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Identification and assessment of medical errors in the triage area of an educational hospital using the SHERPA technique in Iran

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Accidents caused by human error are prominent in the medical field. The present study identified medical errors in the emergency triage area by assessing the tasks of all healthcare workers employed in the triage area of an educational hospital in Tehran, Iran in 2014. Data were collected using the systematic human error reduction and prediction approach (SHERPA). The tasks and sub-tasks were determined and analyzed using hierarchical analysis and the errors were extracted. A total of 199 human errors were identified in the different tasks. The rate of error for action was 46.8%, checking was 25.6%, retrieval was 8.5%, communication was 12.1% and selection was 7%. Rate of unacceptable and unfavorable risks were 21.1% and 38.6%, respectively. SHERPA was shown to be an appropriate technique for detecting medical errors. The establishment of control programs should be a high priority in the management and implementation of health facilities in triage areas.

Keywords: human error; medical error; hierarchical task analysis; SHERPA; Iran; triage area

1. Introduction

Human error is a major cause of accidents and disruption of schematized functions. The catastrophic consequences of this failure have been proven by calculation of human error.[1] In a healthcare setting where all spectrums of human health should be provided, medical error is the main cause of mortality and should be included as the most important cause of mortality worldwide.[2,3]

Numerous studies show that the incidence of medical error imposes heavy costs on society. Because of the sensitivity and importance of the medical occupations, the occurrence of error, even a seemingly simple error, can cause major iatrogenic side effects for patients.[4–6] It has been estimated that medical error affects about 850,000 people each year in Great Britain and prolongs admittance to hospitals or medical centers. The insurance costs of such errors are more than 2000 million EUR with additional treatment costs and clinical negligence totaling about 4 billion EUR.[7,8]

Medical errors are the third main cause of mortality in the USA; medication errors harm at least 1.5 million people each year, 400,000 of which are preventable.[9] Overall, it has been found that 70% of medical errors are preventable, 6% are probably preventable and 24% are not preventable.[10,11] Little attention has been focused on research on medical errors in Iran in contrast to the many studies done around the world. One study determined the frequency and types of medication errors in an academic emergency department in Iran and found that the rate of medication errors was 0.41 per patient; another study calculated the mean number of medication errors as 7.4.[12,13]

Several techniques have been used to identify, assess and predict potential human errors in dynamic systems. The most common of these is the systematic human error reduction and prediction approach (SHERPA). This technique can estimate human error in terms of type, possible consequences and strategies for prevention and control.[14]

These statistics indicate the necessity of assessing human errors by type of medical occupation. Unfortunately, few studies have been conducted on medical errors using standard methods in Iran. The importance of study in this area is essential. The triage area is a key feature of the emergency department in which medical errors can lead to prominent defects in the diagnosis and management of health problems.

1.1. Objectives

The present study was designed to assess the following in the triage area of an academic hospital:

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- Identify and predict human errors
- Identify and predict situations that promote errors
- Identify critical errors
- Provide solutions to decrease human error
- Determine the level of risk.

2. Subjects and methods

This cross-sectional study was performed to identify and assess medical errors in the triage area (triage unit and acute care unit) of an educational and referral hospital in Tehran, Iran in 2014. This hospital contains 600 active beds, including 20 in the triage area.

The activities of 108 physicians and nurses, including 6 nurses working in a triage and acute care unit, and 63 nurses and 39 physicians working in three shifts were examined. Two individuals (1 physician and 1 nurse) refused to participate in the study. The mean (*SD*) age of the assessed workers was 27 (5.3) years and work experience was 5 (2.76) years; 63 subjects (58%) were female.

Information was collected by observation of tasks, interviews with physicians and nurses, and reviews of existing guidelines and regulations using SHERPA. The respondents were informed about the purposes and methodology of the study. A walk-through survey was conducted to precisely delineate the work trends for each type of medical disorder. Comprehensive observation was carried out for all shifts using random observational sessions without advance notice. All findings were reviewed with the manager of the triage area and the heads of nursing and medical officials.

