Relationship Between Factors Associated with Incidence of Medical Error in Iran

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Abstract

Background

Providing safe, efficient, and quality services to all people is critical for achieving effective universal health coverage and the health-related sustainable development goals (SDGs) and in particular SDG 3.8. Medical error as a main challenge of delivery systems is a main influential factor on patient safety and quality of health care services. Investigating factors influencing on medical errors can help to improve quality patient safety. This study aimed to investigate the relationship between several contributed factors on incidence of medical errors in East Azarbaijan province, Iran.

Methods

We conducted a cross-sectional study, resulting in 10700 voluntary reporting of medical errors by medical staff working in all types of hospitals including public and non-educational, educational, private, military, charity and social security hospitals. Poisson regression was used for data analysis.

Results

The most frequency of medical errors reported by 41 studied hospitals was related to educational public hospitals, medical errors with no harm in the fall and the least frequency was related to non-educational public hospitals and surgical errors in the spring season. As the results show, spring and summer have a significantly lower incidence of medical error compared to winter ($P < 0.001$). Also, the incidence of medical error in the morning shift was significantly higher than the night shift ($P < 0.001$). According to the results, the incidence of errors with the consequence of near miss, no harm was significantly higher than the sentinel event error.

Conclusions

The results of the present study showed that the factors, different season, work shift, medical error type, medical error intensity and hospital type have a significant relationship with the incidence of medical error.

Background

Access to safe, quality and effective health care services has been asserted in the third goal of 2030 Sustainable Development Goals (SDG)(1). Patient safety is a critical global public health issue and has a widely accepted role in enabling health systems to achieve effective universal health coverage (UHC)(2). Unsafe care causes 43 million injuries a year and the loss of 28 million disability-adjusted life years (DALYs), about two thirds of them in low- and middle-income countries(3). To establish culture of safety,

medical errors are the being the challenging issue. Medical errors was the third leading causes of death in the United States (2013)(4). A medical error is defined as a “failure of a planned action to be completed as intended or the use of a wrong plan to achieve an aim”(5). Medical errors are referred to: a) failure to do the right thing or doing the wrong thing(6, 7), b) planning error or implementation error, c) errors with potential or actual damage(8). Medical errors have various influences on medical staff, patients and health systems. It may lead to emotional distress and effects, depression, anger and suicide in medical stuff(9, 10) and also can lead to a lots of variety of injuries and increase the length of the patient's stay and death in hospitals(11). The annual expenditures of harmful medical errors in the US was estimated at nearly \$17 billion in 2008(12).

Few studies have performed focusing on incidence of medical errors as a comprehensive concept that encompasses a variety of error categories, but rather focused on specific categories of medical errors. For example, health-care associated infection (4.5% (13), 2.5–14.8% (14)), medication error (23.9 to 39.7) (15), 8.1 to 2344 per 1000 patient-days (16), 0.15 to 17.2 per 100 admissions (17), wrong site surgery, 0.09 per 10 000 surgical procedures (18). The majority of patient safety efforts have focused on medical error in hospitals. Medical errors and health-care related adverse events occur in 8% – 12% of hospitalizations. Approximately 15% of total hospital expenditure is a direct result of adverse events(3)

Work satisfaction, learning from mistakes by an managerial approach, computerized prescriber order entry, use of preoperative checklist-based systems, use of infection control link nurses and use of root cause analysis can lead to decrease in medical error rate (19–24). A variety of factors have contributed to the epidemic of medical errors including the decentralized and fragmented nature of the health care delivery system or non-system, lack of staff, workload, attitudes of physicians and nurses toward patient safety, misinterpretation of prescription or inability to request a proper tests and lack of staff's knowledge (5, 19, 25–27).

In Iran, different rates of incidence of medical errors have reported. One meta-analysis reported overall prevalence of nosocomial infection as 4.5% (2018). One study reported prescribing errors as 35.1% (2012) but another reported 46.3% (2010). One Study stated medication error among nurses were 53% (2018). few studies have been conducted on medical errors incidence and the associated factors. The conducted studies imply that gender and attending classes instructing medication administration(28), nurse's inadequate attention, transfer of medication orders from the patient's profile to cardex and workload (29) were the most contributed factors on medication errors. In another study was carried out in selected educational hospitals in Tehran city, management, environment and nursing care factors influence on nurses' medical errors (30).

In reducing medical errors, developing effective strategies through investigating contributed factors on medical errors are influential. Hence, we conducted this study to investigate the relationship between incidence of medical error and contributing factors. The study was conducted in East Azarbaijan province hospitals. East Azarbaijan Province is located in North West of Iran and covers an area of 45490 square kilometres (31). This province has 41 hospitals including public and non-educational, educational,

private, military, social security and charity hospitals. All hospitals are under the supervision of Ministry of Health and Medical Education (MoHME) in national level and medical universities in provincial level.

