



## Medication Errors and Reducing Interventions: A Mixed Study in a Teaching Hospital

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### ABSTRACT

**Background:** Given the special importance of preventing from medication, the present study aimed to investigate the determining Causes of Medication Errors (CMEs) and their Priorities for reducing interventions in a hospital.

**Methods:** The present mixed, sequential and cross-sectional study was conducted in a teaching hospital (2016). For data collection, Fishbone Diagrams, interviews, note taking and checklists were used, and qualitative data were analyzed through the thematic approach. Moreover, the Maxqda Software v.14.0, Excel, Edraw Max v.9.0 were employed for data analysis and reporting.

**Results:** Seventy-five CMEs were classified under two main themes (human and non-human) and four sub-themes (personal, network, organizational, and meta-organizational). Weakness of professionalism and low experience as the personal causes; Actions of pharmacy colleagues, physicians and other nurses as the network causes; Management of nurses and unit specialty as the organizational causes and the quality of academic education, drug features and macro policies of medication as meta-organizational causes were classified. Six causes were given priority for reducing interventions.

**Conclusion:** In the short term, human factors should be considered with the aim of reducing medication errors. It is also recommended that teaching how to deal with nurses' stress and psychological pressure (especially beginner nurse), resulting from critically ill patients and high workload, be paid special attention. Besides, it is suggested that professionalism be given priority to reduce personal neglects and to create safe environments for reporting personal neglects. In addition, more emphasis should be placed on the right route in the process of medication administration.

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### Introduction

Across the world, medical errors (ME) are one of the most important challenges that threatens patients' safety; and medication errors, as one of the five main categories of medical errors, have accounted for 7.14-14.5% of the total annual mortalities resulting from medical errors in the United

States (1). As another example, it is estimated that 55,000 medication errors occur in Iran each year, thereby leading to 10,500 deaths and 23,000 physical disabilities (2).

Medication errors, as an indicator for patients' safety in hospitals (3, 4) may occur at any stage of the prescription process, but studies have shown that the administration of

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drug orders in hospitals is the most susceptible link (last link) in the prescription chain for mistakes and errors (5). This link is an important part of patients' care and treatment process and is one of the main components of nursing performance (6), to which 40% of nurses' working hours is allocated (7). In the process of administering medication, this time is spent to provide the right medications for the right patients with the right dose at the right time using the right methods as well as assessment and protection of their adverse effects, modification of the procedure in the event of adverse effects, proper recording and training on how to prescribe the right medications (8).

In various studies, the causes of errors have been reported differently, including poor communication between nurses and doctors (9), lack of compliance with drug protocols, poor medication calculations (10), nurses' lack of pharmacological knowledge (11), mistakes in the transfer of prescriptions to the patient's Kardexes (9, 12), long working hours, and individual negligence (13). Researchers also believe that, in general, the human factors have more effects on medication errors and damages to patients compared to management, systems and environmental factors (10).

Whatever the cause of nursing medication errors might be, in addition to the damages that patients are faced with, these errors can lead to numerous problems, such as unsuccessful treatment, incomplete treatment, lengthy stay and high hospitalization costs (14). Furthermore, the medication errors will bring about distrust of patients towards the health system (15), spoiling the nursing profession, reducing the quality of nursing care (1, 16) and legal problems for nurses (17). That is why there should be some interventions to reduce repercussions. However, the dispersion of the causes of errors and their dependence on environment (10) can make it difficult to intervene since interventions require plans in which there are complex interpersonal, contextual and topical interactions along with organizational constraints, existing resources, management and leadership history, and many other factors. In other words, it should be kept in mind that two organizations are never exactly the same (18), and their interventions require special arrangements.

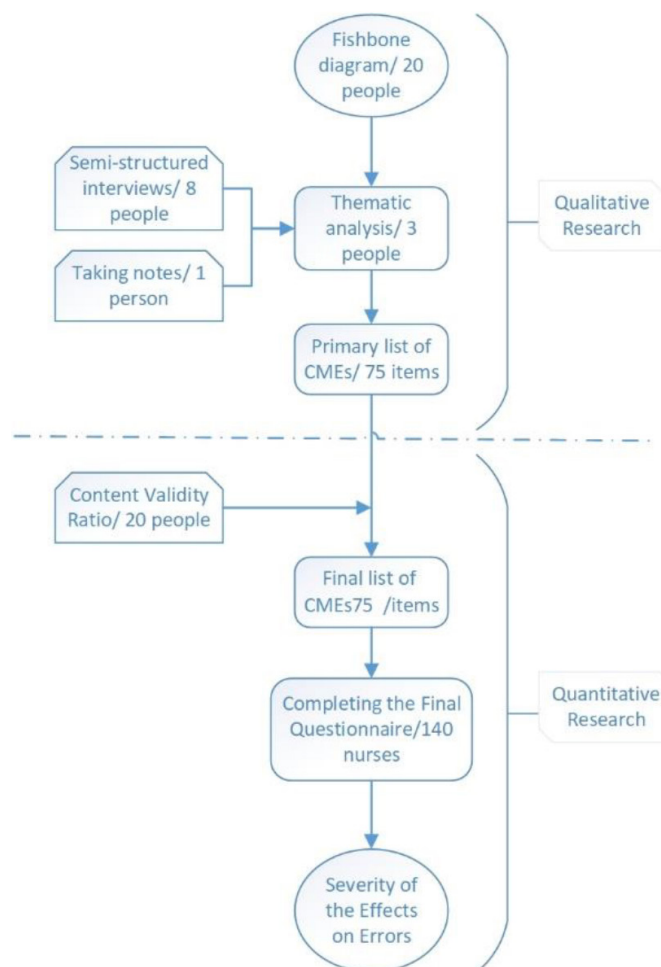
Given the significance of patients' safety and prevention of damages from medication errors from the nursing perspective, the present study aimed to investigate the determining priorities and status of medication errors for reducing interventions in a teaching hospital.

