

Evaluation of human errors using Standardized Plant Analysis Risk among health provider personnel in a hospital in Qazvin Province in 2016-2017



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ABSTRACT

Background: Human error in the health industry that deals with the lives of people can lead to irreparable losses and massive costs.

Aim: The current study aimed at identifying and evaluating human errors using the SPAR-H technique in one of the hospitals in Qazvin Province.

Method: This study was a cross-sectional study that was conducted in one of the training hospitals of Qazvin in 2016-2017. The target community was 49 of the most senior personnel in four groups of nursing, laboratory, radiology, and services. At first, task analysis was conducted to target group using Hierarchical Task Analysis (HTA) technique by Focus Group method. In the next step, the Human Error Probability (HEP) was determined to utilize SPAR-H method and of

performance-shaping factors (PSFs) and functional and diagnosis activities were identified. Finally, after determining the dependency level, the final diagnosis HEP was calculated.

Result: Of the total tasks and errors identified, 9 tasks and 17 errors were related to the activities of the nursing staff, 5 assignments and 17 errors related to the activities of the laboratory experts, 3 tasks and 5 errors related to the activities of radiology experts and 3 tasks and 6 errors related to the activities of the service.

Conclusion: The analysis of errors identified in this study showed that the major causes of errors due to the high volume of work and insufficient time in all target groups could be attributed to shortage of available time, stress and high work pressure of personnel.

Keyword: Medical Error, SPAR-H, Health Provider Personnel, Qazvin University Of Medical Sciences

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INTRODUCTION

All people are exposed to damage caused by human error. The damage led by human error in different professions has different consequences, and small mistakes in important and sensitive businesses may have catastrophic dimensions. Human errors that deal with the lives of people can lead to irreparable damages and high costs in the health care profession,^{1,2} and for this reason, they may be more critical than other occupations.

These mistakes include diagnostic errors, mistakes in prescribing drugs and therapies, errors in surgical procedures, mistakes in the use of technology and types of equipment, mistakes in the interpretation of paraclinical tests, etc. Each of is linked to a series of smaller errors.^{3,4} In the United States, medical errors are the third most common cause of death, causing deaths between 210,000 and 440,000 of people each year and causing more than one million injuries and impose a high cost on the health system.⁵⁻⁷ In addition to measurable costs, the intangible costs of registered and unregistered medical errors are also significant.⁸ Some of these unwanted incidents are inevitable and can be repeated in similar situations, and it is possible to

document their experiences to others and reduce their frequency.^{9,10}

Several methods have been presented to evaluate human error capabilities such as FMEA (Failure Mode and Effect Analysis), HEIST (Human Error Investigation software Tool), HEPI (Human Error Probability Index), SHERPA (Systematic Human Error Reduction and Prediction Approach), CREAM (Cognitive Reliability Error Analysis Method), FTA (Fault Tree Analysis), HEART (Human Error Assessment Reduction Technique).¹¹⁻¹⁷ Among these methods, SPAR-H (Standardized Plant Analysis Risk Human Reliability Analysis) method, based on reviews and troubleshooting problems in the first and second generation of the Human Reliability Analysis Process (HRA) divides human beings into two categories of practical and diagnostic activities, and it can be used to classify errors and reduce the human contribution to error. In this technique, the factors affecting human function are divided into eight categories: available time, stress/stressors, complexity, experience/training, procedures, ergonomics/HMI, fitness for duty, and work processes.

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Furthermore, administrators will decide more easily with the probability of error.¹⁸⁻²⁰ The study of human errors evaluation in nurses of the Emergency Department of Tehran University of Medical Sciences Hospitals with SPAR-H had been conducted. Of the four task groups, the least error was due to the “working with a serum pump” with an error rate of 0.055% and the most probable error related to the task of “injections of blood products” with a probability of 0.78. The leading causes of errors in this section were stress and complexity in the tasks of this section.²¹ In the study of Rasoulzadeh et al. which reviewed human errors in the personnel of medical diagnostic labs in Tehran and Tabriz in 2014 by HTA, 93% of them surveyed reported at least one error in the period of the study. In total, 1188 errors were reported within the period. The error rate was 42% at the stage of adoption and 57% at the response stage.²²

The consequences of medical errors directly concern the health and life of individuals and can lead to people’s lack of trust in the treatment staff, increased stress among them, as well as increased complaints from health centers. Considering the importance and sensitivity of the diagnostic and service staff and the necessity of recognizing and controlling human errors in order to improve the quality of care and safety of patients, this study aimed at identifying and assessing human errors using the SPAR-H technique in medical staff groups were carried out.

