REPORT

INTRODUCTION TO MEDICATION ERRORS AND THE ERROR PREVENTION INITIATIVES IN A TEACHING HOSPITAL IN WESTERN NEPAL

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ABSTRACT

Pharmacotherapy is a complex process and involves interaction of the patient and the healthcare professionals at various levels. Prevention of medication errors is important however, errors may occur even in a carefully monitored healthcare setup. The out comes of the errors may range from mild inconvenience to the patient to even fatal toxic reactions. There are several predisposing factors for the occurrence of errors starting from improper drug selection to errors in administration technique by the healthcare providers' and patients. Several methods can be employed to detect the occurrence of errors. At the Manipal Teaching Hospital, Pokhara, Nepal, the Department of Hospital and Clinical Pharmacy has taken the initiative in identifying the error prone situations and has taken remedial measures including educational and managerial interventions to minimize the occurrence of errors.

Keywords: Manipal teaching hospital, medication error, error prevention strategies.

INTRODUCTION

Drug treatment in the hospital setting requires a series of actions to be performed correctly by several members of the healthcare team, such as the physician, the unit clerk, the hospital pharmacist and the nurse. Errors are possible at any step of the process from medication selection and ordering to drug formulation drug dispensing and to drug administration. Similarly, in the ambulatory settings the patients, the ultimate users of drugs can also make errors at any stage of medicine use. Many times, medication error, adverse drug events (ADEs) and adverse drug reactions (ADRs) are confused with each other. The distinction between these terminologies is crucial. The Institute of Medicine defines an ADE as an injury resulting from medical intervention related to a drug which can be attributable to preventable and non-preventable causes (Bates *et al*., 1995). Of these, adverse reactions include those that are unpredictable such as idiosyncratic or allergic responses and those that are predictable such as adverse effects or toxic effects related to inherent pharmacological properties of the drug. In contrast to non-preventable ADRs, medication errors are preventable and occur as a result of human mistakes or system flaws (Bates *et al*., 1995). An allergic reaction to a medication can be an adverse reaction if there is no history of patient allergy and yet can be a medication error if the patient had history of allergy, but that medical information was not available or not consulted or overlooked (NCCMERP).

Definition of medication error

Medication error can be defined in many ways. In general, it may be defined as a deviation from the physicians' medication order as written on the patients chart (Barker *et al*., 1966). National Coordinating Council for Medication Error Reporting and Prevention (NCCMERP) defined medication error as "any preventable event that may cause or lead to inappropriate use or patient harm while the medication is in the control of the health care professional, patient or consumers (Institute of Medicine, 2000)."

Incidence and economic impact of medication errors

Medical errors have become a major issue among healthcare consumers in recent years. The 1999 Institute of Medicine report "To Error is Human: Building a safer health system" states that 44,000 to 98,000 hospitalized Americans die each year from medical errors (Institute of Medicine 2000). This landmark report galvanized professional, political and social forces into action. For adults, the reported incidence of errors in treatment with medication ranges from 1-30% of all hospitalized admissions (Raschke, 1998) or 5% of orders written (NCCMERP). In pediatrics, however, this number has been reported as high as 1 in 6.4 orders (Marino *et al*., 2000). Also there is a significantly increased rate of medication error resulting in harm or death in pediatric patients (Crowley *et al*., 2001). Drug errors associated with

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morbidity and mortality increased inpatient healthcare cost by an estimated $ 4700 per hospital admission or approximately $2.8 million annually for a 700-bedded teaching hospital (Bates *et al*., 1995). The economic burden for all areas of healthcare from drug misadventures exceeds $100 billion annually in the United States (US) (Schumock, 2000). The data regarding the incidence and economic impact of medication errors is lacking in developing world.

Classification of medication errors

Medication errors can be classified in many ways. Some of the methods of classifying medication errors are listed below.

1. Based on the onset

Medication errors can be classified as active or latent based on the onset. Active errors have an effect that is immediate, like being hit by oncoming traffic after running a red-light. Latent errors on the other hand, have delayed effects (Jackson and Reines, 2003). These errors are identifiable and can be corrected before it recurs. For example if the pharmacist misread the prescription because it was poorly written, one strategy to prevent the recurrence of this type of error is to analyze future prescriptions more carefully and verify the medication with the prescriber when there is doubt. In general most of the medication errors are considered as latent.

