ORIGINAL ARTICLE

Identification of Nurses' Errors in the Emergency Ward, Using SHERPA Technique

ALI KERMANI[1]; ADEL MAZLOUMI[2*]; ZEINAB KAZEMI[2]

[1]M.Sc, School of Public Health, Semnan University of Medical Sciences, Semnan, Iran;

[2]Department of Occupational Health Engineering, School of Public Health, Tehran University of Medical Sciences, Tehran, Iran.

This paper is available on-line at *http://ijoh.tums.ac.ir*

ABSTRACT

Human errors are of the most important issues due to the technological advances in various work settings. In medical professions, including nursing, investigation of human errors would help to find out approaches for the identification and reduction of these errors. Hence, the present study aimed to identify and assess nurses' errors in emergency ward of an educational hospital, using Systematic Human Error Reduction and Prediction Approach (SHERPA). In this qualitative study, first, the purpose and the procedure of the research were completely explained to the nurses. Then, Hierarchical task analysis (HTA) was done and the nurses' tasks and subtasks were identified by observing their activities and conducting interviews. Then, the SHERPA worksheet was completed to find the errors pertinent to each task. Sixty-five tasks and 231 errors were detected regarding the nurse's tasks, of which 59.3% was action errors, 25.55% checking errors, 4.33% retrieval errors, 2.16% information communication errors, and 8.66% selection errors. This means that the highest and lowest errors were respectively belonged to action errors and communication errors. Moreover, the checking errors obtained the highest undesirable risk level. Overall, the action errors and the checking errors should be priority in controlling and reducing of nurses errors in emergency ward. It should be noted that SHERPA can cover a wide range of activities including factors such as patients and their caregivers or other wards of the hospitals which make this technique an appropriate tool for assessing the errors in medical professions.

KEYWORDS: *Human error identification, SHERPA, Risk assessment, Nursing, Emergency ward*

INTRODUCTION

Human errors are among the topics that occupied a significant portion of time, budget, and attention of experts and managers in the field of practical and theoretical management. Working structure of employees in an organization is one of the important factors that play a significant role in reducing human errors [1]. Moreover, human performance impairment is considered as a part of causes of accidents; and human error is the main contributing factor in a large number of accidents. Human error has been referred as the major cause of accident since 1930. In 1960s, about 30 percent of the accidents were attributed to human error [2]. However, in recent decades this rate has gone up to 70-90 percent [2]. Overall, the main cause of up to 90% of accidents is attributed to human errors [3-4].

By the 1990s the frequency and magnitude of medical errors were not clearly identified and several countries had reported different statistics related to patients who harmed and lost their lives due to medical errors [5]. Therefore, in late 1990s a lot of efforts have been undertaken to eliminate or reduce the incidence of medical errors [6].

* *Corresponding Author: Adel Mazloumi*
Email: amazlomi@tums.ac.ir

According to UK Department of Health, medical errors affect 850,000 people in the UK annually, leading patients to spend long time in hospital or other health care centers. Health services insurance costs of these errors are estimated to be more than €2 billion. Moreover, costs of additional treatments and clinical negligence are estimated to be more than €4 billion, twice the costs of health services [7].

Medical errors are a significant cause of death in the United States. A follow-up study by the American Institute of Medicine (IOM) revealed that medication errors harming at least 1.5 million people annually, of whom 400,000 cases are preventable, 800,000 needs long-term hospitalization, and 530,000 requires outpatient treatments [8]. Medical errors impact one out of ten patients around the world [5].

The literature review manifested no study related to financial costs of damages due to medical errors in Iran. The study of errors among medical professions, including nursing, has high importance due to the following reasons:

- Errors in medical professions are rising day to day and are considered as a global problem [6, 9].
- Incidence of human errors in medical occupations imposes heavy financial and health-related costs to the societies.
- Consequences of medical errors are directly related to patients' health and lives, in comparison with those errors in other industries.
- The incidence of human error in health care settings leads to lack of public confidence to the medical occupations, stress increase, and also complaints increase.
- Human errors do not have specific characteristics and usually occur due to many reasons. These errors are often the result of a combination of system errors and also hidden errors [10].
- A few surveys by systemic procedures investigated medical errors; comparing other occupations.
- So far no investigation has been done by systemic methods, in Iran.