METHOD

This study was a cross-sectional study that was carried out during 2016-2017 in one of the training hospitals of Qazvin province. The target community was 4 groups of professional staff between 49 nurses in 9 sections (internal women, internal medicine, hematology, urology, emergency, ICU, ICU and cardiology), 9 laboratory staff, 9 personnel from the radiology department and 3 service staff working (one person in each shift in different section) in the Velayat hospital. All of them had a work experience of over ten years in that department and with the most experienced personnel in the departments. The ethical code was IR.TUMS.SPH.REC.1396.292 granted from Tehran Medical University.

SPAR-H technique was used to investigate the human error in the community, which was carried out in accordance with the following steps, respectively. In the first step, the analysis of tasks by Hierarchical Task Analysis (HTA)²³ was performed independently for each group of diagnostic and practical activities related to the studied groups. Diagnostic activities include interpretation and

decision-making and relies on knowledge and experience to understand existing conditions, plan, prioritize activities, and determine appropriate practices. Functional activities also include one or more activities identified by diagnosis, operational rules, and guidelines. The second step, at this stage, the probability of human error in each task was determined, so that the diagnostic and functional sheet for each task after entering the basic information affecting the error including age, gender, work history, education, presence of the researcher after completing the necessary information, the subjects were completed.

Part I. Evaluate Each PSF for Diagnosis or Functional

A. Evaluate PSFs for the diagnosis or Functional Portion of the Task, If Any.

At this stage, each PSF (Performance Shaping Factor) was evaluated for diagnosis or task performance. PSF include available time, stress/stressors, complexity, experience/training, procedures, ergonomics/HMI, fitness for duty, work processes.^{24,25} Each of these PSF has specific coefficients. Determine each of the PSF in the diagnostic and practical worksheet first by using direct observation techniques and without interfering with the routine task of the laboratories, radiology and services groups by the analyst, and then by interviewing the personnel high working experience. The recording of the interview was carried out using a note-taking method.

B. Calculate the Diagnosis and Actions Failure Probability

- (1) If all PSF ratings are nominal, then the Diagnosis and Actions Failure probability are respectively 1.0E-2 and 1.0E-3.
- (2) Otherwise,
 - ✓ the Diagnosis Failure Probability is: $1.0E-2 \times \text{Time} \times \text{Stress or Stressors} \times \text{Complexity} \times \text{Experience or Training} \times \text{Procedures} \times \text{Ergonomics or HMI} \times \text{Fitness for Duty} \times \text{Processes}$
 - ✓ the Functional Failure Probability is: $1.0E-3 \times \text{Time} \times \text{Stress or Stressors} \times \text{Complexity} \times \text{Experience or Training} \times \text{Procedures} \times \text{Ergonomics or HMI} \times \text{Fitness for Duty} \times \text{Processes}$

C. Calculate the Adjustment Factor IF Negative Multiple (≥ 3) PSFs are Present

When 3 or more negative PSF influences are present, instead of the equation above, you must compute a composite PSF score used in conjunction with the adjustment factor. Negative PSFs are present

when a multiplier greater than 1 is selected. The Nominal HEP (NHEP) is 1.0E-2 for diagnosis and 1.0E-3 for Functional. HEP means Human Error Probability. The composite PSF score is computed by multiplying all the assigned PSF values. Then the adjustment factor below is applied to compute the HEP: $HEP^1 = NHEP.PSF/NHEP(PSF-1)+1$

D. Record Final Diagnosis or Functional HEP

If no adjustment factor was applied, record the value from Part B as your final diagnosis HEP. If an adjustment factor was applied, record the value from Part C.

Part II. Calculate Task Failure Probability without Formal Dependence (PW/OD)

¹Calculate the Task Failure Probability without Formal Dependence (PW/OD) by adding the Diagnosis Failure Probability from Part I and the Functional Failure Probability from Part II. In instances where an Functional is required without a diagnosis and there is no dependency, then this step is omitted.

Part III. Dependency

As for all tasks, except the first task in the sequence, use the table and formula below to calculate the Task Failure Probability with Formal Dependence (PW/D). If there is a reason why failure on previous tasks should not be considered, such as it is impossible to take the current Functional unless the previous Functional has been properly performed, explain here: First task in sequence.

Dependency Condition Table

Using $PW/OD =$ Probability of Task Failure without Formal Dependence (calculated in Part III):

For Complete Dependence the probability of failure is 1.

