Articles

A study of discrepancies in the Meditrol™ system

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INTRODUCTION

Interest in automated dispensing devices is currently at a high level. Factors driving the development of automated dispensing systems include the search for ways to reduce medication errors, the need to control costs and the desire to minimize pharmacists' involvement in dispensing, allowing them time to pursue clinical practice.[1–5] Many of these new technologies and devices may appear to be error-free systems, but there is growing evidence of problems.[6–8] The purpose of this study was to determine the reliability and accuracy of the Meditrol™ automated medication dispensing system.

Meditrol cabinets, used to store medications on nursing units, have a capacity of 80 or 160 spiral medication sleeves. Sleeves are metal coils set in three-sided plastic trays which can store 6–32 doses, depending on the size of the coils. The cabinets and sleeves are made to store a large variety of dosage forms, including tablets, capsules, ampoules, vials, suppositories, transdermal patches, oral syringes and nebules. Each sleeve stores one strength and dosage form of medication.

The automated dispensing process begins when a pharmacist reviews and enters medical orders from any one of the system's computer terminals. Thirty minutes before scheduled medications are due to be administered, a message appears on the nursing unit terminal, and the nurse is given one hour to draw the medication. If a medication has not been issued within this time, the computer prints a "forgot" slip as a reminder, and the nurse is given a second hour to complete the task.

The nurse authorized to administer medication to a patient signs on to a Meditrol terminal using an identification number and a confidential password. When the nurse requests and receives the medication, Meditrol records all details of the transaction, including the dose, number of units in each dose, the time and the identity of the nurse. Medication administered to the patient is then documented manually by the nurse on a computer-generated medication administration record.

The pharmacy sends in a "baggie" medications not in the cabinet at the time an order is entered or medications that do not fit in the cabinet. Baggies are labelled containers carrying up to a 24-hour supply of an ordered medication for a specific patient. Baggies dispensed in the pharmacy are put on shelves in the pharmacy night cupboard to be picked up by the nurses. The hospital does not have a centralized portering system. The nurses then store the baggies in medication carts which have drawers divided into individual slots labelled with patients' room and bed numbers.

EVALUATION OF DISCREPANCIES

We evaluated the Meditrol cabinet on one medical nursing unit at the Misericordia Hospital from July 25–August 25, 1995 to determine the discrepancies between the actual number of medications in the cabinet and the number recorded in the system.

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Each weekday, excluding weekends, we undertook a physical count of every sleeve in the cabinet and all baggies in the medication carts at 1300h. The physical count was then compared with the balance in the computer system. Any discrepancy was noted and corrected by adjusting the computer balance to match the actual physical count. This process identified the period in which the discrepancy occurred.

When a discrepancy was noted, various computer-generated reports (App. A) were analyzed and the nurses, pharmacists and pharmacy technicians involved were consulted to determine the source of the discrepancy.[9] The discrepancies were grouped under one of three classifications:

- errors originating from delivery of medication (e.g. extra medications in a sleeve because the technician placed two doses in one slot)
- errors originating from nurses' failure to follow procedures
- errors originating from pharmacists' failure to follow procedures.

We also performed further tests of the system to verify some of the initial findings.

Filling process test: To determine if the discrepancies in the cabinet were due to the misfilling of the sleeves, all the tablets in the sleeves in the pharmacy sleeve room were counted on one day.

Dispensing process tests: It had been noted that nurses obtaining medication from the dispensing cabinets often hit the keys on the computer keyboard more often than was necessary, especially when they were in a hurry. It was postulated that this was a factor in interrupting the delivery of medications from the cabinet and that it resulted in discrepancies. Using a test cabinet, medications were dispensed with the cabinet doors open so errors could be observed. We used both the "drawing routines" and the "medication without pharmacy entry, menu item 5" functions to test the dispensing of:

- single package dose for one patient
- multiple package dose (multiple packages for one dose) for one patient
- multiple single package doses for the same patient
- multiple medications with multiple package doses.

