

# Medication Errors and Their Relationship with Care Complexity and Work Dynamics

Zahra Sabzi<sup>1</sup>, Reza Mohammadi<sup>2</sup>, Razieh Talebi<sup>3\*</sup>, Gholam Reza Roshandel<sup>2</sup>

<sup>1</sup>Nursing Research Center, Golestan University of Medical Sciences, Gorgan, Iran; <sup>2</sup>Sayyad Medical and Educational Center, Golestan University of Medical Sciences, Gorgan, Iran; <sup>3</sup>Nursing Research Center, Golestan University of Medical Sciences, Gorgan, Iran; <sup>4</sup>Golestan Research Center of Gastroenterology and Hepatology, Golestan University of Medical Sciences, Gorgan, Iran

## Abstract

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**\*Correspondence:** Razieh Talebi. Nursing Research Center, Golestan University of Medical Sciences, Gorgan, Iran. E-mail: [talebi.gr@gmail.com](mailto:talebi.gr@gmail.com)

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**BACKGROUND:** Medication errors are currently known as the most common medical errors. Research shows that work environment and organisation management, in addition to the role of nurses, contribute to the occurrence of an error.

**AIM:** Therefore, the present study was conducted to determine the rate of nurses' medication errors and its relation to the care complexity and work dynamics in the Taleghani Pediatric Hospital of Gorgan in 2017.

**MATERIAL AND METHODS:** This was a descriptive-correlational and cross-sectional study. Sampling was done through census method (N = 100). The data collection tools consisted of four questionnaires of demographic information, Salyer work dynamics, Medication Administration Errors, and Velasquez Nursing Care Complexity. Data were analysed in SPSS V.16 software using descriptive and inferential statistical methods including independent t-test and Pearson's correlation.

**RESULTS:** Medication calculation errors, wrong dose and wrong medication were the most common non-injectable medication errors, respectively. Drug incompatibility, wrong infusion rate and medication calculation errors were the most common injectable medication errors, respectively. There was a positive correlation between medication calculation errors (P = 0.02, r = 0.23), wrong solvent (P = 0.04, r = 0.21), and drug incompatibility (P = 0.01, r = 0.25) with amount of work dynamics. Also, there was a positive correlation between medication calculation errors (P = 0.03, r = 0.22) and wrong medication (P = 0.00, r = 0.31) with the nursing care complexity.

**CONCLUSION:** Regarding the irrefutable impact of working conditions on the occurrence of errors, it appears that the study and complete recognition of nurses' working conditions and their adjustment would lead to a reduction in medication errors.

## Introduction

Medication errors are currently known as the most common medical errors [1]. The US National Coordinating Council for Medication Error Reporting and Prevention (NCC MERP) defines medication errors as follows: "A medication error is any preventable event that may cause or lead to inappropriate medication use or patient harm while the medication is in the control of the healthcare professional, patient, or consumer"[2]. Studies show that medication errors occur three times more frequently in admitted children than adults, and most of these errors are harmful [3]. Because of the wide variation in body mass, children need a unique

dosage calculation based on their weight, body surface, age, and clinical status, which increases the risk of medication errors [4]. Reports from the National Patient Safety Agency (NPSA) in the UK found that medication errors that occur during drug treatments include 16% prescription writing errors, 18% prescription preparation errors and 50% medication administration errors. These errors are estimated at 3-37% prescription errors, 5-15% prescription preparation errors and 72-75% medication administration errors for children [5].

In studies on the type of medication errors, the wrong dose was the most common type of medication error in children [6], [7] while using the wrong medication was the most common medication

error in adults [8]. These findings have been approved by studies conducted in Iran [9], [10], [11], [12]. Based on developed modules of medication errors, errors arise from the interaction among several different factors, including the administrative environment (monitoring), leadership and organisational commitment, management policies and procedures, the complexity of tasks, work culture, and physical environment [13], [14], [15]. Recent studies revealed that the wrong medication was the most common error of injectable medications and 51.5% of the errors were related to the work environment [16]. It was also identified that better nursing work conditions lead to a lower frequency of medication errors [17] and providing proper organisational conditions and work environment can help nurses provide high-quality care based on professional standards. Therefore, work environment conditions can facilitate or hinder nursing [18]. Work dynamics and care complexity were considered as work environment factors in preceding studies [13], [15].