For High Dependence the probability of failure is $(1 + PW/OD)/2$

For Moderate Dependence the probability of failure is $(1 + 6 \times PW/OD)/7$

For Low Dependence the probability of failure is $(1 + 19 \times PW/OD)/20$

For Zero Dependence the probability of failure is PW/OD

Calculate PW/D using the appropriate values:

$$PW/D = (1 + (\text{_____} * \text{_____}))/ \text{_____} =$$

RESULTS

Totally, nine tasks and 17 errors were related to nursing activities, five tasks and 17 errors related to

the activities of laboratory experts, three tasks and five errors related to the activities of radiologists, as well as 3 task and six errors to service activities. HTA analyzes of each of the main tasks were drawn up in a diagram, and the degree of error in various occupational groups was measured regarding different tasks (Table 1 - 4).

Among the diagnostic errors, the highest error rate was related to the patient who was not matching with the case, wrong injection due to nominal or apparent similarity with 0.4%. The lowest error rate was associated with the probability of entering the wrong code in the system and the probability of entering the wrong patient in the system of laboratory and paraclinical services with 0/0016 percent. Among the functional errors, the highest rate was related to the patient's bedsores with 0.005, and the lowest rate was the probability of error in entering the numbers associated with the vital signs with 0.000125. Among the composite error, the most probable error was related to an improper Venipuncture with a probability of 0.7 and the lowest probability error was related to the probability of a mistake to enter at least one of the drugs due to the nominal similarity with the probability of 0/0045 (Table 1).

According to the findings from this study in the lab, among the diagnostic errors, the highest error rate was related to the wrong registration request or not registering it with 1, and the lowest percentage error was related to the error in typing the test response with 0.4%. Among the Functional errors, the error rate was lack of sampling skill with 0.02% and the least probable error was related to the failure or loss of samples, failure to comply with requirements after sampling, and delay in response with a probability of 0.00025%. Among the composite errors, the most probable error was related to interruptions in device performance with a probability of error 0.0825 and the least probability of errors related to the Inappropriate labeling with the probability of error 0.00225.

Based on the findings of the study in the field of radiology, the highest error rate was related to the incorrect registration of the member for the radiology with the probability of error 0.004. The lowest error rate associated with the wrong injection method with 0.225% and the most error associated with the wrong report to the patient with a possible error of 0.040125. The lowest probability error associated with the wrong injection method with the probability of error of 0.0225/0 reported (Table 3).

Of the errors diagnosis related to patient falls from the bed, the possibility of error is 0.2. The lowest percentage of errors pertaining to disinfecting beds perfectly and the possibility of contamination with

Table 1 The probability of human error (nursing)

Row	Task list	Indictable Error	The probability of the diagnosis error	The probability of the functional error	Error probability without dependency factor	Error probability with coefficient of dependency
1	Admission	Wrong registration request	-	0.00025	0.00025	0.00025
		Failure to match patients with the case	0.4	-	0.4	0.04
		Incorrect recording of the patient's lens number in the case	0.4	0.0005	0.4005	0.4005
		Mistake in closing the patient's bracelet and error in identifying the patient	-	0.0025	0.0025	0.0025
2	Enter the doctor's orders at the Card	Probability of not entering at least one order in the card	-	0.0025	0.0025	0.0025
		The mistake in entering at least one case of drugs due to the nominal similarity	0.004	0.0005	0.0045	0.0045
3	Control of patient's vital signs	Error in entering numbers related to vital signs	-	0.000125	0.00125	0.00125
4	control the patients	Falling patient from bed	-	0.0025	0.0025	0.0025
		patient's bed sore	-	0/005	0/005	0/005
5	Attach the peripheral venous catheter	Venipuncture	0.1	0.6	0.7	0.7
6	serve drug to the patient	The wrong injection due to the nominal or apparent similarity	0.4	-	0.4	0.4
		-serving wrong oral medicine	0.1	-	0.1	0.1
		Needlestick when injecting medication or sampling	0.016	0.001	0.017	0.017
7	Blood injection	Injecting wrong blood products to the patient	0.05	-	0.05	0.0975
8	Enter paraclinical tests and services in the system	the probability of entering the wrong code in the system	0.0016	0.0001	0.0017	0.0017
		the probability of entering the wrong patient's name in the system	0.0016	0.0001	0.0017	0.0017
9	Delivering patients to the next shift	Uncertainty about the correctness of patient connections	0.008	0.001	0.009	0.009

*Compound error is an error that occurs due to diagnostic and functional errors

Table 2 The probability of human error (lab)

Row	Task list	Indictable Error	The probability of the diagnosis error	The probability of the functional error	Error probability without dependency factor	Error probability with coefficient of dependency
1	Admission	Wrong registration request or not registering it	0.81	-	0.81	1
		Failure to match patients with the version	0.04	-	0.04	0.04
		Inadequate explanation for referring to the sampling conditions	-	0.005	0.05	0.05