As doses were drawn from the cabinet, we hit the keys on the keyboard at different times and recorded the observations and computer balances for each trial.

Because we suspected that some dosage forms were particularly vulnerable to discrepancies due to their bulky sizes and shapes, we tested this suspicion. After conducting the tests, we evaluated drug master sleeve file maintenance (DSFM) parameters that affect the dispensing of each medication. Medications placed in the sleeves were adjusted to meet the specifications provided by the DSFM and tested again. Observations were recorded again.

RESULTS

During the 31-day study period, 11,962 doses were dispensed, yielding an average of approximately 386 doses per day. The total number of discrepancies was 74. The mean of discrepancies per day was 2.39, with a standard deviation of 2.14, a range of 0–9, and a mode of 2. The rate of discrepancy was 0.62%. Overall accuracy of the dispensing system was 99.4%.

Over the 31-day period of the study, we recorded 38 cabinet discrepancies, an average of 1.23/day. Extra medications in the sleeves accounted for 34% of these discrepancies. Medications missing from the sleeves accounted for 13%; in 53% of discrepancies the medications were found on the floor of the cabinet.

Of the 20 medications found on the floor of the cabinet, we identified the causes of 4 discrepancies. Two instances were due to the medication hanging on the edge of the sleeves without dropping into the elevator to be dispensed. One instance resulted from an error that a pharmacy technician made in entering an incorrect quantity into the computer during restocking. The other instance was due to an error made by a pharmacy technician who took the wrong sleeve out of the cabinet during restocking. The rest of these discrepancies were believed to result from problems with the sleeves and interruptions during the dispensing process caused when nurses hit the keyboard inappropriately.

The average number of discrepancies in the baggie was 1.16/day, a total of 36 discrepancies. Delivery problems were responsible for 39% of the baggie discrepancies. Nurses' failure to follow procedures accounted for 56% of baggie discrepancies; 6% were due to errors originating from pharmacists' procedures. Table I highlights the types of error in each class of discrepancy.

Table I — Causes of discrepancies in baggied medications

Delivery problems
- Baggies not picked up from pharmacy shelves
- Baggies picked up but nurses could not find them on the nursing unit

Errors originating from nurses' failure to follow procedure
- Nurse gave wrong dose
- Nurse failed to return medications to pharmacy
- Nurse gave dose from baggie without documenting it in the computer, and baggie dose therefore not decremented from the system. Subsequent doses from the cabinet could not be accessed until all baggie doses were decremented.
- Nurse did not give medication after dispensing it from Meditrol
- Nurse borrowed medication for a patient from a baggie of another patient who was on the same medication

Errors originating from pharmacists' failure to follow procedure
- Pharmacists did not send initial medication when order was entered
- Pharmacists sent extra medication

Filling process test

During the physical count of the filled sleeves in the pharmacy storage room, three sleeves out of the 1295 were found to have discrepancies. One sleeve carried 6 bottles instead of the required 3, another sleeve had 2 slots that carried 2 tablets in each slot, and the third sleeve had 1 empty slot.

Dispensing process tests

We found that hitting keys on the keyboard for a single package dose after the dispensing process had begun stops the elevator from moving further to pick up the requested medication. The elevator instead returns to the top of the cabinet with nothing to dispense.

The same interruption happened when this test was performed for multiple dose dispensing. However, after opening and closing the lid of the cabinet as if to retrieve the medications, the elevator recycles, goes down and picks up only 1 package of the drug. We also observed that the remaining packages not dispensed the first time were sometimes dispensed with the next patient's medications.

For multiple medication dispensing, if the keyboard was hit inappropriately after the elevator picked up the first medication and before it picked up the second medication, the second medication was not dispensed. For multiple medications with multiple package doses, only 1 package of each multiple dose of medication was picked up by the elevator.

The computer still decremented the requested quantity of each medication in all cases, even though the system dispensed only partial doses or nothing at all.