Nevertheless, most of these errors are preventable. Between 9,000 to 24,000 Canadians die annually after a preventable medical error [11]. In Iran, medication errors had been made by 64.55% of the nurses [12]. In southern Iran, 57.2% of errors were reported to be drug errors [13]. In health care settings the occurrence of an error is often blamed to nurses and also they usually do not report their errors because of their fear of the errors consequences. Considering the important role of human errors in medical professions and given that so far few comprehensive surveys in Iran has been conducted, the aim of the present study was to

investigate nurses' errors in emergency ward of an educational hospital in Semnan city, Iran. In this sense, the Systematic Human Error Reduction and Prediction (SHERPA) technique has been used as a standard and systematic error prediction and prevention method.

MATERIALS AND METHODS

The present cross-sectional and qualitative study was performed in order to identify and to assess human errors in nursing profession. The study group was nurses who worked in Emergency Unit of Amir Al-Momenin Hospital, affiliated to Semnan University of Medical Sciences, Semnan, Iran. Fifteen nurses, including 10 females and 5 males, working in three shifts in circulation were studied. Tasks performed in this unit include: catheterization, stomach intubation, suction, blood transfusion, preoperative cares (appendicitis, hernia, hemorrhoids), trauma, fractures and dislocations, burns care, wound dressing, bed sore treatment, stop bleeding, changing the splint, intubation (tracheal), injections, giving medication, surgical suturing, electrocardiography, eye wash, taking vital signs (pulse rate, blood pressure, temperature), CPR (cardiopulmonary resuscitation).

SHERPA technique was employed in order to identify and assess human errors in nursing profession. It is one of the most common methods for investigating errors in terms of the type of error, possible outcomes, and control and preventive strategies for all the subtasks related to an occupation. This technique is amongst the most reliable available instruments for determining human errors which is simple and comfortable, both for training and application. Moreover, it has the ability to detect the hidden, potential, comprehensive, and also structured errors which propose controlling methods after identification of errors [14-15].

SHERPA is done through 8 steps. In the first step, tasks and the sub-tasks should be analyzed using hierarchical task analysis (HTA). Following, using specific checklists, errors and their types would be identified (Table 1) and the risk assessment would be done. In the last stages, the critical errors would be identified and finally practical solutions to control and prevent errors would be proposed [15].

In addition to the necessary training to nurses and making them familiar with study aims, the whole procedure was explained to them both theoretically and practically, during different shifts. Furthermore, documents related to job descriptions, guidelines, regulations, and also the relevant statistics were studied. After, achieving a comprehensive understanding of nurses' duties and activities, their main tasks outlined using HTA. Following, the tasks which could be divided into

smaller components or tasks with specific subtasks were defined as the main tasks in HTA and this process continued until no more sub-tasks could be obtained by these divisions. The end sub-tasks were underlined. Various specific errors were identified according to the checklists of SHERPA technique. The types of errors identified and the columns containing the error code (indicating type of the error), description of the error, consequences of the

error, error recovery, risk level of the error, and also controlling methods were completed. Hazard analysis was done according to the risk assessment matrix [16], presented in Table 2. In order to validate and ensure the accuracy of the tasks and identified errors and also to assure their comprehensiveness, several interviews were conducted with nurses.