Table 2 Continue

Row	Task list	Indictable Error	The probability of the diagnosis error	The probability of the functional error	Error probability without dependency factor	Error probability with coefficient of dependency
2	Sampling	Lack of sampling skill	-	0.02	0.02	0.02
		Inappropriate and inadequate sample	-	0.0005	0.0005	0.0005
		Failure or loss of samples	-	0.00025	0.00025	0.00025
		Inappropriate labeling	-	0.0015	0.0015	0.0015
3	Separating of sample	Failure to comply with requirements after sampling	-	0.00025	0.00025	0.00025
		Inappropriate labeling	0.002	0.00025	0.00225	0.00225
4	Carry out tests in different parts of the lab	Do not do the test in time	-	0.0005	0.0005	0.0005
		Mistake in doing the test	-	0.0005	0.0005	0.0005
		Inadequate personnel skills to work with the device	0.008	0.0005	0.0085	0.0085
		Interruptions in device performance	0.08	0.0025	0.0825	0.0825
5	Responsibility	Inappropriate kits, materials and Past expiration date	0.04	0.0025	0.0425	0.0425
		Wrong Typing	0.004	-	0.004	0.004
		Incorrect report	-	0.005	0.005	0.1
		Delay in response	-	0.00025	0.00025	0.00025

Table 3 The probability of human error (radiology)

Row	Task list	Indictable Error	The probability of the diagnosis error	The probability of the functional error	Error probability without dependency factor	Error probability with coefficient of dependency
1	Patient reception	Registration Wrong member for Radiology	0.004	-	0.004	0.0538
		Take wrong photo organ	0.004	0.00125	0.00525	0.0549
2	Providing services	Inject the wrong drug volume	0.004	0.00025	0.00425	0.00425
		Wrong drug injection method	0.00025	-	0.00025	0.00025
3	Responsibility	Incorrect report	0.004	0.000125	0.40125	0.088

a probability of 0.005 percent. In addition, in the composite error, the most likely error was related to the manipulation of patient connections with an error probability of 0.22 and a low probability error, needlestick when collecting garbage with an error probability of 0.01025.

DISCUSSION

The results of this study showed that the highest probability of error in the nursing profession was related to the patient's improper Venipuncture with a probability of error of 0.7. At least, it was

the probability of error in entering the numbers related to the vital signs with an error probability of 0.000125. In a study in 18 hospitals covered by Mazandaran which used a health checklist to evaluate probable errors, among 317,966 admissions, 182 cases, approximately 60% of the medical errors were reported, which most reports (51.6%) were from non-teaching hospitals, including inadequate dosage injections, bed sores, falling patient from bed, and wrong injection which were adaptable with this study.²⁶

Tanha et al. reported the most probable error in the nursing department was related to blood

Table 4 The probability of human error (service)

Row	Task list	Indictable Error	The probability of the diagnosis error	The probability of the functional error	Error probability without dependency factor	Error probability with coefficient of dependency
1	Displacement of patients	Patient falls from the bed	-	0.2	0.2	0.2
2	Washing and cleaning of all parts of the hospital	Manipulation of patient connections	0.2	0.02	0.22	0.22
		Mistake in the combination of suitable detergents	0.008	0.005	0.013	0.013
		Disinfecting beds perfectly and the possibility of contamination	-	0.005	0.005	1
		Needlestick when collecting garbage	0.01	0.00025	0.01025	0.01025
3	Take samples to the lab	Delays in taking samples to the laboratory and sample failure	0.01	0.001	0.011	0.011

injection and blood products with a probability of 0.78. The probability of error was related to the operation of the pump with an error rate of 0.055.²¹ In order to prevent wrong blood injection, two nurses can be reassessed by requesting blood and sending separate samples for requesting and cross-wrist blood products. They could control the vital signs and clinical status of the patients in the first 51 minutes of initiation of blood transfusion, informing the symptoms of the reaction blood tests, and empowering staff to carry out the relevant actions reduce the probability of this error. In a study by Ghasemi et al., who used SHERPA to evaluate the error in the triage area of one of Tehran's teaching hospitals, they found that the probability of operating error had the highest share (46.8%) among the measurable error.²⁷

In the present study, among the obvious errors of a drug error, one of the most common drug errors which were identified. It was consistent with Ehsani's survey of 94 scholars at Imam Khomeini Hospital in Tehran and Koopl.^{28,29} The results of Desai and Manias studies revealed the highest incidence of drug errors due to the high volume of work, drug intervention, delivery issues, incomplete and inappropriate communication of personnel during the delivery of shifts and unreadable prescription.^{30,31} Due to the importance and probability of occurrence of this type of error, proper administration of the correct method based on 8 right, adequate implementation of the double-check process in high-risk drugs, identification of similar drugs with similar form, pronunciation, and related text can be achieved by the correct

application of the method for the nurses. Each section, the separation and labeling of high-risk drugs from the pharmacy, and the sensitization of nurses/midwives to relevant labs, and the identification of care, the complications of new drugs by the pharmacy to related sectors, could reduce the likelihood of such an error.