2. Based on the underlying cause (Allan and Barker, 1990)

Based on their cause medication errors can be classified as follows.

Omission error: This error takes place when a patient has not received his or her medication by the time the next dose is due. Example: Missing dose of insulin.

A wrong dose error: This type of error occurs when the patient receives an amount of medicine that is greater than or less than the amount ordered. Example: Suboptimal dose of antibiotics leading to resistance

An unordered error: This error occurs when a patient receives a medication for which the physician did not write an order. Example: Receiving insulin meant for some other patient leading to hypoglycemia/death

Wrong dosage form error: It involves the administration of a drug in a dosage form different from the one that was ordered. Example: Giving a drug by intravenous route when oral was ordered.

A wrong time error: It occurs when the patient does not receive his/her medication within a predefined interval. For example giving drugs carbidopa+ levodopa combination in Parkinson's disease inappropriately

Wrong route error: They occur when the correct dosage form is administered, but in the incorrect site on the patient's body. Example: Per rectal preparation given orally.

Deteriorated drug error: It is reported when the physical or chemical integrity of a medication dosage form has been compromised, as with expired drugs or intravenous medications requiring refrigeration that are stored at room temperature. Example: Insulin stored in freezer instead of storing it at 2-8 degrees.

Wrong rate of administration errors: These errors can occur with infusions of intravenous fluids or liquid enteral fluids. Example: Dopamine and dobutamine infusion given at wrong rate

Wrong administration technique errors: It involves the use of an inappropriate procedure during administration of a drug. Example giving intramuscular iron injection Z technique.

A wrong dose preparation error: It occurs when a product is incorrectly made or manipulated before administration. Example: Giving phenytoin in dextrose solution

An extra dose error: It occurs when the patient receives one or more dosage units in addition to those authorized, such as the dose administered after the dose was cancelled. Example: Continuing gentamicin after detection of renal failure

3. Based on the medication error index (Hartwig *et al* 1991):

Medication errors may also be classified based on their error index. This method helps in classifying medication errors based on the outcomes. The NCERP has classified the medication errors based on the medication error index. The medication error categorization index in listed in table 1.

4. Based on the severity (Lustig, 2000)**:** Based on their severity medication errors may be classified as A, B and C. The details are listed in Table 2.

Causes of medication errors

Medication errors can occur at many points in a highly complex process, involving many personss and decision points, from prescribing and ordering through administration and monitoring. Most medication errors occur as a result of multiple, compounding events rather than from a single individual. Medication errors invariably represent the collapse of a faulty system, not a faulty human being. The top 10 causes of medication errors identified by the United States Pharmacopoeia (USP) are performance deficit, procedure or protocol not followed, miscommunication, inaccurate or omitted transcription, improper documentation, drug distribution system error,

knowledge deficit, calculation error, computer entry error and lack of system safeguards (Crowley *et al*, 2001). The Institute of Safe Medicine Practices (ISMP) identifies the following areas as potential causes of medication error (Reason, 1990). Failed communication: Hand writing and oral communication, drugs with similar names, missing or misplaced zero and decimal points, use of non-standard abbreviations, poor drug distribution practices, complex or poorly designed technology, access to drugs by non-pharmacy personnel, work place environmental problem that lead to increased job stress, dose miscalculations, lack of patient information, lack of patient understanding of their therapy.

Table 1: Medication error categorization index

Error category	Result
Category A	Circumstances or events that have the capacity to cause error
Category B	An error occurred, but the medication did not reach the patient
Category C	An error occurred that reached the patient but did not cause patient harm
Category D	An error occurred that resulted in the need for increased patient monitoring, but no patient harm
Category E	An error occurred that resulted in the need for treatment or intervention and caused temporary patient harm
Category F	An error occurred that resulted in initial or prolonged hospitalization and caused temporary patient harm
Category G	An error occurred that resulted in permanent patient harm
Category H	An error occurred that resulted in near-death event
Category I	An error occurred that resulted in patient death