The way in which the medication is placed in the sleeve is critical, especially with bulky dosage forms. There were position problems when vials of medication such as potassium chloride injection (10 mmol/20 ml) or cefuroxime injection in a 1.5 g vial were placed in the sleeve leaning to the right. When these medications were adjusted to an upright position as indicated in the DSFM program, they were dispensed with no difficulty. There were problems in dispensing erythromycin 500 mg injection if the vial was placed up-side down. When it was in an upright position, it was dispensed with no problem.

Some unit dose packages had been observed to slip under the coil into the next slot immediately behind when the coil of the sleeve turned. As a result, they were not dispensed on the initial turn of the coil. However, sometimes two medications were dispensed on the next turn. Acetaminophen 325 mg tablets, ranitidine 150 mg tablets (due to the size of the unit dose packaging) and glycerin adult suppositories were subject to this slipping problem.

DISCUSSION

Based on the opinions of nurse administrators, Robinson predicted that the Meditrol system would eliminate all errors except those in which doses were administered to the wrong patient or by the wrong route.[10] In our study, however, we identified other technical and procedural errors that could occur in the system. The discrepancy rate of 0.62% in this study included pharmacy dispensing errors, delivery problems, mechanical problems and nursing

procedural errors. It compares favourably to Klein's[9] total pharmacy fill error rate of 0.65% with a Baxter ATC-212™ and Ray's[10] pharmacy fill error rate of 0.61% with Pyxis™ cabinets.

As a result of this study, we made the following recommendation to improve the reliability of the system and eliminate potential errors.

- Educate nurses about proper procedures for dispensing, and emphasize the importance of not hitting any keys on the keyboard unnecessarily.
- Adjust all coils in sleeves to ensure proper dispensing. To adjust them, stretch the metal coils so medications are pushed completed out into the elevator tray on dispensing.
- Prepare a list of medications for which dispensing is affected by their position or positioning in the sleeves, and indicate the proper position or positioning within the coils so pharmacy technicians can consult the list to fill sleeves correctly.
- Consider whether there are better ways to fill sleeves with transdermal patches and suppositories.
- Continue to emphasize the need for pharmacy technicians to double-check all steps when filling sleeves, during restocking and when exchanging sleeves in the cabinet.
- Address the need for routine delivery of the baggies to the nursing unit so medications are there when required.
- Emphasize the need for nurses to follow the procedure of putting baggied medications into the correct patient's slot in medication carts after the baggied medications have been picked up or delivered so they are there when needed.
- Re-educate nurses regarding the proper procedures for documenting baggie medications given to patients as well as those returned through the Meditrol system.
- Re-educate pharmacists to take into account when entering medication orders the time required for delivering baggied doses to the nursing unit so the initial dose is not due before the dose can arrive.
- Remind pharmacists to be more careful and to avoid sending the wrong initial quantity of medications.

In summary, this study documented mechanical and system problems that led to discrepancies in the medication count. Many of these problems have been rectified, but they illustrate the need for vigilance in detecting system malfunction and for rigourous staff training. The tendency to rely on the system is natural, but it is wise to test system reliability. Ongoing research into the accuracy and reliability of new systems is needed.

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Appendix A — Computer-generated reports used in this analysis

- Drug usage report (DUR): A report of the total usage of specified medications in a specified period of time.
- MPD #5 report: A usage report of the medications without pharmacy order entry (MPD #5) function. The report lists nurses by name, the medication, date and time issued, nursing unit, patient name, quantity of packages issued and prescription number.
- Medication administration record (MAR): A printed record of the patient's medication regime for a 24-hour period, used for charting the administration of medications.
- Drug inventory trace report (DITR): A report that traces specified medications in a specified time period. It gives the date and time of the inventory movement in or out of specific cabinets.
- Restock station inventory report: A report printed when a cabinet is restocked. It lists all medications returned and reissued by nurses and all medications put into or taken from the cabinet every day. It gives the name of medications, and nurses' and patients' names.

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