In the study of Bagheri Nasami et al. who reviewed the frequency of non-traumatic drug errors among nurses of cardiac care units in Mazandaran province in 2014, show that the most reason for causing nursing errors was the lack of available time, stress, and high work pressure reported. The study was consistent with the present study.³² It is possible to reduce the probability of occurrence of preventable errors by employing experienced personnel and training personnel in stressful situations.

In the laboratory, the most probable error is due to incorrect entry or failure to enter the application with the probability of error 1 and the least probability of not performing the test promptly, a mistake in the trial, and getting an insufficient sample from the patient with a chance of 0.0500 error. In the study of Rasoulzadeh et al. (1393), it was concluded that the most incongruous errors in the laboratory section of the hospitals were incorrect entry patient information (% 6/14), error in the acceptance of the requested materials (% 12/4), inappropriate sampling% (10/1), and error in the labeling of sample containers% (9/8), which was studied by the present was in line.³³ Based on the study conducted by PalBella in one year, over 81% of laboratory errors occurred at the admissions stage.³⁴ On the other hand, Aranjena Chawla et al.

reported that the rate of errors observed in the admission of 51,244 blood samples was inadequate in inappropriate sampling (low volume), error in the sample (laiz or limp sample) were reported to be consistent with the current study.³⁵

Since laboratories have a high impact on patient safety and 80-90% of medical diagnosis are based on the results of laboratory tests, errors in laboratory tests lead to delay in treatment or error in treatment, and thus additional costs and causes increase the patient's risks.³⁶ Considering the fact that the highest number of reported errors occurred at the patient's admission stage and given the high volume of patients visiting hospitals laboratories, especially public hospitals, it is necessary to allocate more personnel in the admission and response department. It seems that the establishment of a system which is in terms of the quality of the laboratory support and can in addition to controlling the laboratory. It can cover the errors and errors and provide correct training. So, it can play a useful role in reducing laboratory errors.^{21,37} Next, by controlling the patient's profile with the application form, the control of the request submitted by the physician's order and the test recorded in the HIS system can be cured by the patient's request to express the person's profile and the type of diagnostic test requested for a possible error in the field.

According to the result in this study in radiology, the highest and the lowest probability of error was related to an incorrect report (0.088%) and wrong drug injection method (0.00025). When imaging an organ, the factors such as mistakes in typing when admission a left and right in the requesting section, imaging for the patient, the crowding of the radiology department, and stress on the personnel, especially in amateur persons, can lead to incorrect imaging of the organs and send the inaccurate report. As to prevent this error, it can mark the target organ during the transfer of the patient to the radiology department, or the personnel themselves ask from the patient alert or companion patient to make sure.

The findings from the study in the service profession showed that the most probable error was the disinfecting beds perfectly and the possibility of contamination (1%) and the least probable error associated with the needlestick when collecting garbage (0.01025). Due to the high workload on service and over bed turnover, the service staff does not properly disinfect the beds, which can lead to contamination, but by training the service staff and increasing the number of service staff and reducing their workload, the occurrence of these errors should be prevented.

CONCLUSION

The analysis of errors identified in this study showed that the major causes of errors due to the high volume of work and insufficient time in all target groups can be attributed to a shortage of available time, stress and high work pressure of personnel. According to the SPAR-H method which leads to the identification and determination of a variety of human errors, their probability of occurrence, and also the role of different conditions influence the performance of personnel in the performance of their duties; the possibility of defining and provides ergonomic interventions to reduce the risk of human error.

LIMITATION

Due to the time consuming of filling in the questions about the hospital questionnaire and the lack of sufficient personnel time to complete them, the questioner should refer several times to each section. After finishing and analyzing them, except in the nursing sector, this study had to compare the probability error data with other risk assessment methods. The reports were also probably the error in radiology and services has not been considered, so it is recommended that this study is conducted in other provinces and other treatment groups, due to the failure to complete a similar article to this method.

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CONFLICT OF INTERESTS

There is no conflict of interest to be declared.

AUTHORS' CONTRIBUTIONS

All authors contributed to this project and article equally. All authors read and approved the final manuscript.

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