Table 1. Risk assessment matrix

Hazard category assessment matrix	(1) Catastrophic	(2) Critical	(3) Marginal	(4) Negligible
(A) Frequent	1A	2A	3A	4A
(B) Probable	1B	2B	3B	4B
(C) Occasional	1C	2C	3C	4C
(D) Remote	1D	2D	3D	4D
(E) Improbable	1E	2E	3E	4E
HRI	**Risk decision criteria**			
1A, 1B, 1C, 2A, 2B, 3A	Unacceptable; stop operations and rectify immediately			
1D, 2C, 2D, 3B, 3C	Undesirable; upper-management decision to accept or reject risk			
1E, 2E, 3D, 3E, 4A, 4B	Acceptable with management review			
4C, 4D, 4E	Acceptable without review			

Table 2. SHERPA error mode checklist

Error type	Code	Error mode
Action errors	A1	Operation too long/short
	A2	Operation mistimed
	A3	Operation in wrong direction
	A4	Too little/much operation
	A5	Misalignment
	A6	Right operation on wrong object
	A7	Wrong operation on right object
	A8	Operation omitted
	A9	Operation incomplete
	A10	Wrong operation on wrong object
Checking errors	C1	Check omitted
	C2	Check incomplete
	C3	Right check on wrong object
	C4	Wrong check on right object
	C5	Check mistimed
	C6	Wrong check on wrong object
Retrieval errors	R1	Information not obtained
	R2	Wrong information obtained
	R3	Information retrieval incomplete
Communication errors	I1	Information not communicated
	I2	Wrong information communicated
	I3	Information communication incomplete
Selection errors	S1	Selection omitted
	S2	Wrong selection made

RESULT

Overall, 65 tasks and 231 types of errors were identified related to the activities of nurses in the emergency ward. An example of HTA diagrams provided for the nurses' tasks is depicted in Fig.1. Of the all identified errors, 59.3% was action (Table 3). 2.8 errors were occurred per task. The nurses' risk of errors and their level of errors were determined according to the Classic Safety Risk

Assessment Matrix (CSRAM) based on Mil-Std-882D [17]. Regarding the risk of errors, 2 errors (0.86%) were in unacceptable level of risk, 67 errors (29%) in undesirable risk level, 155 errors (67.1%) in acceptable level, with reviews, and 7 errors (3%) in acceptable level risk, without reviews. Risk level of errors separately for each type of tasks is presented in Table 4.

Additionally, 48.5% of nurses' potential errors were in the levels 1 and 2 (catastrophic and critical levels, respectively). However, because the probability of their occurrence is very low they were not categorized in unacceptable errors group (Table 4). Regarding retrieval errors, 35% of the errors were non-recoverable that including 38.6% action errors, 28.8% checking errors, 80% retrieval errors, 20% information communication errors and 10% selection errors. Table 5 presents an example for errors related to the tasks of a nurse, using worksheet SHERPA.

Table 3. Descriptive data related to types of errors related to nursing in emergency unit

	Types of error					
	Action	**Checking**	**Retrieval**	**Information communication**	**Selection**	**Total**
Frequency(percentage)	137(59.3)	59(25.55)	10(4.33)	5(2.16)	20(8.66)	231(100)

Table 1. Risk level, separately for each type of errors

	Unacceptable	**Undesirable**	**Acceptable, with reviews**	**Acceptable, without reviews**	**Total**
Action	0(0)	30(21.9)	105(76.6)	2(1.45)	137(100)
Checking	2(3.39)	24(40.67)	28(47.45)	5(8.47)	59(100)
Retrieval	0(0)	3(30)	7(70)	0(0)	10(100)
Information communication	0(0)	0(0)	5(100)	0(0)	5(100)
Selection	0(0)	10(50)	10(50)	0(0)	20(100)
Total	2(0.86)	67(29)	155(67)	7(3)	231(100)

Table 5. An example of a table of errors related to the tasks of a nurse (worksheet SHERPA)