The selection of SHERPA was based on the results of a comparative study of six techniques designed to identify human errors. The results indicate that SHERPA was top rated for validity (0.8) and reliability (0.9).[15–17] The implementation of the SHERPA technique was based on the following steps:

(1) Hierarchical task analysis (HTA): this step analyzed the tasks and relied on the perceptions of participants about an occupation and its related tasks. HTA created a scenario for a task and divided the tasks in every stage into: action (A); retrieval (R); checking (C); selection (S); information communication (I).
(2) Human error identification (HEI): classification of task levels by an assessor to identify human errors caused by healthcare workers. Potential errors in each task identified in step 1 were identified.
(3) Consequence analysis: this step reviewed the consequences of each error. An assessor identified each error and provided a complete description of the consequences identified in the previous step.
(4) Recovery analysis: the assessor identified potential recovery of identified errors. If it was determined that there was no possibility for recovery, the task was moved to the next step.
(5) Ordinal probability analysis: the probability of the risk was determined according to MIL-STD (military standard) standards and its measurement was based on the results of analysis of integration for the probability of an error for each task and its respective consequences. This standard was introduced in 1984 by the US military to identify the likelihood of a risk classified as: frequent (A); likely (B); occasional (C); seldom (D); unlikely (E). The severity of the error was classified as: catastrophic (1); critical (2); marginal (3); slight (4). Table 1 shows the matrix of the decision criteria based on the risk index.[17]
(6) Criticality analysis: if an error was determined to be critical without possible recovery, posed a serious incident with critical consequences and was damaging to the structure of the healthcare setting or personnel, it was defined as 'critical'; where there is no serious damage or negligible consequences, it was called 'insignificant'.
(7) Remedy analysis: this step proposed solutions to reduce errors and prevent error occurrence.

Table 1. Decision criteria based on risk index.

Risk criteria	Risk categorization
Unacceptable	1A, 1B, 1C, 2A, 2B, 3A
Unfavorable	1D, 2C, 2D, 3B, 3C
Acceptable but needs revision	1E, 2E, 3D, 3E, 4A, 4B
Acceptable (safe)	4C, 4D, 4E

Note: The frequency of risk is stated as A = frequent; B = likely; C = occasional; D = seldom; and E = unlikely. The importance and severity of outcomes are stated as 1 = catastrophic; 2 = critical; 3 = marginal; and 4 = slight.

3. Results

A total of 199 errors were identified from analysis of the SHERPA worksheets. The number of errors, in order, were for action at 93 (46.8%); then checking at 51 (25.6%); communication at 24 (12.1%); retrieval at 17 (8.5%); and selection at 14 (7%). After determining the critical tasks, an HTA diagram was drawn for each job. Figure 1 shows a sample HTA diagram. Table 2 shows a sample SHERPA worksheet and Table 3 shows the types and number of identified errors in the occupations under study (nurse triage unit, nurses and physicians in acute care unit).

The activities of the nurses in the triage unit were observed and the highest percentages of errors were for selection (40%) and the lowest were for action (6.66%) tasks. The percentages for nurses working in the acute care unit were action at 6.30%, checking at 5.41%,