Methods

Study design and Target population

This is a cross-sectional study was performed in 2019 in East Azarbaijan province hospitals. The statistical population was all of hospitals were under the supervision of Tabriz University of Medical Sciences.

Sampling method and sample size

Voluntary medical error reporting forms including five studied variables (Medical Error Type, Medical Error Intensity, Hospital Type, Different Seasons and Work Shifts) were collected. The statistical population contained 41 hospitals: non-educational public hospitals (19 cases), educational hospitals (10 cases), private hospitals (6 cases), charity hospital (1 case), military hospitals (3 cases) and social security hospitals (2 cases).

Data collection

Data were gathered in hospitals through medical error reporting forms collected from each hospital between 21 March 2018 and 20 March 2019. These forms contained several data about patients with medical error, ward name, work shift, medical error type and intensity, date, complications related to medical error occurrence reported by voluntary fulfilled forms in the hospitals. When a medical error occurs, someone who has made a mistake or his/her supervisor fill out the form and deliver to patients' safety supervisor. These forms are same in studied hospitals and are designed by Treatment Deputy of MoHME. The forms gather and analyze in each hospital then confirmed forms including medical errors types and its rate are reported to Treatment Deputy of MoHME.

Variables

Hospital types

We categorized hospitals based on hospital ownership to three main categories: non-educational public hospitals, educational hospitals and other types of hospitals (private, charity, military and social security).

Different seasons

To investigate influence of different months on incidence of medical error, we categorized a year based on four seasons: spring, summer, autumn and winter.

Medical error types

We used six categories for medical error types including: 1) surgical errors, 2) medication errors, 3) blood and test errors, 4) hospital infections, sores, treatment failures and complications, 5) falls, 6) documentation, CPR and other errors.

Work shifts

We divided daily work ours to three time periods: morning, evening and night.

Medical error intensity

We used three categories for medical error intensity: 1) Near miss which refers to errors appeared before happen so do not harm to patients. 2) No harm which refers to errors happened but do not harm to patients. 3) Sentinel event which refers to errors happened and are harmful.

Statistical Analysis

We entered data in SPSS software V.21 and categorized hospital types to three main categories. This grouping was based on primary estimated medical errors frequencies in each hospital type. Different seasons contained four categories, work shifts contained three categories and medical error intensity contained three categories. We entered 10700 error reporting forms data in SPSS software. Both descriptive and inferential statistics were used for data analysis. Poisson regression was used to determine the relationship and predict independent variables in the medical errors.

The used model to find related variables to incidence of medical errors in hospitals supervised by Tabriz University of medical sciences was confirmed by Goodness of fit test. The model included incidence of medical errors as dependent variable and seasons, medical error types, medical error intensity, hospital types and work shifts as independent variables. Estimation of model parameters is fitted using Poisson regression.

Results

As it is shown in Table 1, the most frequency of medical errors occurred in educational hospitals (53.1%). The least frequency of medical errors related to medical error types referred to surgical errors (3%) and the most frequency referred to hospital infections, sores, treatment failures and complications (25.8%). 46% of errors were occurred in morning work shift and 22.7% of them were related to evening shifts as the least frequency of medical errors. The fall season had the most errors (29.4%) and spring had the least errors (18.8%). In the medical error intensity category, no harm errors were the most frequent and sentinel events had the least errors (10.7%).

Table 1
-Frequency of medical error

Variables	Variables categories	Frequency	Percent
Hospital Types	Public non educational	3263	30.5
	Educational	5686	53.1
	Other	1751	16.4
Medical Error Types	Surgical errors	324	3.0
	Medication errors	1661	15.5
	Blood and test errors	1303	12.2
	Hospital infections, sores, treatment failures and complications	2765	25.8
	Falls	479	4.5
	Documentation, CPR and other errors	4166	38.9
Work Shift	Morning	4942	46.2
	Evening	2430	22.7
	Night	2944	27.5
Different Season	Spring	2013	18.8
	Summer	2553	23.9
	Fall	3142	29.4
	Winter	2992	28.0
Medical Error Intensity	No harm	7334	68.5
	Near miss	2219	20.7
	Sentinel event	1146	10.7

The following regression model has been examined to determine the relationship between season, work shift, severity of error, medical error type and type of hospital in predicting the incidence of medical error.

$$IME = \alpha + \beta_1x_1 + \beta_2x_2 + \beta_3x_3 + \beta_4x_4 + \beta_5x_5$$

Table 2 examines the presence of independent variables including, different season, work shift, medical error type, medical error intensity and hospital type in the model. Based on the results of Table 2, the presence of all variables Different Season, Work Shift, Medical Error Type, Medical Error Intensity and Hospital Type in the model was significant ($P < 0.001$).