Task	Error type	Description of error	Errors Consequences	Recovery	Risk level	Control measures
Drug selection	S1	Forgetting medication selection	Untreated patients, prolonged treatment, the risk of death	Common and specific pharmaceutical complications, the risk of death	1E	Providing checklists for nurses to complete, checking the patients medication profile, controlling by the supervisor and the person in charge of the shift, Distrust in mind
	S2	Choosing the wrong medication	Untreated patients, prolonged treatment, the risk of death	Common and specific pharmaceutical complications, the risk of death	1E	Providing checklists for nurses to complete, checking the patients medication profile, controlling by the supervisor and the person in charge of the shift, Distrust in mind
Vessel selection	S2/C2	Selection of inappropriate vessel, incomplete vessel selection process	Tissue injury, inability to drugs, cut off the blood supply to the organ, artery damage, accumulation artery and gangrene, the possibility of blood clots in the arteries and thrombosis and embolism and enter to various tissues and Related complications, such as stroke	Unable to inject	3D	Experienced nurse, A careful review of the patient's condition and his vessel before proceeding
	S2	Selection of artery	Increasing risks for safety and treatment procedure of patients	Bleeding, spasm, paralysis	2E	Experienced nurse, A careful review of the patient's condition and his vessel before proceeding
	A8	Forgetting to open the tourniquet	Increasing risks for safety and treatment procedure of patients	Slow injection or lack of injection, gangrene	2E	Experienced nurse, controlling the injection area and status, checking the patients' condition

Fig.1. An example of HTA chart for tasks of a nurse
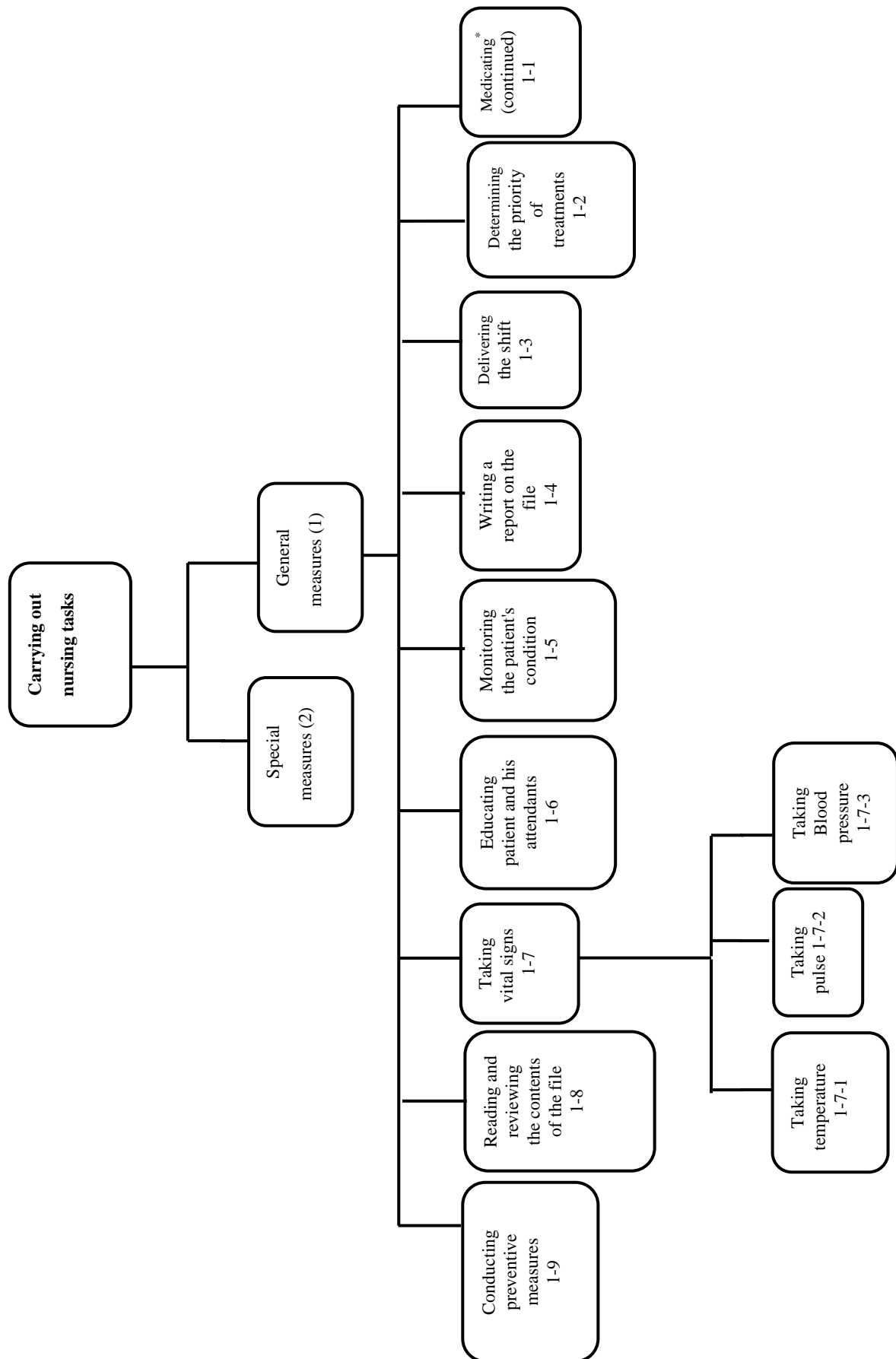
DISCUSSION