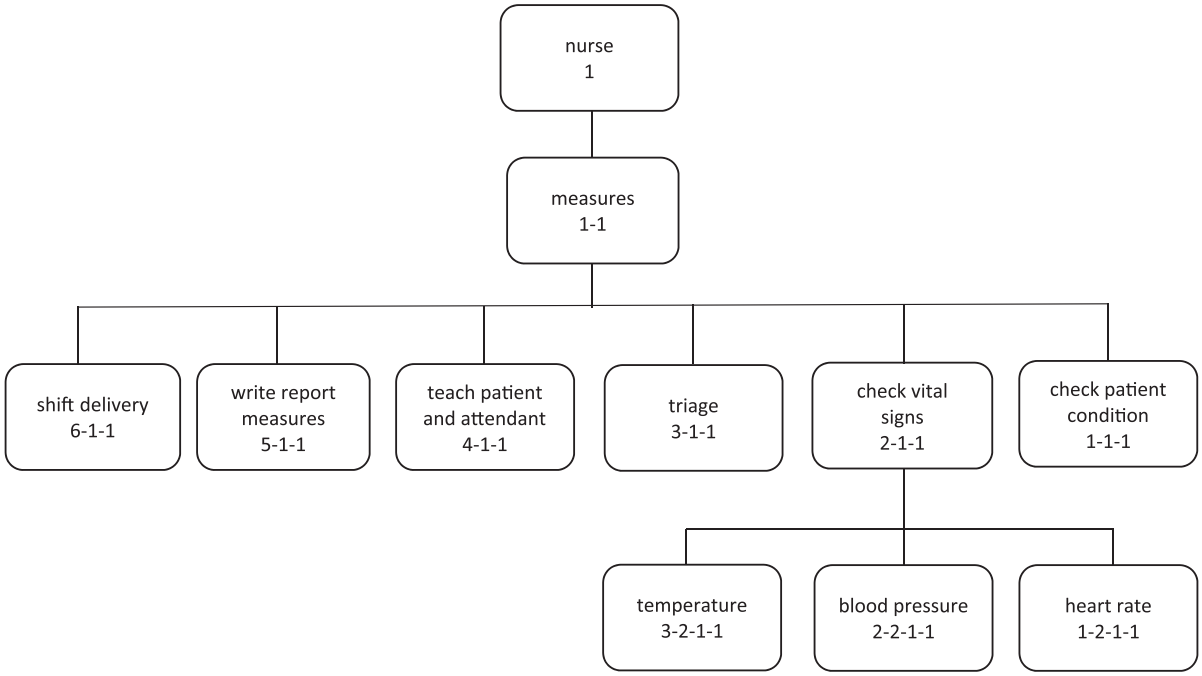

Figure 1. Task analysis of nurses working in the emergency triage unit using hierarchical task analysis (HTA).

Table 2. Summary of SHERPA output for human error.

Task step	Task	Error mode	Description	Consequence	Recovery	Risk level	Remedial measures
1-1-1	Check patient condition	C1	Forget review of patient condition	Possible worsening of patient condition	No	2B	Prepare regulatory worksheets Prepare evaluation form and monitoring by supervisors
		C2	Incomplete review of patient condition	Possible worsening of patient condition	No	2B	Prepare regulatory worksheets Prepare evaluation form and monitoring by supervisors
1-2-1-1	Check vital signs (heart rate)	A8	Forget measurement of heart rate on time	Probable mistake in later stage of treatment	Yes	3D	Prepare schedule sheet and monitoring by supervisors Check reminder lists from other nurses
		A8	Forget measurement of heart rate on time	Probable mistake in later stage of treatment	No	3E	Prepare schedule sheet and monitoring by supervisors Check reminder lists from other nurses
		A8	Forget measurement of pulse rate	Endanger patient condition	Yes	2E	Prepare relevant guidelines Check reminder lists from other nurses
		C1/C2	Failure of action or inaccurate function of heart rate device	Inaccurate recording of heart rate	Yes	2C	Repair and maintain device intermittently

(*Continued*).