## Methods

The present mixed (qualitative-quantitative), sequential and cross-sectional study was conducted in a teaching hospital in 2016. The research team was comprised of five people with different backgrounds: E.M. psychiatric subspecialist and Hospital Chief Executive Officer; A. S. general practitioner and hospital manager with 6 years of work experience in hospitals; S.S. BS, health care management and responsible for improving the quality of the hospital with 5 years of work experience in hospital;

M.L. MA of nursing with 21 years of work experience; A.R. MA of nursing with 22 years of work experience; and G.S. MA of health care management and PhD student in health policy.

The overview of conducting the present research is presented in Figure 1.



**Figure 1.** The Steps of Conducting a Sequential Qualitative-Quantitative Research

The purpose of this section is to determine the causes of medication errors. Considering the fit between the experience of individuals and the questions of the research, the existence of the characteristics of a good informant (19), and the abundance of data from each sample (20), twenty supervisors and head nurses and eight nurses working in the teaching hospital affiliated to Tehran University of Medical Sciences participated in the present study (21). The inclusion criteria were at least four years of work experience in the special (Emergency Department, Intensive care unit and Cardiac Care Unit) and non-special units of the hospital (See Table 1).

**Table 1.** The Characteristics of Participants in the Qualitative and Quantitative Research.

| Job        | Number | Gender |        | Work Experience <sup>#</sup> |      | Education |           | Activity                         |               | Data collection tool <sup>*</sup> |
|------------|--------|--------|--------|------------------------------|------|-----------|-----------|----------------------------------|---------------|-----------------------------------|
|            |        | Male   | Female | Min.                         | Max. | B.A./BSc. | M.A./MSc. | Special care units <sup>**</sup> | General units |                                   |
| Head nurse | 13     | 2      | 11     | 10                           | 28   | 13        | -         | 2                                | 11            | 1                                 |
| Supervisor | 7      | 1      | 6      | 4                            | 29   | -         | 7         | -                                | -             | 1                                 |
| Nurse      | 8      | 2      | 6      | 4                            | 12   | 8         | -         | 2                                | 6             | 2                                 |

\* 1: Fishbone Diagram; 2: Semi-structured interview

# Years

\*\* Emergency Department, Intensive care unit and Cardiac Care Unit

The fishbone diagram was used as one of the useful and user-friendly tools for determining and categorizing qualitative and multi-factor issues among head nurses and supervisors (22, 23). The hospital's supervisors and head nurses (20 people) independently were asked to write the possible medication errors in the hospital, within one week (21).

After analyzing the data from fishbone diagrams, a series of interviews was conducted with the nurses in order to ensure that the data were saturated. The interview questions were asked from the nurses and recorded. The data collection continued until data saturation (eight people), and the primary list of CMEs was finally created. In addition, to enhance the cross-validation of the data, the field notes, collected separately by one of the researchers (M.L.) during the study, also were analyzed.

Qualitative data were analyzed through the thematic approach. The application of this method is very common in health-related studies (24). Therefore, to analyze CMEs, the first attempt was made to form the fish bone charts, but due to the large divergence of the views of the participants, the data categorization was changed. Finally, having been notified of the existence of numerous frameworks and rankings in the field of medication errors (25) and given the goal of the present study (describing the causes of errors for reducing interventions), the causes of errors were classified into two human and non-human groups.