Studies on medication errors worldwide

A study from UK determined the frequency and types of dispensing errors identified both at the final check stage and outside of a UK hospital pharmacy, to explore the reasons why they occurred, and to make recommendations for their prevention. One or more dispensing errors were identified at the final check stage in 2.1% of 4849 dispensed items, and outside of the pharmacy department in 0.02% of 194,584 items. The majority of those identified at the final check stage involved slips in picking products, or mistakes in making assumptions about the products concerned. The study concluded that dispensing errors occur in about 2% of all dispensed items (Beso *et al*, 2005). Another study from UK determined the incidence and type of medication errors in a large UK pediatric hospital over a five year period. The study found that medication errors occurred in 0.15% of admissions (195 errors; one per 662 admissions). While the highest rate occurred in neonatal intensive care (0.98%), most errors occurred in medical wards. Nurses were responsible for most reported errors (59%). Errors involving the intravenous route were commonest (56%), with antibiotics being the most frequent drug involved (44%). Fifteen (8%) involved a tenfold medication error. Although 18 (9.2%) required active patient intervention, 96% of errors were classified as minor at the time of reporting. Forty eight per cent of parents were not told an error had occurred. (Ross LM *et al*, 2000).

A study from Israel recorded prospectively the frequency of medication order errors in a general hospital in Israel with the objective of assessing the impact of pharmacist intervention in preventing potential harm. Principal types of errors detected were incorrect dosage (27.5%), interactions between drugs (20%), incorrect drug (12.5%), route (11.2%) and frequency (11.2%). Medication error rate by degree of severity was calculated per 100 patient days. The highest rate was found in Hemato-Oncology (2.48 %), followed by Intensive Care (0.82), Surgery (0.48) and Internal Medicine (0.26). Anti-infectives were the most frequently implicated (38.7%) followed by total parenteral nutrition preparations (21.8%), antineoplastics (15.6%) and anticoagulants (11.3%). Changes in medication orders due to pharmacists' intervention only occurred in 73.8% of error cases, most referring to dosage or route change (37.5%) (Lustig, 2000).

A study from Thailand determined the incidence and type of medication errors, severity of events, patient outcomes and categories of drugs involved in the largest pediatric hospital

Table 2: Classification of medication errors based on the severity

Degree of severity	Definition	Examples
A	Potentially serious error that can cause permanent harm to patient, may increase hospitalization or need of additional treatment	Overdose of potasium chloride in total parenteral nutrition, order of doxorubicin instead of daunorubicin
B	Clinically significant error can increase need for patient monitoring	Tazobactam 4 gm twice daily to an obese septic patient
C	Clinically non-significant error that does not harm the patient	Pantoprazole IV to a patient who can swallow

in Thailand over a fifteen-month-period. The study found that medication errors occurred in 1 per cent of admissions (322 errors in 32,105 admissions). The most common error type was prescription error (35.40%). The majority of errors were detected and prevented before the drugs were administered (76.71%). (Sangtawesin *et al,* 2003)

A study from America reported the analysis of a 9-year experience with a systematic program of detecting, recording, and evaluating medication-prescribing errors in a teaching hospital. A total of 11,186 confirmed medication-prescribing errors with potential for adverse patient consequences were detected and averted during the study period. The annual number of errors detected increased from 522 in the index year 1987 to 2115 in 1995. The rate of errors occurring per order written, per admission, and per patient-day, all increased significantly during the study duration ($P < .001$). Increased error rates were correlated with the number of admissions ($P < .001$). Antimicrobials, cardiovascular agents, gastrointestinal agents, and narcotics were the most common medication classes involved in errors. The most common type of errors were dosing errors, prescribing medications to which the patient was allergic, and prescribing inappropriate dosage forms (Lesar , 1997).

A systematic literature review using several databases was conducted to investigate the incidence and nature of dosing errors in children; 16 studies were found to be relevant. Eleven of the 16 studies found that dosing errors are the most common type of medication error, three of the remaining studies found it to be the second most common type. This review of published research on medication errors therefore suggests that dosing errors are probably the most common type of error in the pediatric population (Wong *et al*., 2004).

Methods to detect medication error (Allan & Barker, 1990)
In order to prevent the further occurrence of medication errors, it is essential to detect them. Often it is difficult to detect medication errors as it is unnoticed in most of the cases. Several methods are employed to detect the occurrence of medication errors. Some of them are discussed below.

Anonymous self reports: This lets the person committing the error (or witnessing one) report the mistake without being associated with it. The main advantage of this method is its low cost. However, the obvious limitation is that one cannot report the error unless they realize the error.