The present research was carried out to identify and evaluate human errors of nursing in emergency ward, using SHERPA technique. Using hierarchical task analysis (HTA), Phips et al. identified the tasks involved in the preparing and delivering anesthesia and they used SHERPA to identify potential human errors at each task. Results of this research demonstrated the value of task analysis and systematic human error reduction and prediction approach in identifying human-related errors. The outputs of task analysis would be useful for future interventions in order to eliminate or reduce errors [18].

According to results of this study, most of errors were categorized in action group (59.3%) in accordance with the results in Zagros Methanol Company (48.62%) and the study in Esfahan Oil Refining Company (67.64%) [19-20]. However, the working environments in these two researches differ from the present study.

Results showed that checking errors were the second most important errors (25.55%) while the information communication errors were the least important. No similar findings were found for comparison purpose. Moreover, results of this study revealed that 67.1% of errors were in acceptable level, while this value was 42% in the study done among delivery emergency nurses [21].

Few researches have been conducted in the field of medical errors by systemic procedures and standards particularly SHERPA technique, in the context of nursing job. On the other hand, structure of the nursing tasks represents the high number of action and checking tasks which is the reason for high number of related errors. Therefore, providing on time theoretical and practical training program for this occupational group and focusing on strategies for prevention of errors can be useful.

Considering recovery of errors (error identification), retrieval errors formed the highest percentage (80%) of this kind of errors. This may be due to the lack of nurses' experience and knowledge or lack of up to date information, the nature of these errors, and patient-related factor (problems in communicating with patients or their families, taking the patients' history, or providing information for them). Usually, controlling these errors is more difficult than other errors because of their unpredictability. Following measures can be adopted in order to reduce these errors: providing general information for the public or the patients, training the requirements to patients and making them aware of their health status, providing clear and necessary information for them, and training the nurses.

Overall, establishing standard, computerized, and voluntary reporting systems, standard training, preparing and using guidelines and standard checklists, employing experienced nurses, preventing or reducing fatigue and sleepiness, careful shift delivery, and careful arrangement of shift schedules by the management, revising and improving the managing and monitoring systems, and stress management are of the most essential strategies for control and prevention of medical errors. Regarding experience, work pressure and stress, Tamayo et al., investigated the causes of nurses' errors using simulation method in Japan and found that the more experienced nurses the less errors [22]. In a study of the working conditions of a Japanese hospital in 2001, workload and lack of experience showed to be associated with errors [23]. Moreover, stress increases error by 50% [19].

Considering the computerized reporting systems, a computerized error reporting system was used in an educational hospital and it was reported that reporting error increased by 20 times [10, 24]. In Japan, a computerized medical error reporting system was acceptable for nurses and facilitates their analysis [25].