Table 2. Continued

Task step	Task	Error mode	Description	Consequence	Recovery	Risk level	Remedial measures
				Failure to measure heart rate			Prepare worksheet for a routine check of heart rate device
2-2-1-1	Check vital signs (blood pressure)	C1	Failure of action or inaccurate function of sphygmomanometer	Mistake in measurement of blood pressure	Yes	4E	Repair and maintain device intermittently Prepare worksheet for a routine check of sphygmomanometer
		A8	Forget measurement of blood pressure on time	Mistake in measurement of blood pressure	Yes	3D	Prepare schedule sheet and monitoring by supervisors Check reminder lists from other nurses
3-2-1-1	Check vital signs (body temperature)	A8	Forget measurement of body temperature on time	Mistake in measurement of body temperature	Yes	3C	Prepare schedule sheet and monitoring by supervisors Check reminder lists from other nurses
		S2	Select inappropriate location to measure body temperature	Mistake in measurement of body temperature	Yes	3E	Prepare relevant guidelines Run training and retraining courses
		C1	Failure of or inaccurate function of thermometer	Mistake in measurement of body temperature	Yes	3C	Check operation of thermometer regularly
		A8	Forgot shaking the thermometer before using	Mistake in measurement of body temperature	Yes	3C	Run relevant practical training and supervise personnel
3-1-1	Triage	R2	Receive false information	Probability of patient's death Failure in prioritizing patients to receive treatment	Yes	1B	Prepare regulatory worksheets Prepare evaluation form and monitoring by supervisors
		R3	Receive incomplete information	Probability of patient's death Failure in prioritizing patients to receive treatment	Yes	1B	Prepare regulatory worksheets Prepare evaluation form and monitoring by supervisors
		S2	Inappropriate prioritization of patients	Probable patient death	Yes	1B	Prepare regulatory worksheets
				Failure to prioritize patients needing treatment			Prepare evaluation form and monitoring by supervisors
		A11	Prioritization of patients by unqualified personnel	Probable patient death	No	1B	Prepare regulatory worksheets
				Failure to prioritize patients needing treatment			Prepare evaluation form and monitoring by supervisors
4-1-1	Awareness of patient and attendants about disease	I1	Lack of patient and attendants understanding about disease	Possible worsening of patient condition from lack of medical/nursing knowledge	Yes	2C	Training of patients and attendants by nurses

(*Continued*).

Table 2. Continued

Task step	Task	Error mode	Description	Consequence	Recovery	Risk level	Remedial measures
							Make pamphlets, posters and training guidelines
		I3	Incomplete patient and attendant understanding about disease	Possible worsening of patient condition from lack of medical/nursing knowledge	Yes	2C	Training of patients and attendants by nurses
							Make pamphlets, posters and training guidelines
		I2	Misunderstanding of patients and attendants about disease	Possible worsening of patient condition from lack of medical/nursing knowledge	Yes	2C	Training of patients and attendants by nurses
							Make pamphlets, posters and training guidelines
5-1-1	Writing report measures	A8	Failure to record measures	Failure to follow up patient	Yes	3B	Prepare recording checklists
							Control and follow up of recording checklists by supervisors and shift officials
							Encourage policies to record cases accurately
		A9	Incomplete recording	Failure to follow up patient	Yes	3B	Prepare recording checklists
							Control and follow up of recording checklists by supervisors and shift officials
							Encourage policies to record cases accurately
		A7	Failure to record case properly	Failure to follow up patient	Yes	3B	Prepare recording checklists
							Control and follow up of recording checklists by supervisors and shift officials
							Encourage policies to record cases accurately
6-1-1	Shift delivery	I3	Transmission of incomplete information about patient to next shift	Possible worsening of patient condition	No	3B	Prepare record and follow-up checklists and monitoring by supervisors before shift delivery
		R3	Next shift receives incomplete information about patient	Possible worsening of patient condition	No	3B	Prepare record and follow-up checklists and monitoring by supervisors before shift delivery
		R2	Transmission of wrong information about patient to next shift	Possible worsening of patient condition	Yes	3B	Prepare record and follow-up checklists and monitoring by supervisors before shift delivery

Note: Error modes were as follows: A = action; R = retrieval; C = checking; S = selection; I = information communication. Risk level: The frequency of risk is stated as: A = frequent; B = likely; C = occasional; D = seldom; E = unlikely. The importance and severity of outcomes are stated as: 1 = catastrophic; 2 = critical; 3 = marginal; 4 = slight.

Table 3. Occupation and type and number of error identified.

No.	Job classification	Type of error				
		Action	Checking	Retrieval	Information communication	Selection
1	Nurses in triage	6.66% (2)	13.34% (4)	13.30% (4)	26.66% (8)	40% (12)
2	Nurses in acute care unit	6.30% (8)	5.41% (7)	6.94% (9)	27.12% (35)	54.23% (70)
3	Physicians	10% (4)	15% (6)	27.50% (11)	20% (8)	27.50% (11)
4	Total number of identified errors	7.05% (14)	8.44% (17)	12.07% (24)	25.65% (51)	46.79% (93)

communication at 27.12%, retrieval at 6.94% and selection at 54.23%. Analysis of physician tasks showed the percentages were action at 10%, checking at 15%, communication at 20%, retrieval at 27.5% and selection at 27.5%. Table 4 shows each type of errors in the triage area.