According to Ritchie and Lewis (2003), the thematic analysis can be implemented in three phases (26):

- Data Management: familiarization with data (reading and re-reading) helps identify themes/categories. Moreover, data can be reduced and better managed through creating a coding matrix and assigning data to existing themes and categories.
- Descriptive Accounts: In the next step, summarizing and combining the wide range of encoded data occurs through refining the primary themes and categories. It should be noted that detecting the relationship between themes to create a "whole image of the phenomenon" leads to further summarization and description of the data.
- Explanatory Accounts: For the explanatory phase of

data analysis, it is necessary to formulate collections/patterns in concepts and themes. At this stage, reflection on the main data and analytical steps to ensure accurate reporting of the participants and to reduce the likelihood of misrepresentation leads to the interpretation/discovery of meaning and explanation of the real concepts and themes, and ultimately a wider range of concepts and themes should be sought in the environment (26, 27).

The credibility of the present study and acceptance of results were contributed through some factors, including prolonged engagement in data (spending enough time to collect and analyze data), using multiple data collection methods, interviews, observations and notes, reviewing by participants in the study, reviewing data by the hospital safety officer, and peer reviews (28).

Data analysis was carried out by G.S., S.S. and M.L. After summarizing, the data were given to the safety officer of the hospital (nursing BS) and other researchers to receive their supplementary comments. The Maxqda Software Version 14.0, Excel, Edraw max Version 9.0, were employed for data analysis and reporting.

The goal of the first stage of the quantitative section was to determine the participants' agreement on the necessary MEC for intervention. To quantify the agreement of experts, the Lawshe Formula (1975) was used (see Formula 1). According to this formula, if the number of positive responses and the number of participants are such that the agreement score is higher than a certain limit, it shows that at least 50% of the respondents agree on a problem. This limit depends on the number of participants, and at least 0.42 was set for 20 participants in this study (29). An agreement score higher than this minimum limit would mean more agreement among participants on the item in question.

The hospital's supervisors and head nurses (20 people) were asked: "What do you think of CMEs for intervention? Then, they were given three answers to choose from: 3: it is essential. 2: useful but not necessary. 1: not necessary." To determine the agreement score, the number of "necessary" answers in Formula 1 was regarded as positive responses. The result of this phase was the shortened list of CMEs, but necessary for intervention.

|                  |  |
|------------------|--|
| <b>Formula 1</b> | $\text{Agreement score} = \frac{\text{number of positive answers} - \frac{\text{total number of participant}}{2}}{\frac{\text{total number of participant}}{2}}$ |
|------------------|--|

In the second stage of the quantitative section, this checklist was distributed at the beginning of the month among all clinical nurses (140 people) to obtain their comments and complete the events of the past month. Then, they were asked to report the severity of the effects of each of the causes in medication errors on a Likert scale (1=the lowest effects to 5=the highest effects).

The Scatter Plot was used to combine the two group of practitioners' views: "necessity for intervention" and "Causes effects on the incidence of errors". For this purpose, a threshold point of 0.6 was set as the first item, and 60% of the total score was regarded as the score of the second. The errors that took both of these indicators were identified as priority errors.

The ethical approvals of the study were obtained from both Tehran University of Medical Sciences and the Clinical Research Office of the Hospital, and informed consent was obtained from all participants before the study began.

## Results

### 3.1 Qualitative Findings

At this stage, the list of medication errors includes 75 factors was extracted. Then, considering the objective of the study, the causes of errors were classified under two main themes (human and non-human) and four sub-themes (personal, network, organizational, and meta-organizational).

#### 3.1.1 Causes of Human Errors: Individual

This group of causes refers to factors that are related to the final nurse in the consumption cycle of drugs. In this field, two issues (themes) may cause medication errors: disabling characteristics and professionalism.

These factors are factors beyond the control of nurses. Insufficient experience and potential physical weakness can be the cause of errors.

**Inadequate Experience:** The low-experienced nurses with/without supervision of supervisors fall in this category. This issue becomes even more acute when the hospital sometimes has to recruit these people in special units. "New inexperienced personnel may have lots of errors of which they are/are not aware", Nurse # 1 said.

**Physical disorders:** Some physical disorders, such as visual impairment, may be the cause of increasing errors. "Because I am long-sighted, I sometimes have difficulty reading the small black instructions on brown ampoules. So, I have to check the instructions three to four times. I think I would need a magnifier to read the instructions", Nurse # 2 said.

#### B. Professionalism:

Professionalism means the accountability and commitment of nurses to the proper management of patient safety (30) and professional weaknesses is one of CMEs. These factors can be greatly addressed by nurses if they wish.

Forgetting or not following the proper use of the drug up with further attention are indications of this issue. "Oral

medicines may not be given to children by their mothers. For example, the child is asleep at six a.m., and the mother says I will give him/her the medicine as soon as he/she wakes up. At 8:00 a.m., I still see that the drug has not been taken", Nurse # 2 said.

The lack of precision in reading medication instructions and labels during administering drugs has been described as follows. "Nurses fail to read the drug labels or just see the color of the drug", Nurse # 3 said. This negligence has also been reported in reading the physician's instructions or other drug-related documentation.