Nurses' activity in the hospital environment is physically and psychologically difficult and can lead to burnout, stress, and error. Busy work environments can contribute to stress in employees, which increases the risk of medication errors [14]. On the other hand, effective and safe medication management for children ensures good health and provides social and economic benefits [19]. Therefore, one of the important aspects of effective and safe medication management is the evaluation of medication errors and their properties to identify and implement preventive strategies [20], [21].

Work environment and its variables can vary in different care centers and consequently the amount and type of medication errors can also vary, this study aimed to determine the rate of medication errors of nurses and its relationship with care complexity and work dynamics in Taleghani Pediatric Hospital of Gorgan in order to provide the grounds for understanding the work environment of nurses in pediatric units and to take an effective step toward defining and implementing preventive strategies of medication errors in pediatric units.

## Material and Methods

This study was a descriptive-correlational, cross-sectional survey. The study population consisted of all nurses working in different units of Taleghani Pediatric Hospital (N = 100). Sampling was done through census method, and all nurses who had inclusion criteria participated in the study. The inclusion criteria were: The tendency and consent of nurses to enter the study, employment at the time of the studies, having at least six months of work experience in the pediatric units, having at least a

bachelor's degree, and working in different working shifts. Data were collected by self-report and questionnaires. Data collection tools were a demographic questionnaire (age, sex, educational level, type of employment, work experience, ward, number of working shifts), Salyer Work Dynamics Scale, Velasques Nursing Care Complexity Scale and Medication Administration Error Questionnaire.

The 7-item Salyer's was used to measure the work dynamics of nurses. This tool is scored base on a 6-point Likert scale (strongly disagree to agree strongly) with a total score ranging between 7 and 42. A low score indicates a lack of dynamics and a high score indicates high dynamics. The content, structure and face validity of the scale have been approved in the studies. In Iran, a study by Pazoukian et al. (2014) reported its high reliability (Cronbach's alpha coefficient = 0.81) and stability over time [22]. In the present study, the Cronbach's alpha coefficient was 0.80.

Care complexity scale was used to measure this variable in the nurses' work environment. This scale was developed by Dona Maria Velasques in 2005 and had 15 items scored based on a 4-point Likert scale (never to always) with a total score ranging from 15 to 60. In Iran, Pazoukian et al., (2015) reported its reliability with Cronbach's alpha of 0.61, and its correlation coefficient using test-retest as  $r = 0.88$ , indicating that the scale has acceptable validity and reliability for use in Iran's health system [23]. In the present study, the Cronbach's alpha coefficient for consistency was 0.77.

The Medication Administration Error questionnaire was used to determine the amount and type of medication errors. The first part provides information on the number of medication errors occurring in the past 6 months and the working shift with the highest number of mistakes. The second part of the questionnaire consists of the questions related to the type of medication errors categorized into two groups of non-injectable medication errors (9 items) and injectable medication errors (12 items) scored by the percentage of medication errors (0-25, 25-50, 50-75 and 75-100) with total score ranging between 0 and 100. The content validity and reliability of the scale have been approved in different studies [11], [12]. In the present study, the questionnaire's Cronbach's alpha coefficient was 0.88.

The researchers started collecting data after obtaining the approval of the Ethics Committee of the Golestan University of Medical Sciences (the ethics code of IR.GOUMS.REC.1395.207) and necessary permits, and coordinating with the research setting authorities. After briefing the participants about the research goals and their rights, and answering their questions, written informed consent was obtained from them. The participants were assured that their information would be confidential. Data were analysed in SPSS v. 16 using descriptive and inferential

statistics. That is, nominal qualitative variables were described by frequency distribution and quantitative variables by the mean and standard deviation. Pearson's correlation and student t-test were used to analysing the data, taking into account a significance level of less than 0.05.

## Results

A total of 91 nurses from different parts of the Taleghani Pediatric Hospital were enrolled. Demographic characteristics of the study participants are presented in Table 1.