Table 2
Tests of Model Effects

Model	Wald Chi-Square	df	Sig.
(Intercept)	11423.764	1	< .0001
Different Season	256.008	3	< .0001
Work Shift	1032.823	2	< .0001
Medical Error Type	4460.899	5	< .0001
Medical Error Intensity	4803.115	2	< .0001
Hospital Type	2104.135	2	< .0001
Dependent Variable: Incidence of Medical Error			
Model: (Intercept) + Different Season + Work Shift + Medical Error Type + Medical Error Intensity + Hospital Type			

Table 3 examines the relationship between the independent variables different season, work shift, medical error type, medical error intensity and hospital type with incidence of medical error and estimating the independent parameters using Poisson regression. As the results show, spring and summer have a significantly lower incidence of medical error compared to winter ($P < 0.001$). Also, the incidence of medical error in the morning shift was significantly higher than the night shift ($P < 0.001$), while the incidence of medical error in the evening shift was significantly less than the night shift ($P < 0.001$). The incidence of medical error in surgical errors, medication errors, blood and test errors, hospital infections, sores, treatment failures and complications falls, medical error was significantly lower than the documentation, CPR and other errors ($P < 0.001$). According to the results of the study, the incidence of errors in teaching and non-teaching hospitals was significantly higher than other hospitals ($P < 0.001$). Also, the incidence of medical error with the consequence of near miss, no harm was significantly higher than the sentinel event error.

Table 3
Poisson Regression Output for Model Predicting the Incidence of Medical Error

Parameter	Estimate	Standard Error	Wald 95% Confidence Limits		Sig.
(Intercept)	1.625	.0460	1.535	1.716	< .0001
[Season = Spring]	– .390	.0291	– .447	– .333	< .0001
[Season = Summer]	– .162	.0273	– .216	– .109	< .0001
[Season = Fall]	.031	.0260	– .020	.082	.237
[Season = Winter]	0 ^a	.	.	.	.
[Work Shift = Morning]	.528	.0232	.482	.573	< .0001
[Work Shift = Evening]	– .194	.0274	– .248	– .141	< .0001
[Work Shift = Night]	0 ^a	.	.	.	.
[Medical Error Type = Surgical]	-2.659	.0607	-2.778	-2.540	< .0001
[Medical Error Type = Drug]	– .885	.0288	– .942	– .829	< .0001
[Medical Error Type = Blood & test]	-1.175	.0320	-1.237	-1.112	< .0001
[Medical Error Type = infection sore & treatment]	– .509	.0254	– .559	– .459	< .0001
[Medical Error Type = falls]	-2.159	.0483	-2.254	-2.064	< .0001
[Medical Error Type = other, Doc, CPR]	0 ^a	.	.	.	.
[Medical Error Intensity = No harm]	1.887	.0327	1.823	1.951	< .0001
[Medical Error Intensity = Near miss]	.717	.0372	.645	.790	< .0001
[Medical Error Intensity = sentinel event]	0 ^a	.	.	.	.
[Hospital Type = Public non educational]	.763	.0309	.703	.824	< .0001
[Hospital Type = Educational]	1.280	.0288	1.224	1.337	< .0001

Dependent Variable: Incidence of Medical Error

Model: (Intercept), Different Season, Work Shift, Medical Error Type, Medical Error Intensity, Hospital Type.

a. Set to zero because this parameter is redundant

b. Fixed at the displayed value.

Parameter	Estimate	Standard Error	Wald 95% Confidence Limits	Sig.
[Hospital Type = Others]	0 ^a	.	.	.
(Scale)	1 ^b			
Dependent Variable: Incidence of Medical Error				
Model: (Intercept), Different Season, Work Shift, Medical Error Type, Medical Error Intensity, Hospital Type.				
a. Set to zero because this parameter is redundant				
b. Fixed at the displayed value.				

Discussion

This study investigated the relationship between incidence of medical errors and the influential factors including hospital type, different work shifts, different seasons, medical error type and intensity.

According to the results, the most reported medical errors were in morning work shift, educational hospitals, hospital infections, sores, treatment failures and complications errors, fall season and no harm intensity and the least reported medical errors were in evening work shift, other hospitals (military, social security, private and charity), surgical errors, spring season and near-miss intensity.