Sometimes nurses refuse to use the necessary equipment for taking medication. "Nurses sometimes fail to use the required equipment, such as syringe pumps, infusion, and trolleys, etc., and drugs are sometimes administered regardless of the patient or drug's identity", Nurse # 3 said. For example, the dose, time, type, and name of the drug are not paid sufficient attention (8Rights).

Along with this issue, the nurses' inadequate drug information is also a reason that might have resulted from his/her educational system. In addition to collegiate education, periodic and up-to-date nursing training can be one of the factors that affect the type and number of errors of a nurse. "My information about drugs is low and we do not know much about drugs and require to be retrained", Nurse # 4 said. This may also be due to two factors. It may be due to the lack of sufficient or up-to-date on-the-job training by hospitals, or it may result from nurses' unwillingness to training and observing standards and policies (low professionalism). "They do not care about learning when they are trained. They ask questions again and again, and I do not receive any feedback", Nurse # 5 said.

Nurse #8 also describes the failure to comply with the defined guidelines and standards. "Now, if you check the medical records, 80 to 90 percent of the high-risk drugs have two stamps, but I have no idea whether they have been checked by two personnel or not. Re-checking prevents medication errors if done according to policies".

#### 3.1.2 Causes of Human Errors: Network

Medication errors may occur at any stage in the medication use chain. The multiplicity of human factors is one of the most important factors in this respect. "Every morning, one staff is in charge of checking the injectable drugs because pharmacy staff may make mistakes and even nurses who receive drugs or put drugs into boxes may make mistakes. Human errors may even happen in the rechecking phase", Nurse #5 said.

Among the cited causes, the groundwork for a nurse's mistake in the patient's bedside is laid by other colleagues in the drug supply chain. In the present study, three groups of these colleagues were considered: colleagues of pharmacy staff, doctors and nurses.

Pharmacy colleagues lay the groundwork for errors by the final nurse through sending the requested medication by mistake. "For example, we ask for Methylprednisolone 250 mg, and the pharmacy sends us Methylprednisolone

500 mg instead, thereby leading to making mistakes by nurses”, Nurse #2 said.

The question that might be raised here is that why the nurse does not recheck the medications. It seems that rechecking takes a lot of time, and as noted above, there are human errors in the following checks. In addition, crowds and high workload also contribute to this issue along with fatigue due to working long hours. “Large crowds of patients, long working hours and subsequent shifts may cause medication errors”, Nurse #1 said.

In addition, cutting medicine in the pharmacy to send the requested number of drugs to the unit and distortion of the instructions on labels lead to errors made by nurses in the unit.

In the case of doctor’s colleagues, failure of communication between doctors and nurses can lead to errors apart from the quality of personal communication between nurses and doctors, one of the sources of failure is the existence of idioms and unclear words used between them. “Another problem is the term ‘cocktail.’ Each doctor has his/her own definition of this term. For example, the term may refer to the combination of Haloperidol and Bipyridine, or it may refer to the combination of Aluminium MG and Lidocaine 3 cc, thereby confusing the nurses in this respect”, Nurse #5 said.

The existence of similar terminologies but with different meanings between hospitals and different treatment centers is one of the main CMEs. “There is Ondansetron 4 mg and 8 mg, and its dose is not written. On the other hand, doctors tell nurses to give patients the routine dose, which is not obvious which dose they are implying, thereby causing problems for Beginner nurse”, Nurse #5 said. In this case, the medication errors are not necessarily due to the physician or nurse’s lack of experience because an experienced but *Beginner* person may make these errors in the hospital/unit.

Another major reason that may lead to the failure of the relationship between doctors and nurses is the illegible handwriting or inadequate information on the prescription (name, dose, time, mode of administration). “Doctors write one or two initial letters, and the rest is completed by a continuous line, and the name of the medicine is not written completely. For example, Ranitidine IV is written without giving any information about its dose or its type (ampoule or tablet) or how to use it”, Nurse #5 said.

Other nurse colleagues also help the final nurse to some extent to manage drugs. For instance, arranging the patients’ kardexes and medications on the drug shelves are among the most important contributions. The complete registration of the drug features and patient’s identity are two important aspects in arranging kardexes. Additionally, the wrong arrangement of drugs leads to mistakes by the final nurse who uses the drugs.

### 3.1.3 Non-human Causes: Organizational

According to the findings of the present study, the specialty of the unit/hospital and the management of nurses are two sub-themes of this group.

### Specialty of the Unit/Hospital

The participants’ remarks indicated that the type and number of medication errors were affected by the specialty of the unit/hospital. In addition, the requirements and conditions of patients in specific units determine the process of administering drugs, the type of medication, medical equipment, and the required nursing skills. By increasing the complexity and sensitivity of patient care, each of these factors becomes particularly complicated, thereby leading to more medication errors. The units in charge of taking care of elderly people with multiple underlying illnesses are similar to special units.