Incident reports: The term incident report is used to designate the official written legal report of a medication error as documented by hospital staff.

Critical incident technique: This event-sampling technique involves in-depth analysis of a large number of individual errors to identify common causal factors. This method can involve either the direct observation of subjects or interviewing people who have committed the error.

Disguised-observation technique: In this technique, an observer accompanies the person giving the medications and witnesses the administration of each dose. The observer writes down exactly what the subject does while when administering drugs and notes consumption of the medication by the patient.

Dispensing error detection techniques: Several methods are employed to study the errors that occurred before the medication is prepared for administration to the patient, such as pharmacy dispensing errors. Some of them includes participant observer technique, critical incident method etc.

Prevention of medication errors
Healthcare professionals need to develop and maintain an ongoing process that uncovers potential risk while promoting ways to eradicate vulnerability to error. In order to accomplish these tasks, the system needs to provide resources to monitor and evaluate errors and to implement methods to reduce them. This process is referred to as a system approach to medication error reduction (Jackson and Reines, 2003). A system is defined as "an interdependent group of items, people, or process with a common purpose (Leape, 1995)." Some system approaches are relatively inexpensive and easily implemented such as the pharmacy computer system. The ISMP suggest a number of error prevention tools ranging from forcing functions to independent double check systems (Allan and Barker, 1990). These include software programs with forcing functions that require the entry of additional pertinent patient information before the order is completed and the medication is dispensed. These programs also trigger other alerts such as look alike and sound alike medications. A number of agencies like United States Food and Drug Administration (US FDA), ISMP and USP keep track of medication errors and publish guidelines to avoid medication errors.

Predisposing factors for medication errors: experience from Manipal Teaching Hospital
The Manipal Teaching Hospital (MTH) is a 550 bedded multidisciplinary tertiary care teaching hospital located in Pokhara city, Western Nepal. The hospital has an average out patient of 500 per day and an average bed occupancy of 250 patients. The department of Pharmacy at MTH often faces several problems associated with the occurrence of medication errors. The errors occur at various levels; prescribing, billing the medicines, picking the medicines from the shelves, dispensing medicines and the use by the patients. Some of the common causes of errors occurring in the MTH pharmacy are discussed below.

Table 3: Look alike and sound alike preparations available in the MTH pharmacy

1	Isosorbid-5-mononitrate	Isosorbide-5-dinitrate
2	Inac (Diclofenac)	Imax (Iron preparation)
3	Imol (Ibuprofen+Paracetamol)	Cemol (Paracetamol)
4	Betamethasone	Beclomethasone
5	Fluoxetin	Fluvoxamine
6	Amox (Amoxicillin)	Diamox (Acetazolamide)
7	Amoxy-Clav(Amoxicillin+Clavulanic acid)	Damoxy (Amoxicillin)
8	Anti thyrox (Carbimazole)	Atarax (Hydroxycine)
9	Perimox (Amoxicillin)	Periclox (Cloxacillin)
10	Algina (Paracetamol)	Pyzina (Pyrazinamide)
11	Tranchlor (Chlorpromazine)	Triquilar (Levonorgetrel+Diethylstilbosterol)
12	Fluvoxin (Flovoxamine)	Flucloxacin
13	Lobet (Labetolol)	Lobate (Clobetasol)
14	Laxil (Lactulose)	Lasix (Frusemide)
15	Cephadroxyl	Cefalexin
16	Imol (Paracetamol)	Inac (Diclofenac)
17	Perimox(Amoxicillin)	Periclox (Cloxacillin)
18	Damoxy (Amoxicillin)	Diamox (Acetazolamide)
19	Novoclox (Cloxacillin)	Novomox (Amoxicillin)
20	Transostat (Tranexamic acid)	Tranchlor (Chlorpromazine)
21	Taxim (Cefotaxime)	Taxim-o (Cefixime)
22	Zosert (Sertaline)	Zosta (Simvastatin)

Table 4: Commonly used abbreviations prone to cause errors

S.No.	Abbreviations	Intended meaning	Interpreted as	Outcome
1	Mcg	Micrograms	Milligrams	Over dose
2	Tab.CTZ	Tab. Cetrizine	Tab. Chlorpromazine	Wrong drug
3	H_2O_2	Hydrogen peroxide	Water for injection	Wrong drug
4	Inj. NTG	Inj.Nitroglycerin	Inj.Nitrofurantoin	Wrong drug
5	Tab. AZT	Tab.Zidovudine	Tab.Azathiprine	Wrong drug
6	Tab. CPZ	Tab.Chlorpromazine	Tab.Cetrizine	Wrong drug
7	Inj. NTZ	Inj.Nitroglycerin	Inj.Nitrazepam	Wrong drug

1. Look alike and sound alike preparations

One of the commonest causes of errors are due to sound alike and look alike preparations. Some of the sound alike preparations available in the MTH pharmacy are listed in table 3.