In another related study a web-based reporting system used by nurses in pediatric ICU ward of 54 hospitals was evaluated. The results showed that this system was acceptable and applicable for identification of a large number of medical errors. Moreover, it facilitated multi-purposes and intersectoral studies.

Sleep deprivation has also been cited as a contributing factor in medical errors. One study found that being awake for over 24 hours increased medical errors by 2-3 times. Especially those errors result in death or injury, and the risk of inappropriate or incomplete cares up to 168% and near miss accidents by 460% [26, 27]. Seventy percent of all medical shifts are due to improper communication and 50% during the shift change, and the emergency ward is not an exception. Shift work is a complex phenomenon, which needs special attention.

Dhingra et al. surveyed a variety of emergency medicine residency programs and demonstrated that 75% of written trainings were not standard and 50% of the programs and policies have not been written [6]. Using structured checklists in the ICU reduced infections due to on-time actions for stopping the bleeding [28]. Using checklists reduced patients' mortality by 46.7% among 3955 patients [29].

Moreover, Phipps et al. in their survey investigated anesthetic practitioner errors, using the SHERPA technique. They suggest usage of standards checklist in the process of monitoring the patients and maintaining patients' anesthesia [18].

Proper and efficient monitoring can prevent many of action errors [19]. There are several limitations of the present study including lack of managers, doctors and nurses and other personnel familiarity with the research topic and especially

research method, crowded and stressful work environment, personnel tiredness due to work, legal and administrative constraints, the time limit for being in their workplace etc.

CONCLUSION

The selection and checking errors ranked, respectively, first and second among errors with undesirable level of risk. However, the checking errors were as the second high frequency errors. Therefore, it can be concluded that reduction and prevention of checking errors must be given priority. However, the action errors, which had the highest frequency and ranked third errors of undesirable risk level must not be forgotten.

Overall, according to the results of the present research and similar studies, SHERPA technique can be a useful tool for identification and assessment of medical errors. Particularly, in the activities of the medical centers, factors such as the relationship with managers, patients and their families, colleagues, and other wards are involved and these factors cannot be analyzed by a few methods including SHERPA.

Currently, clinical governance program is being implemented in hospitals and investigation of errors is incorporated in this program. Therefore, it is recommended that hospitals managers and researchers use systemic and standards techniques, such as SHERPA and other similar techniques.