In addition, according to respondents, many medication errors, especially in non-special units, are less likely to be detected due to lack of acute errors. “In non-special units, where medications are not very specialized, in the case of administering wrong drugs, it is not noticed and there will not be any particular problems”, Nurse # 2 said.

During taking care of acute patients in special units, the number of visits and consultations will increase, and consequently there will be more changes in prescriptions, thereby increasing the likelihood of errors in the drug process. “Different counseling and different prescriptions by various physicians and many changes in the type of medicine and dose would result in major errors”, Nurse # 6 said. In addition, in these units, nurses with less skill and experience would have more stress and occupational pressures in the face of acute patients.

The specialty of units affects the type of equipment and facilities available in the department. For example, pump syringes and infusion pumps are required in special units to adjust the droplets with a suitable dose. Moreover, two scenarios can be discussed about equipment. First, there should be good equipment and facilities in the unit, and secondly nurses should be aware of the way and the need for using them.

Medical kardexes, mainly in the form of cards or sheets, are filled in special units and need to be rewritten, thereby leading to increasing the likelihood of errors. “Despite the comprehensiveness of medical kardexes, their space is not very much, and they should be rewritten after two days, and something may be ignored or not written properly while rechecking”, Nurse # 4 said.

Furthermore, recording by mistake or failure to record all done for the patient and the lack of a proper assessment and monitoring system can further worsen all of the said issues. “Failure to provide feedback on the factors leading to a rise in errors is another reason”, Nurse # 6 said. According to the interviewees, these issues are less important in non-special units.

### B. Management of Nurses

In the present study, management of nurses was defined in two dimensions: the quality and quantity of nursing personnel and the provision of facilities for their activities. As for the former, management policies towards exploitation without supervision of people with low experience, especially in special units, and determining the

number of nurses in relation to patients can be considered. *"The number of nurses in relation to patients is low. For example, personnel only work in haste at emergency units at peak hours, thereby confusing drugs or their doses with others"*, Nurse # 5 said.

As for the latter, the availability of adequate and safe equipment, proper processes and standards, and essential and up-to-date training are essential for nurses with the aim of hampering unwanted errors. *"If we have computer equipment and the doses are set in the first place ... for example, adjusting 100 cc of insulin per hour is hard to be done by hand"*, Nurse # 5 said.

The commentary of researchers about the remarks made by some departmental officials saying, 'when drugs are put into syringes, place labels on them,' is that there are no coherent and defined processes to perform an activity in all units. Therefore, appropriate experiences are not appropriately shared by nurses, and each nurse and department individually apply their experiences, thereby weakening interpersonal and interdepartmental communication.

However, the quantity and quality of nursing education inside and outside hospitals are questionable. *"We do a lot of redundant excessive training and ignore the necessary training. For me, as a CCU-nurse, pharmacology education is required either permanently or periodically. Moreover, we only search something when we face it"*, Nurse # 4 said. In addition, many new drugs are listed in the pharmacopoeia of the country and doctors tend to use new medications, but nurses do not have information about these new drugs.

In the end, it should be expressed that after the preparation of essential factors for drug management (adequate equipment and processes/standards, etc.), it is more important to encourage nurses to use them correctly (raising commitment and professionalism).

#### 3.1.4 Non-human causes: extra-Organizational

In this group, there are two sub-themes of drug features and upstream policies in the drug management. Moreover, two categories of factors beyond the scope of the authority of hospital officials are included for reducing interventions.

##### Quality of Academic Nursing Education

Given the responses of participants, the issues relating to the quality of academic education are first raised. *"College education has some problems. Take for example, they work at clinics, while they are not very skilled. Therefore, they can't safely handle patients even after six months of the first year"*, Nurse # 5 said.

##### B. Drug Features

The wide variety of drugs, along with their similar appearance, is a known problem in the field of medication errors. In the second place, the issues relating to how drugs can be used, such as dilution, can lead to mistakes. *"For example, eight milligrams should be taken from Prednisolone IV 500 mg, but there may be problems at the time of dilution"*, Nurse # 2 said. Diversity in the dosage

of drugs are among the factors that exacerbate medication errors. *"Doctor may not prescribe Azithromycin Syrup 200 or 100 milligrams. Moreover, some syrups, such as Metronidazole, are available in 500 mg and 250 mg. The pharmacy will deliver the wrong drugs and they are careless"*, Nurse # 2 said.

If the shape and dosage of drugs are similar, even sufficient experience cannot prevent more of errors during stressful and challenging periods. On the other hand, one's greater experience is equal to reducing the person's physical strength and vision. *"After 20 years of working, it's hard for me to read the instructions on ampoules, especially where there is Cardiopulmonary resuscitation, it is so difficult to read the instructions on ampoules one by one. In my view, if they have a different look, it is much better"*, Nurse # 5 said.