Accordingly, estimation of parameters, a significant relationship was observed between the season, type of error, intensity of error, type of hospital and work shift with the incidence of errors. Morning shifts, spring season, surgical errors, no-harm errors, and educational hospitals have played a major role in predicting incidence of medical errors. Also, estimation of the regression model in the study showed that the incidence of medical errors in the spring and the evening shift was significantly low. Morning shift, educational hospitals and no harm error were significantly associated with an increased incidence of medical errors.

We found out there is a significant association between season and medical error types. Various studies have showed increased mortality is associated with year-end physician changeovers(32). In the UK this is called the Killing Season and in the North America it is called the July Effect(33).The findings of the studies showed that the quality of health care decreases during trainee changeovers at the end of the academic year(34–37).Wen et al(2015) reflect the mentioned relationship to increase likelihood hospital-acquired complications occurrence(38). On the contrary Lee et al(2019) stated that there is no evidence of the July effect in post-ERCP complications(39). Murtha et al(2019) did not found any significant differences between the rate of pancreatic fistula, reoperation, readmission, mortality intra-abdominal

abscess and seasons(40) Malik et al(2018) denied association between summer surgeries and surgical site infections(41).

Our findings confirmed the relationship between work shifts and medical error types. Several studies were directed to show this relationship. Zargarzadeh et al(2018) showed that medication error occurrence was high in night shift time works(42). Allan et al(1990) demonstrated that types of errors are related to reporting errors in different shifts (43). Markowitz et al(1981) and harkanen et al(2015) found that nurses have lower medication error in day shift than evening and night shifts(44, 45) despite this Raju et al(1989) stated that medication error was occurred in the morning shift more than night and evening shifts(46). Izadpanah et al(2018) confirmed work shift and medication errors relationship (47). Jones et al(1986) showed that there is no significant relationship between work shifts and nurse' medication errors(48).

According of our findings there is a relationship between hospital types, different seasons and medical error types. Various studies have implied that teaching hospitals in more affected by the July effect and they also struggle with efficiency, quality and patient safety during the dawn of the academic year(49). Rockov et al(2020) stated that there are a July Effect for Total Joint Arthroplasty in teaching hospitals(50). Nandyala et al(2014) also showed a greater July effect for dysphagia in educational hospitals than non-educational hospitals(51).

Our findings showed that there is no relationship between work shifts and medical error intensity ($p = .951$). Saremi et al(2013) stated that the severity of medical error was related to fatigue and work shifts (52). Seki et al(2006) said that there was no significant relationship between the occurrence of near-miss errors and work shifts (53).

Our findings showed that a relationship between hospital types and medical error intensity. Da Silva et al(2014) said that "there is an association between neonatal near miss and hospital type"(54). Also educational hospitals are associated with higher rate of never events compared with non-educational hospitals as Allareddy et al(2013) stated in his study(55). Our findings showed that there is a significant relationship between Medical error intensity and different seasons. This relationship is reflected in several articles where demonstrated this relationship through the July Effect as Wen et al (2015) and Chow et al (2005) showed the July effect influence on hospital-acquired complications (never events) occurrence and near miss events(38, 56) but Kirshenbaum et al(2019) demonstrated the July effect has no impact on never events(57).

As it said there are various factors influential on incidence of medical errors. Most of the study results were consistent with the results of other studies although the study results are not the same. It may related to context of studies and the related factors. Also the method of data gathering is an important factor which affect on study results.

Conclusions

Identifying factors influencing medical error are imperative in reducing medical error incidence and severity. Reducing medical error requires a multifactorial approach. According to our study results, there was a significant relationship between incidence of medical error and hospital types, seasons, medical error intensity, medical error types and work shifts. Health policy makers and planners should consider multifactorial nature of medical error. Identifying determinants in relation to medical error reporting will help establish an appropriate error reporting system. Further studies should be performed to find a comprehensive perception of influencing factors on incidence of medical errors.

List Of Abbreviations

SDG

Sustainable development goals

UHC

Universal health coverage

DALYs

Disability-adjusted life years

CPR

Cardiopulmonary resuscitation

SPSS

Statistical Package for the Social Sciences

Declarations

Ethics approval and consent to participate

The medical ethics committee of Tabriz University of Medical Sciences, Iran approved the study (Approval No: IR.TBZMED.REC.1398.557).

Consent for publication

Not related.

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests

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Authors' contributions

EA-E and LD conceived the basic and original idea and outlined the study and drafted the manuscript. HB helped to data analysis and revised the manuscript for important intellectual content. All authors participated in the final design and revision of the manuscript.

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