2. Use of abbreviations

Use of abbreviations is associated with medication errors. In many cases, the pharmacist interprets the abbreviations in a different way and may contribute to errors. Table 4 shows some of the common abbreviations observed in the prescriptions of MTH that are prone to cause medication errors.

3. Medication packaging

Pharmaceutical companies adopt several strategies to avoid medication errors. One of the strategies is to differentiate the different preparations by making the packs in different colors. However in some cases, the packing of different preparations look similar. This can contribute to errors while picking the medicines by the pharmacist and obviously leading to dispensing errors. Figure1 shows the packing of Tab. Metformin 500 Mg and Tab. Ciprofloxacin 500 Mg by the same manufacturer having the similar appearance.

Fig. 1: Packing of tab. metformin 500 Mg and tab. ciprofloxacin 500 Mg having similar appearance.

Fig. 2: Tab. Amitryptiline 25 Mg and Tab. Imipramine 25 Mg having similar appearance.

Figure 2 shows one strip each of Tab. Amitryptiline 25 Mg and Tab. Imipramine 25 Mg having similar appearance manufactured by the same pharmaceutical company.

Fig. 3: Cap. Nubex forte and Cap. Proxyvon having similar appearance.

Figure 3 shows one strip each of Cap. Nubex forte (Multivitamin) and Cap. Proxyvon (Paracetamol +Dextropropoxyphene) having similar appearance manufactured by the same pharmaceutical company.

Fig. 4: Insulin syringes 40 Units per ml and 100 units per ml having similar appearance with different colors.

4. Administration devices

Errors may also occur due to improper selection of administration devices. One of the common causes of errors due to administration devices is improper selection of insulin syringes. There are reports of wrong selection of insulin syringes leading to errors. However, these syringes have different colors on their cap which are used as identification marks.

Medication error prevention initiatives in MTH

In the recent past, several steps have been taken in MTH in order to minimize medication error. Some of the strategies are discussed below.

1. Drug Information

The hospital runs a Drug Information Center (DIC) that provides drug information to the healthcare providers of the hospital as well as in the Western region of Nepal. The drug information request forms are placed in the wards and the out-patient departments. Queries can sent to the DIC by filling these forms, through telephone and by personal contact with the DIC personnel. Based on the queries, the answers are provided by referring high standard references. The DIC is a member of the Drug Information Network of Nepal (DINoN) for the Western region of Nepal. The center is equipped with various authentic drug information sources including the Micromedex database. Providing drug related information helps the clinicians to prescribe the drugs as per the indications at appropriate dose and help them to individualize the drug regimen.

2. Medication counseling

MTH also runs a Medication Counseling Center (MCC) located adjacent to the out-patient pharmacy of the hospital. The center provides counseling to the patients as per the Omnibus Budget Reconciliation Act of 1990 (OBRA 90) recommendations (OBRA 1990, 1990). The various points counseled are the name and description of the medication, the dosage form, route of administration, duration of therapy, special directions and precautions for preparation, administration and use by the patient, common side effects or adverse effects or interactions and therapeutic contraindications that may be encountered, including their avoidance, and the action required if they occur. Techniques of self monitoring of drug therapy, proper storage, prescription refill information, action to be taken in case of missed dose are also detailed. Counseling is provided mainly to the patients with chronic diseases and patients using specialized dosage forms like metered dose inhalers. Providing counseling to the patients on drug related issues help the patients to understand their medications in a better way and may reduce the occurrence of medication errors.

3. Continuing pharmacy education (CPE) programs

It is well established that improper knowledge of pharmacist can be a cause for medication errors. The DIC at MTH has taken initiatives to provide education program for the working pharmacists. To begin with the pharmacists were detailed about the various counseling points regarding diabetes. During the sessions they were explained regarding the various aspects of diabetes management. They were also explained the possibilities of errors due to confusion between insulin preparations, insulin syringes etc.