**Table 1: Frequency distribution of demographic characteristics of the nurses in Taleghani Pediatric Hospital in 2017**

Variable	Classification	Frequency	Percent
Age (years)	< 35	42	48.27
	> 35	45	51.73
Marital status	Single	18	20
	Married	72	80
Educational level	Bachelor's degree	90	98.9
	Master's degree	1	1.1
Employment Status	Permanent (official-permanent contract)		
	Temporary (obliged service, temporary contract, through service companies)	48	53.93
		41	46.07
Working shifts	Fixed	14	16.5
	Rotating	71	83.5

The most common types of medication errors for non-injectable medications were respectively medication calculation errors ( $37.25 \pm 09.37$ ), wrong dose ( $34.22 \pm 89.01$ ), wrong medication ( $30.15 \pm 49.72$ ) and wrong time ( $30.15 \pm 22.59$ ). Furthermore, the most common types of medication errors for injectable medications were respectively drug incompatibility ( $43.29 \pm 41.09$ ), wrong infusion rate ( $43.26 \pm 13.37$ ), medication calculation errors ( $38.25 \pm 46.08$ ), wrong dose ( $38.24 \pm 46.80$ ) and wrong solvent ( $37.24 \pm 91.54$ ) (Table 2).

**Table 2: The mean and standard deviation of types of errors in injectable and non-injectable medication in the Taleghani Pediatric Hospital in 2017**

Non-injectable medication errors	Mean and standard deviation (percent)	Injectable medication errors	Mean and standard deviation (percent)
Wrong administration technique	$27.75 \pm 16.85$	Wrong administration technique	$28.85 \pm 16.21$
Wrong Time	$30.22 \pm 15.59$	Wrong Time	$29.67 \pm 12.86$
Wrong patient	$27.20 \pm 9.60$	Wrong patient	$29.40 \pm 12.68$
Wrong medication	$30.49 \pm 15.72$	Wrong medication	$31.32 \pm 13.74$
Wrong Dose	$34.89 \pm 22.01$	Wrong dose	$38.46 \pm 24.80$
Medication calculation errors	$37.09 \pm 25.37$	Medication calculation errors	$38.46 \pm 25.08$
Administration without a physician's order	$25.27 \pm 4.55$	Administration without a physician's order	$28.02 \pm 15.29$
Administration after a physician's order to discontinue the medication	$29.12 \pm 14.07$	Administration after a physician's order to discontinue the medication	$28.85 \pm 13.90$
Medication administration to a newborn with a known allergy	$28.02 \pm 26.57$	Medication administration to a newborn with a known allergy	$25.55 \pm 6.43$
-	-	Wrong solvent	$37.91 \pm 24.54$
-	-	Wrong infusion rate	$43.13 \pm 26.37$
-	-	Drug incompatibility	$43.41 \pm 29.06$

The results showed no significant relationship between demographic characteristics of study participants and the number and type of medication errors. However, there was a significant correlation between types of shift work (fixed and rotating) and the wrong medication error (non-injectable) ( $P$ -value = 0.009). That is, this error occurred more in the rotating shift schedule.

The mean number of medication errors by nurses during the past six months was less than once (0.84). Furthermore, most nurses (59.68%) reported that most of the medication errors occurred in the morning, evening and morning-evening shifts, respectively, as the administration without a physician's order ( $P$ -value = 0.03) for injectable medications, and wrong dose ( $P$ -value = 0.05) for non-injectable medications had a significant relationship with these working shifts.

The results revealed a relatively high level of work dynamics ( $28.94 \pm 6.24$ ) and the care complexity ( $43.75 \pm 5.004$ ) in the study units.

A positive correlation existed in the relationship between work dynamics and medication calculation errors ( $r = 0.23$ ,  $P = 0.02$ ) wrong solvent ( $r = 0.21$ ,  $P = 0.04$ ) and drug incompatibility ( $r = 0.25$ ,  $P = 0.01$ ). Also, a positive correlation showed in the relationship between care complexity and the medication calculation errors ( $r = 0.22$ ,  $P = 0.03$ ) and wrong medication ( $r = 0.31$ ,  $P = 0.00$ ).

## Discussion

Today, patients' safety is one of the most important goals of health systems and based on that goal, reducing the incidence of adverse events and medical errors has received a lot of attention as it is the most important one.