The total number of unacceptable risks was 42, unfavorable was 77, acceptable but needs revision was 74 and acceptable risk was 6. The task classification for nurses in the triage unit was acceptable (3.34%), acceptable but needs revision (20%), unfavorable (50%) and unacceptable risks (26.66%) (Table 5). In addition, 52.3% of identified errors were not covered. Activities related to the triage nurse at 26.67% were the lowest and physician activities at 67.5% were the highest. Table 6 shows that a total of 104

Table 4. Type and number of errors identified in triage area using SHERPA.

Error code	Error type	Number of identified error	%
A1	Operation too long/short	13	6.5
A2	Operation mistimed	0	0
A3	Operation in wrong direction	0	0
A4	Operation too little/much	7	3.6
A5	Operation is inappropriate	0	0
A6	Right operation on wrong object	2	1
A7	Wrong operation on right object	11	5.5
A8	Operation omitted	48	24.1
A9	Operation incomplete	11	5.5
A10	Wrong operation on wrong object	0	0
C1	Check omitted	32	16.1
C2	Check incomplete	19	9.5
C3	Right check on wrong object	0	0
C4	Wrong check on right object	0	0
C5	Checking is done untimely	0	0
C6	Wrong check on wrong object	0	0
R1	Information not obtained	1	0.5
R2	Wrong information obtained	8	4
R3	Information retrieval incomplete	8	4
I1	Information not communicated	3	1.6
I2	Wrong information communicated	7	3.6
I3	Information communication incomplete	14	7
S1	Selection omitted	1	0.5
S2	Wrong selection made	14	7

Note: Error modes were: A = action; R = retrieval; C = checking; S = selection; I = information communication.

Table 5. Frequency distribution of risk level based on occupation.

Order	Type of job	Risk level				
		Acceptable	Acceptable but needs revision	Unfavorable	Unacceptable	Total
1	Nurses in triage unit	3.34% (1)	20% (6)	50% (15)	26.66% (8)	100% (30)
2	Nurses in acute care unit	3.88% (5)	50.38% (65)	34.88% (45)	10.86% (14)	100% (129)
3	Physicians	0% (0)	7.5% (3)	42.5% (17)	50% (20)	100% (40)
4	Total	3.03% (6)	37.18% (74)	38.69% (77)	21.10% (42)	100% (199)

Table 6. Frequency error recovery based on type of error.

Order	Error recovery	Type of error					
		Action	Checking	Information communication	Retrieval	Selection	Total
1	Number of errors	46.79% (93)	25.65% (51)	12.07% (24)	8.44% (17)	7.05% (14)	100% (199)
2	Number of non-covered errors	42.31% (44)	28.86% (30)	10.57% (11)	10.57% (11)	7.69% (8)	100% (104)

errors were not covered, which means they had no acceptable recovery; action errors had the highest percentage of non-covered error.

4. Discussion

4.1. Main findings

The results show that medical errors were common in the triage area. SHERPA appears to be an appropriate method of predicting and classifying medical errors and reveal hidden failures. Phipps et al. [18] identified human errors using SHERPA in anesthetic practice and stated that this technique appropriately identified, classified and assessed human errors in human–machine systems. Harris et al. [14] used SHERPA to predict design-induced error on flight decks and reported the validity and stability of the technique to be .7 and .9, respectively. Salvendy [19] reported the validity and stability to be .8 and .9, respectively. All these studies confirm the strong ability of this technique to predict, assess and control human errors in various industries.

The findings of the present study indicate that the most common errors by physicians were action and retrieval errors; this is consistent with previous research conducted in an emergency ward.[20] Results from earlier studies in other industries suggest similar findings. One survey in an oil refinery showed that action errors are common.[21] The medical profession includes many tasks that include action and retrieval; theoretical and practical ongoing training programs can be effective for this occupational group to improve preventive strategies for decreasing medical errors.