ACKNOWLEDGEMENT

REFERENCES

1. Reason J. *Human error*: models and management. *BMJ* 2000; 320(7237): 768–770.
2. Karwowski W. *International encyclopedia of ergonomics and human factors*. CRC Press, 2001.
3. Feyer A, Williamson A. Human factors in accident modelling. In: Stellman J(Ed). *Encyclopaedia of occupational health and safety*. 4th edn. International Labour Organization, 1998.
4. Kermani A, Mazloumi A, Kazemi Z. Using SHERPA technique to analyze errors of health care staff working in emergency ward of Amiralmomenin hospital, Semnan. *Iran Occup Health* 2015; 12(2): 12-23.
5. WHO. *World Alliance for Patient Safety*. The Launch of the World Alliance for Patient Safety. Oct 2004.
6. Dhingra KR, Elms A, Hobgood C. Reducing error in the emergency department: a call for standardization of the sign-out process. *Ann Emerg Med* 2010; 56(6): 637-642.
7. Lane R, Stanton NA, Harrison D. Applying hierarchical task analysis to medication administration errors. *Appl Ergon* 2006; 37(5): 669-679.
8. The National Academy of Science. *Medication Errors Injure 1.5 Million People and Cost Billions of Dollars Annually*. Jul 2006.
9. Fontan J-E, Maneglier V, Nguyen VX, Brion F, Loirat C. Medication errors in hospital: computerized unit dose drug dispensing system versus ward stock distribution system. *Pharm World Sci* 2003; 25(3): 112-117.
10. Ivy ME, Cohn K. Human error in hospitals and industrial accidents. *JACS* 2001; 192(3): 421.
11. Baker GR, Norton PG, Flintoft V, Blais Rg, Brown A, Cox J, et al. The Canadian Adverse Events Study: the incidence of adverse events among hospital patients in Canada. *CMAJ* 2004; 170(11): 1678-1686.
12. Cheragi MA, Manoocheri H, Mohammadnejad E, Ehsani SR. Types and causes of medication errors from nurse's viewpoint. *Iran J Nurs Midwifery Res* 2013; 18(3): 228-231.
13. Ghanbari Jahromi M, Khammarnia M, Haghayghi F, Eslahi M, Saeed A, Kassani A. The Medical Errors and Causes in the General Public Hospital, Southern Iran. *Med Public Health J* 2014; 1(3): 10-14.
14. Mohammadfam I, Movafagh M, Bashirian S. Comparison of Standardized Plant Analysis Risk Human Reliability Analysis (SPAR-H) and Cognitive Reliability Error Analysis Methods (CREAM) in Quantifying Human Error in Nursing Practice. *Iran J Public Health* 2016; 45(3): 401-402.
15. Lyons M. Towards a framework to select techniques for error prediction: supporting novice users in the healthcare sector. *Appl Ergon* 2009; 40(3): 379-395.
16. Stanton NA, Walker GH. *Human factors methods: a practical guide for engineering and design*. 2nd ed, Ashgate Publishing, Lt, 2013.
17. Bahr NJ. *System safety engineering and risk assessment: a practical approach*. CRC Press, 2014.
18. Simpleman L, McMahon P, Bahnmaier B, Evans K, Lloyd J. *Risk management guide for DOD acquisition*. Department of Defense Acquisition University, June 2003.
19. Phipps D, Meakin GH, Beatty PCW, Nsoedo C, Parker D. Human factors in anaesthetic practice: insights from a task analysis. *Br J Anaesth* 2008; 100(3): 333-343.
20. Ghasemi M, Zakerian A, Azhdari M. Control of Human Error and comparison Level risk after correction action With the SHERPA Method in

a control Room of petrochemical industry. *Iran Occup Health* 2011; 8(3): 14-22.

21. Habibi E, Garbe G, Reasmanjeyan M, Hasanzadah E. Human error assessment and management in Isfahan oil refinery work station operators by Sherpa technique. *Inj Prev* 2012; 18: A229.

22. Tanha F, Mazloumi A, Faraji V, Kazemi Z, Shoghi M. Evaluation of human errors, using Standardized Plant Analysis Risk Human Reliability Analysis technique, among nurses of delivery emergency ward of one of the Tehran University of Medical Sciences hospitals. *J Hosp* 2015; 14(3): 57-66.

23. Kazaoka T, Ohtsuka K, Ueno K, Mori M. Why nurses make medication errors: a simulation study. *Nurse Educ Today* 2007; 27(4): 312-317.

24. Seki Y, Yamazaki Y. Effects of working conditions on intravenous medication errors in a Japanese hospital. *J Nurs Manag* 2006; 14(2): 128-39.

25. Plews-Ogan ML, Nadkarni MM, Forren S, Leon D, White D, Marineau D, et al. Patient safety in the ambulatory setting. *J Gen Intern Med* 2004; 19(7)719-725.

26. Furukawa H, Bunko H, Tsuchiya F, Miyamoto K-i. Voluntary medication error reporting program in a Japanese national university hospital. *Ann Pharmacother* 2003; 37(11): 1716-1722.

27. Barger LK, Ayas NT, Cade BE, Cronin JW, Rosner B, Speizer FE, et al. Impact of extended-duration shifts on medical errors, adverse events, and attentional failures. *PLoS Med* 2006; 3(12): e487.

28. Nocera A, Khursandi DS. Doctors' working hours: can the medical profession afford to let the courts decide what is reasonable? *Med J Aust* 1998; 168(12): 616-618.

29. Gawande A. The checklist. *N Y* 2007; 83(39): 86-95.