According to the results of the study, medication calculation errors, wrong dose, wrong medication and wrong time were the most common types of non-injectable medication errors by nurses, respectively. In line with these results, Ramezani et al. also showed that the most common types of non-injectable medication errors in the neonatal unit and NICU were medication calculation errors and wrong dose, respectively [24].

In the present study, drug incompatibility, wrong infusion rate, medication calculation errors, wrong dose, and wrong solvent were the most common types of injectable medication errors by nurses, respectively. Consistent with the results of the present study, several studies reported wrong dose, wrong infusion rate and wrong solvent as the most common injectable medication errors [25], [26], [27].

In the present study revealed that the wrong

medication error (non-injectable) occurred more in the rotating shift schedule. Also, the results of the study showed that the rate of the administration without a physician's order for injectable medications and wrong dose for non-injectable medications significantly increased in the morning, evening and morning-evening working shifts, respectively. In line with these results, Bagheri Nesami et al., reported that the highest non-injectable medication errors (34.5%) occurred at evening shift, (33.1%) at morning shift (32.4%) and night shift [16]. In a study by Mohammadi et al., in Kermanshah teaching centres, most medication errors occurred at morning shift [28]. Unlike the results of the present study, Yousefi et al., showed that the mean number of medication errors was higher at night shift than that of the morning shift, and there was no difference between the morning shift and the rotating shift [29]. Seki et al. did not report significant differences in the occurrence of medication errors between the three working shifts [30]. It appears that the reason for these inconsistent results can be due to different policies in different hospitals about the ratio of nurses to patients, the duration of each shift, the number of personnel in each unit, and how the forces are assigned to each shift concerning background and work experience.

The results of the present study showed that an increase of work dynamics in the study units is accompanied by an increase in the number of medication calculation errors, wrong solvent, and drug incompatibility. Contrary to these results, Chang & Mark showed that in an appropriate work environment with a high dynamic, a low degree of distraction and confusion, the probability of medication errors is relatively lower [31]. Therefore, the occurrence of these medication errors in an environment that is highly dynamic and desirable can be due to other reasons, such as lack of pharmacological knowledge, inappropriate communication among the members of the treatment team and low work experience. Developed medication errors model in recent studies show that error-producing conditions include work environment, team, and individual factors, in which, care complexity and work dynamic are the work environment factors, the physician-nurse relationship is the team factor, and age and nursing work experience are the personal factors [32]. Also, this study released the greater care complexity in the study units resulted in a greater number of medication calculation errors and wrong medication. In line with these findings, the results of Chang and Mark study indicated that care complexity was positively associated with medication errors [31]. Jolaee et al. also reported a statistically significant relationship between the occurrence of medication errors and the working conditions of nurses such that the mean number of medication errors can be reduced by changing the working conditions from unfavourable to favourable conditions [33]. Other studies also reported inadequate staff in the unit, working load and fatigue as the main reasons for medication errors [24], [29],

[34]. Inappropriate working conditions such as high workload, disorder, lack of staff, distraction, inappropriate patient-nurse ratio, and delayed execution of patient's medication orders can lead to increased medication errors [30], [35]. Complicated conditions make nurses spend more time taking care of the patient, and this, even with skilled staff, can lead to defects in the care process [36].

*Limitations:* The self-reporting nature of the questionnaire was a limitation. In this regard, researchers tried to gather real data by creating a friendly atmosphere and mutual trust, and by describing the objectives of the study. Also, the cross-sectional nature of the study cannot determine the causal relationships between the variables, so the interpretation of the findings of the study should be made with caution.

In conclusion, regarding the irrefutable impact of working conditions on the occurrence of errors, it appears that the study and complete recognition of nurses' working conditions and their adjustment would provide a basis for reducing medication errors. Nursing managers and health care providers should identify the causes of medication errors and implement strategies to reduce them. Medication errors occur more often in the children and infant units as the patients in these wards are more vulnerable and need more care. Therefore, paying attention to medication errors and the process of medication administration is highly important. It is suggested that studies be conducted on the occurrence of nursing medication errors in other units and their related factors. Therefore, an efficient error reporting and recording system may reduce medication errors by minimising reporting barriers.

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