##### C. Macro Policies towards Medication

The countries' policies to provide generic and non-generic drugs in hospitals also contribute to medication errors. *"Previously, the drugs were all generic, and it was clear to which category and generation they belonged. Moreover, we were aware of the complications of drugs, but now we do not know what is going on"*, Nurse # 6 said.

*"Atropine and Adrenaline should be next to each other in terms of trolley code. Both are brown with a black line and both are one cc"*, Nurse # 5 said. In this experience, it is sometimes seen that national guides and protocols are the cause of nursing errors. *"State and manufacturer's protocols contribute to our errors"*, Nurse # 5 said.

Sometimes the combination of several wrong approaches in the drug management process may lead to much more serious mistakes. *"For instance, the type of verbal communication between the nurse and the doctor may also lead to medication errors. For example, the doctor says, 'give the patient five Diazepams, and an apprentice nurse with five months of work experience might have injected the patient with 50 mg of Diazepam instead of five mg. In other words, the nurse was about to inject the patient with 10 times of the demanded dose"*, Nurse # 7 said. In cases like this error, i.e. the combination of lack of verbal communication between the doctor and the nurse in conjunction with hiring inexperienced nurses in stressful and intensive care units while experienced nurses are not around will endanger the lives of patients for sure.

##### 3.2 Quantitative Findings

Based on the agreement of head nurses in the hospital, 35 reasons were identified for intervention. Three cases (causes 5, 23, and 26) were also included in the final list at the request of researchers. Moreover, the severity of the effects of each of the factors on causing medication errors from the perspective of nurses is also shown in Table 2. Considering the threshold point of 0.6 and 60 percent for the criteria of the necessity for interventions and the severity of the effects on the incidence of medication errors, the position of each of the causes is shown in Figure 1.

**Table 2.** The Score of CMEs Based on the Necessity of Interventions and the Severity of the Effects of Each of the Causes.

| Row | Cause of Errors  | Score of the Necessity of Intervention | Score of the Severity of Effects |
|-----|--|--|----------------------------------|
| 1   | Lack of enough staff in relation to the number of patients in the nursing area   | 0.89                                   | 0.82                             |
| 2   | Stress and psychological pressures from the crowds in the nursing area   | 0.47                                   | 0.77                             |
| 3   | Nurses' long and unconventional working shifts   | 0.47                                   | 0.72                             |
| 4   | Stress and psychological pressures from critically ill patients under the supervision of nurses  | 0.67                                   | 0.70                             |
| 5   | Night shifts of nurses   | 0.11                                   | 0.67                             |
| 6   | Forgetting drug injections by nurses   | 0.47                                   | 0.65                             |
| 7   | Inaccuracies in recording medication route in patient's Kardex in the nursing area   | 0.79                                   | 0.64                             |
| 8   | Illegible/ imperfect prescriptions written by doctors in terms of the time of administering drugs  | 0.47                                   | 0.64                             |
| 9   | Lack of control over how the drugs are administered by nurses  | 0.79                                   | 0.62                             |
| 10  | Illegible prescriptions written by doctors in terms of the route of administering drugs  | 0.68                                   | 0.62                             |
| 11  | Administering wrong injection by nurses  | 0.79                                   | 0.61                             |
| 12  | Inexperienced nurses' activities in special units (Emergency Department, Intensive care unit and Cardiac Care Unit)  | 0.47                                   | 0.60                             |
| 13  | Arranging similar medications next to each other in the nursing area   | 0.89                                   | 0.56                             |
| 14  | Nurses' ignorance of the side effects of medications they handle.  | 0.47                                   | 0.55                             |
| 15  | Using incorrect solvents of medications by nurses  | 0.89                                   | 0.54                             |
| 16  | The inability of the nurse to read the doctor's instructions   | 0.58                                   | 0.52                             |
| 17  | The similarity of drugs that nurses handle   | 0.68                                   | 0.52                             |
| 18  | The nurses' ignorance of the formulas used for calculating the concentration of drugs that they handle.  | 0.78                                   | 0.51                             |
| 19  | Inappropriate drug labels and incomplete name spelling due to cutting the drug packets   | 0.47                                   | 0.51                             |
| 20  | Improper use of solvent volumes of medications by nurses   | 0.89                                   | 0.50                             |
| 21  | Nurses' lack of basic information about the drugs they handle.   | 0.58                                   | 0.50                             |
| 22  | Nurses' failure to observe the intervals and hours when the drugs should be administered according to the physician's prescription   | 0.47                                   | 0.50                             |
| 23  | Lack of drug preparation on the patient's bedside  | 0.05                                   | 0.49                             |
| 24  | Lack of sufficient attention to checking the dose of medications for double check at the time of administering them  | 0.89                                   | 0.49                             |
| 25  | Carrying out various consultations and different prescriptions from different doctors in terms of the dose of drugs that should be administered to patients under the supervision of nurses  | 0.47                                   | 0.49                             |
| 26  | Lack of or no use of pharmaceutical equipment such as pump and infusion syringes   | 0.37                                   | 0.48                             |
| 27  | Illegible prescriptions written by doctors in terms of the dose of drugs   | 0.68                                   | 0.48                             |
| 28  | Nurses' failure to check the dose of medication at the time of administering them  | 0.89                                   | 0.48                             |
| 29  | The incorrect calculation of the concentration of medications by the nurse   | 0.89                                   | 0.48                             |
| 30  | Lack of attention to recording the names of medicines in patient's Kardex in the nursing area  | 0.79                                   | 0.48                             |
| 31  | Carrying out various consultations and different prescriptions from different doctors in terms of the kinds of drugs that should be administered to patients under the supervision of nurses | 0.47                                   | 0.48                             |
| 32  | Lack of sufficient attention to recording the patients' information in their Kardexes in the nursing area  | 0.47                                   | 0.48                             |
| 33  | Nurses' failure to correctly identify the patient's identity while administering drugs   | 0.89                                   | 0.47                             |
| 34  | Lack of sufficient attention to recording the time of administering drugs in patient's Kardex in the nursing area  | 0.68                                   | 0.47                             |
| 35  | The nurses' ignorance of the solvent volumes of medicines they handle  | 0.89                                   | 0.47                             |
| 36  | Lack of attention to recording the dose of medicines in patient's Kardex in the nursing area   | 0.79                                   | 0.47                             |
| 37  | Nurses' lack of check over the names of medicines at the time of administering them  | 0.89                                   | 0.45                             |
| 38  | Illegible prescriptions written by doctors in terms of spelling the names of drugs   | 0.68                                   | 0.44                             |