In the present study, action errors had the highest number of unacceptable and unfavorable risks; the critical nature of medical responsibility means that control measures should be a priority for these. Other variants, such as lack of sufficient experience and up-to-date scientific information, work pressure and exhaustion are involved in these areas. It is necessary to reduce or prevent such errors. Job-specific recommendations include patience, concentration, updating business information, obtaining medical advice from experts, use of highly qualified and experienced physicians, and decreased work pressure and fatigue. Several studies have determined that work pressure, stress, fatigue and lack of training are the main causes of medical errors.[22–24]

Checking errors are the second most common types of unacceptable and unfavorable risks. These resulted from a lack of ability to communicate well with patients, lack of a detailed physical examination, inability to remain calm while communicating with patients and failure to obtain the necessary information from a patient. The hospital emergency triage area works under a five-level triage systematic and standardized regulatory system. The triage unit activities were necessary, but the high number of referrals and congestion in the emergency ward make it difficult for nurses to perform their tasks correctly which increases errors. Special attention should be paid by the supervising system to improve the technical capacities of nurses working in the triage area.

Medication errors are very important in health and medical services; 25% of medical errors are related to medication [25] and this figure was 8% in the present study. A study in a Sudanese hospital indicated that only 19% of prescriptions contained the full name of the patient, 20% contained the generic name of the drug, 60% were not listed correctly and 16% of the drug prescriptions were illegible.[26] A study of several pharmacies in Norway found that, of a total of 4667 prescriptions, 1359 prescriptions contained drop-out medications.[27] The most medication errors result from confusion of drug names, medication selection errors, injection errors and dosage errors, and resulted from a high workload, intervention medication delivery issues, incomplete communication and inappropriate transmission of information to the next shift, and illegible prescriptions.[28,29] An efficient method to control such errors is the use of software systems, which have been found to decrease medication errors by about 80%.[30]

One important factor in the occurrence of errors is shift work processes. Studies show that 70% of medical errors in shift workers are caused by poor communication and 50% of errors occur during a change in shifts.[20] Employment of full-time persons for night work is strongly recommended, especially employees below 50 years of age, without pre-exiting disorders such as psychological or metabolic diseases who are not employed in second jobs.[31]

Error recovery was also addressed in the present study. Non-recovered errors are those which cannot be easily detected and identified. The results showed that more than half of errors were non-recovered, with nurses showing the lowest rate and physicians showing the highest rate. Action errors were more commonly non-covered. These types of errors are hidden and can underlie other errors. The Swiss cheese model showed hidden errors to be organizational and systemic failures and play the greatest role in the occurrence of human error. The more complex the system, the more defects occur.

It was found that, if conditions favorable to the occurrence of error exist in the workplace, they will eventually occur; therefore, the system must be designed to eliminate conditions favorable to the occurrence of errors and, if an error occurs, it should be recognized immediately and its effect on the system should be minimized.[32] Training of staff and development of work instructions should be priority reforms in the system. The recommended methods are to assess human factors in medical issues and medical staffing, understand the limitations of human performance and systemic reasons behind these limitations.[33]

4.2. Limitations

This research contained a number of limitations, so the interpretation of findings should be done with caution. Lack of familiarity with the purpose of the study by managers, physicians and other personnel, crowded and stressful workplaces, and time limitations for the presence of researchers in the workplace were some limitations that interfered with data collection. After completing each SHERPA sheet, researchers discussed the sheets with a team of experts composed of ward managers and specialists in emergency medicine. Any corrections deemed necessary were made by the team after each assessment and required the cooperation of all members.

5. Conclusion

The present study used SHERPA in the triage area of a hospital for the first time in Iran. The study described the quality and quantity of human errors that occurred in an emergency triage area as a baseline for the prevention or decrease of such occurrences. It was demonstrated that action errors formed the highest percentages of unacceptable and unfavorable risk levels and were ranked as first in frequency, necessitating control programs as priorities over the other types of error.

The importance of triage in medical practice should be considered and management planning for triage must be carried out according to the highest standards. Since 50% of errors were related to physician tasks and were of the unacceptable risk level, a comprehensive review of the management, planning, processes and physician actions in the emergency section should be conducted and strategies applied to improve the system to reduce errors.

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Disclosure statement

No potential conflict of interest was reported by the authors.

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