4. Triplet billing system

The Pharmacy of MTH follows a triplet billing system. As per the system, three computer bills are made for every prescription. Each bill is checked by three pharmacists before dispensing. Thus the possibility of dispensing error is minimized.

5. Batch dispensing

Dispensing of medicines is done as per the batch number of the preparations. According to this system, before dispensing the medicines, the batch number in the bill is checked with the preparations. This may prevent the possibility of occurrence of Medication errors while dispensing by providing a double check.

6. Telephonic queries to the prescribers

The Pharmacy is provided with telephone facility linked with all the wards and the out-patient departments. Many times this enables the pharmacist to contact the prescriber and hence is beneficial in reducing the occurrence of errors. Most of the telephonic calls from the pharmacy to the prescribers are related to illegible hand writing.

7. Envelope system for drug dispensing

One of the better means of reducing medication errors is to provide compliance aids so as to increase patient understanding of their medication and their safe and appropriate use. The pharmacy department follows an envelope system. This allows the pharmacist to write the details of the patients medication with the instructions. This helps the patients understand their medication in a better way and hence the possibility of error by the patient is minimized. The envelope system used in MTH is shown in fig. 5.

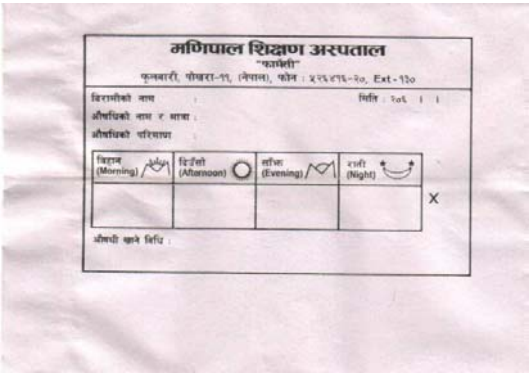

Fig. 5: Envelope used in to dispense medications.

8. Computer billing

The pharmacy of MTH uses the computer system of billing. Computer billing creates printed bills that are legible. This enables the pharmacist to read the bills along with the prescription and thus the possibility of error may be reduced.

9. Separation of inpatient from outpatients

The department has opened a new pharmacy unit (inpatient pharmacy) near the inpatient wards so as to dispense the medication for hospitalized patients. This reduced the patient load in the out- patient pharmacy. Reducing the patient load gives more time to the pharmacist and thus may help in reducing the occurrence of errors.

10. Dispensing with prescription only

The pharmacy dispense the medicines only if it is written in the prescription format of the hospital. The prescription has the space for patient name, age, sex and other ancillary details. This improves the legibility of the prescription and can be a useful tool in reducing the occurrence of medication errors.

11. Dispensing by qualified pharmacist

The pharmacy department of MTH appoints only qualified pharmacists. Hence the possibilities of errors are less. In order to be a dispensing pharmacist, one should have the minimum requirements set by the Nepal Pharmacy Council and the Department of Drug Administration (DDA), Kathmandu.

12. Arrangement of medicines

Improper arrangement of medicines in the pharmacy is known to be one of the causative factors for dispensing errors. In the MTH pharmacy the drugs are arranged as per the therapeutic category. This allows the pharmacist to pick the correct medicines and thus helps in minimizing errors.

Future plans

The MCC of MTH plans to use pictorials while counseling the patients. The hospital is also in the process of making a hospital formulary which may help to minimize the occurrence of medication errors by helping the prescribers to individualize the dosage regimen.

CONCLUSION

The economic impact, human sufferings and the quality of life outcomes due to medication errors is significant. An effective medication error program should address the basic cause of medication errors and should also strive to educate the healthcare members involved in the healthcare chain. We have started an initiative to minimize and prevent medication errors at MTH. Though errors are unavoidable, a systematic approach may help prevent the further occurrence of similar type of errors in the future. It is better to check our errors ourselves rather than have someone else pointing out the same. Continuing education program for pharmacists, nurses, doctors and patients will be of definite importance in reducing the occurrence of medication errors. A combined approach of regulatory, managerial and educational interventions may be an ideal way to minimize the occurrence of medication errors.

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