According to Chart 1, the six most important factors suggested for intervention were CMR1: the lack of enough staff in relation to the number of patients; CMR4: stress and psychological pressure from patients; CMR7: inaccuracies in recording “medication route” in patient’s Kardexes;

CMR9: Lack of control over how the nurse should take medicine (medication route); CMR10: illegible/imperfect prescription written by doctors about “medication route” and CMR11: administering wrong injection methods by nurses.

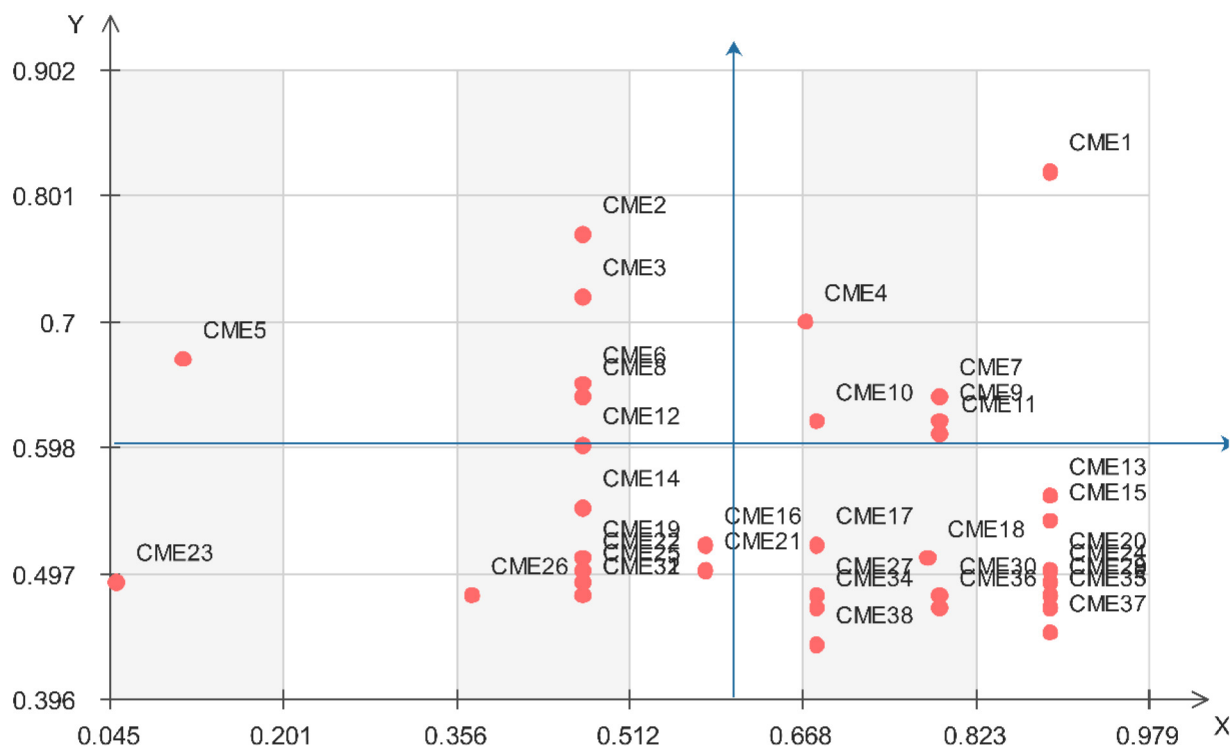


Chart 1. The Status of CMEs Based on the Two Criteria of Necessity of Interventions (Y) and Severity of the Effects on Errors

**Discussion**

The present study aimed to investigate the determining factors, priorities and status of medication errors for reducing interventions in a teaching hospital. In the present study, the errors in the process of drug management were classified under human and non-human factors.

