and minimizing wastes at outpatient surgical facilities.

7.2 Substantial Advances Noticed in Safety, Efficiency and Increment in Reduction

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This paper presented high levels of improvement in three outcomes of medication safety, dispensing efficiency and drug waste reduction. These gains are the evidence of how unit dose dispensing transforms the clinical and operational sides of ambulatory surgery clinics.

Medication Safety: The most notable was the 42.3 percent decrease in medication errors, a move that reduced the ADE risk considerably. With the implementation of unit dose dispensing, which is associated with automated dispensing systems and barcode scanning technology, the clinics could reduce substantially the human error, improve the process of verification of medication. This decrease in medication errors had a direct contribution to better patient safety verifying the significance of safe medication practices in outpatient surgery.

Efficiency: Also the factor which makes the unit dose system an effective system is its percentage increase in dispensing efficiency by 23%. Robots and pre-packaged doses enabled the staff to prepare fewer medicines so that they could spend more time on clinical responsibilities like consultation on medications and medication safety. This productivity boost was not only able to accelerate the delivery of medication but was also able to coalesce towards a less sluggish workflow by minimizing patient care delays. Faster dispensing times with high safety standards offered by the system can be of great help in the high-volume surgical scenario.

Waste reduction The biggest operational impact was a reduction of drug waste by 37.8 percent. Unit dose system reduced the number of over-ordering and wasted medications by distributing medications with pre-measured single-chemistry doses. This decrease in drug wastage can be understood to mean huge savings to the clinics as fewer drugs are wasted through expiry or surplus. Further, the system promotes environmental sustainability as it will lessen the volume of unwanted or expired drugs, which could have gone to the landfills.

These findings show that units dose dispensing has a potential to alleviate some of the most debilitating problems presented at ambulatory surgical clinics, such as errors in medication administration, inefficiencies in the preparation of medication, and unnecessary amount of pharmaceutical waste. Unit dose dispensing is a useful solution in the ambulatory care unit in terms of the positive effect it has on the operational efficiency, patient safety, and cost-cutting.

7.3 Suggests Scale-up to be Broader and Study to be Further Conducted

Owing to the positive outlook of this research, the clinical application of unit dose dispensing should be widely adopted in other healthcare systems in ambulatory surgical clinics. The fact that medication safety has improved, the workflow efficiency increased, and the level of waste reduced is more than strong evidence that this system should become a common practice in the outpatient surgical settings. Since the two clinics involved in this study were successful, the possible expansion of the unit dose dispensing to other clinics may achieve the same positive effects, which may help to raise the quality of patient care and decrease the costs of operations in a wider selection of facilities.

Nevertheless, the outcomes are encouraging, but additional studies should be conducted to determine the scalability of unit dose dispensing systems in the process of ambulatory surgical care. It is possible that future research would be done to find answers to the following:

Long-term results: Review the effect of unit dose dispensing on the long-term medication security, efficacy, and wastage on a bigger scale with constant post-assessment to see improvement or changes needed.

Cost-effectiveness: a detailed cost-benefit analysis to determine the long-term financial implication of the unit dose system implementation in various ambulatory surgery facilities with a further discussion of the infrastructure cost and savings that go down the road.

Transfer to different ambulatory care systems: Exploring the potential of the further implementation of the unit dose dispensing in the other systems of ambulatory cares, like primary care clinic or specialty clinic, to determine its flexibility and the generalizability.

Patient satisfaction: To obtain an understanding of the impacts of the unit dose dispensing system on the experiences of the patients, especially on adherence, contentment with the delivery of the medication, and general care quality, surveys or focus groups should be conducted.

To sum up, unit dose dispensing is a great step forward in the ambulatory care pharmacy practice which demonstrates measurable results in terms of the medication safety, efficiency of operations and financial management. The fact that this study was successful means that there has been plenty of evidence to back up its further implementation and motivates other studies to apply the findings of this study in other clinics and health care facilities to scale up this practice in a larger population.

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Conflicts of interest

The authors have no conflicts of interest to declare

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