The results of the present study were consistent with those presented in the systematic review of Keers et al. (25), in which it was shown that there was no complete overlap between the reported errors, thereby strengthening the idea of the dependence of CMEs on environment (10). The findings of the present study have also pointed to some new aspects. For example, multiple visits by physicians and changes in prescriptions given to patients was identified as one of CMEs. To further explicate the matter in some examples, let’s suppose patients are given various and sometimes contradictory prescriptions even during one day, and sometimes the intervals between these changes are so short that nurses do not find time to inform and execute them. The patient’s complicated clinical condition (due to acute illness or old age), inconsistencies between doctors and the teaching feature of the hospital

can increase the number of visits. In addition, the defaced instructions on drug packets by other colleagues can also increase the incidence of errors.

The non-human CMEs are mainly due to systematic factors and interstitial inconsistencies inside and outside hospitals. For example, the errors caused by naming and similar forms of medicine in Iran are affected by the way in which this process is managed at macro levels (31). Besides, the development and implementation of clinical guidelines in Iran is also a novel topic, and its strengthening requires scientific and practical cooperation in the country and departments (32).

Human factors (individual and network) have been introduced in two groups of intentional and unintentional errors (33). According to the present study, it is difficult to detect intentional or unintentional errors. However, consistent with the results of other studies (30), intentional errors are thought to be rooted in lack of professionalism among nurses, whereas unintentional errors are thought to be due to lack of necessary training and easy-to-use facilities such as clinical guides. In some studies, the lack of professionalism, known as personal neglect, has ranked first in the incidence of errors (34). Although



few studies have been carried out on professionalism of nurses in Iran, there is evidence of the low inclination of nurses to undergo periodic training (1, 11), which is itself influenced by individual characteristics and organizational structure and atmosphere (35), thereby making it a sign of nurses' low professionalism and commitment to improve patient care.

As other studies have shown (36), the above-mentioned set of factors indicate that medication errors are individual and organizational issues that are also beyond issues occurring in departments, thereby requiring long-term interventions in each of the four groups of causes. However, for short-term interventions, the priority of interventions should be determined based on the existing context.

The quantitative findings of this study indicated that lack of enough staff in relation to the number of patients, stress and psychological pressure from patients, inaccuracies in recording medication in patient's Kardex, and Lack of control over how the nurse should take medicine (medication route) were found as the main CMEs.

The results of conducted studies have shown the inappropriateness of the proportion of nurses to patients in other hospitals affiliated to this university (TUMS) (37) and other hospitals based in Tehran (38), and this study has shown one of the effects of this deficiency. The shortage of staff and the resultant long working hours, known as 'heavy workload,' has been identified as the second leading cause of errors in studies conducted in other countries (34). It should be noted that the inadequacy of this index leads to burnout and nurses' dissatisfaction (39), thereby affecting the quality and quantity of health care (40).

High stress and mental pressures in the care of acute patients are highly influenced by medication errors. For instance, the results of a study conducted by Tang et al. (34), 'taking care of critically patients' (complex prescriptions) was ranked the sixth leading cause of errors, and in a study conducted by Wang et al. (41), it was shown that the probability of errors in special units exceeded that in other units (41). Not to mention, the issue of continuous changes was added to complex prescriptions, which is likely to be witnessed more in educational hospitals. That is why studies argue that taking care of patients in special units requires more skilled and qualified staff (42).

In the present study, the route in the administering medications was identified as the most important factor. According to six rights, one of the main causes that can lead to medication errors in nurses is the route of administering medications (43, 44). The findings of the present study, along with confirming this issue, indicate that to reduce the error caused by the non-observance of each of the rights, the route in the administering medications should be properly and fully documented by the doctors and recorded correctly in the patient's Kardex and properly executed by nurses.

To cope with CMEs in the short term, human factors are suggested to be considered by hospital authorities. In the first stage, it is highly recommended that nurses, especially newcomers, be trained in coping with heavy workload and the pressures and psychological stresses caused by patients. In addition, to alleviate the major CMEs, the second recommendation is to strengthen professionalism and commitment towards reducing personal neglects and creating safe environments for reporting personal neglects. Moreover, among the six or eight rights of medication management, all factors involved in 'route medications' should be considered.

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