

Identification, Assessment, and Control of Errors in Chemotherapy Process: A Case Study between Physician and Nurse

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ABSTRACT

Human errors are considered as one of the main causes of incidents in the field of healthcare. It is very important to predict errors and identify the factors causing them. The present study was performed to identify and assess physician and nurse errors during chemotherapy process, and to determine the corresponding risk and safety principles. This cross-sectional descriptive study was conducted in chemotherapy ward at Imam Reza hospital in Kermanshah, Iran, in 2015. Different activities were carried out including review literature, examining statistics and scientific resources, interviewing with physicians and nurses in chemotherapy, training the aim and research methodology, studying the instructions of chemotherapy, and monitoring activities and measures. Tasks were analyzed by (HTA) method, then errors were identified by SHERPA instruction, and their risks were evaluated. Finally, appropriate control measures were presented to reduce the risks of errors. Overall, 459 errors were identified among the 122 task, 10.46% of errors were unacceptable, and 42.11% were undesirable. Most of the errors were functional, and the fewest were retrieval. These errors occurred for some reasons including lack of doctors and nurses in relation to a large number of patients, lack of comprehensive guidelines, lack of cooperation between doctors, lack of proper training. Functional errors should be prioritized to control and reduce errors, which are possible through the development of guidelines and training courses, the careful monitoring of supervisors and frequent checkup, registering errors and disclosing.

KEYWORDS: SHERPA, Human errors, Risk assessment, Physicians, Nurses, Chemotherapy

INTRODUCTION

Medical errors are one of the major threats to health care quality [1]. Every person makes an average of 15 errors per workday.

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This estimate is true only in a stress-free working condition. As the work pressure and stress increase, the number of errors is expected to rise up to an error per half-minute rate [2]. "Human error" is still responsible for 75% of incidents in advance, and generally, it is responsible for 88% of incident,

unsafe acts [3]. Saying that human being was created to make mistakes, American medical institution in its annual report attracted all the attention to the mistakes and errors in the field of health [4]. The human error is inevitable in any profession.

Therefore, every person may make mistakes. Physicians and nurses are not the excluded from this rule [5]. There is considerable debate about the quality of healthcare in the health system. One out of every ten patients is injured when receiving health care [6]. About 50% to 96% of medical errors are not reported. About 96% of these errors has not been evaluated and cannot be prevented from happening again [7]. Most of these damages are caused by medical negligence.

Thousands of people lose their lives annually due to medical errors [8]. In the United States, almost 400 thousand deaths occur annually due to medical errors and it is the third cause of death in America, which is more than those deaths occur in motorcycle accidents and breast cancer [9, 10]. National Board of Health and Welfare in Sweden, according to the study in 2011, stated, "Annually, among 100000 error cases led to incidents, about 3000 patients die in Sweden. According to the studies conducted in America, England, and Australia, 4% to 16.6% of patients die or become disabled because of damages that half of them can be prevented [11, 5].

Nurses play a significant role in the treatment sections of hospitals. Nurses play crucial roles in patient care and prevention of incidents in recent decades [12]. Among the clinical professions, nurses are highly susceptible to human error as on the one hand, they are subject to physical and psychological pressures and on the other hand, they should remain motivated at the same time [36]. Overall, 2000 deaths and medical malpractice related to nursing error have been occurred in America [13]. So far, despite its importance, chemotherapy process has not been studied in terms of human errors.

The process of chemotherapy is so complicated that it is possible to have errors in each step of the process. In addition to patient safety, errors in the field of chemotherapy threaten the safety of physicians and nurses as well [14, 15]. The most common types of errors are: errors in prescribing [16], in patient identification [17], medication errors [18, 19], distribution of drugs [20], errors in calculating treatment doses, periods of chemotherapy and resting, the way of drug preparation, drug injection in comparison with other drugs [21], error associated with chemotherapy drugs are more likely to lead to severe injuries and even patient death [20, 35]. Moreover, serious errors in the process of chemotherapy are associated with serious consequences, most of which are predictable and preventable [5]. These errors, in addition to

harm the patients, cause irreparable complications for physician and mostly for all nurses. Nurses are considered as a principal key to reducing medical errors in the health care system [12]. Like other physicians, oncologists are even more probable to commit medical errors. While the low therapeutic index and high toxicity of chemotherapy drugs make the errors extremely dangerous in this area, and the nurses and physicians, and others would be exposed to the risks of the process.

That is why the chemotherapy ward of one of the largest hospitals in the western regions of Iran was selected for this study. Totally, 2440 people annually come to the hospital for chemotherapy. Systematic Human Error Reduction & Prediction Approach (SHERPA) method was used in this study. Six methods of PHEA, HEIST, TAFEI, GEMS, CREAM, and SHERPA were examined regarding different characteristics in terms of accuracy, reliability, credibility, comprehensiveness, usability, checkup, structure and efficiency that SHERPA method gained the most points among these methods. It is proper to assess the performance of the medical team [22]. In 2008, it was used to investigate medication administration process. This technique was used to identify laparoscopic surgery errors (2015) and endoscopic surgery errors [23]. SHERPA was employed to evaluate human errors in the emergency ward [24]. In 2014, [25] advantage was taken of this method to identify the ophthalmologists' errors in cataract surgery. SHERPA is widely used in the nuclear, petrochemical, and oil and gas industries, and it is applied more than other techniques to study errors in the field of health and treatment. The widespread use of the method is mainly due to its validity and acceptable reliability. The role of human error seems to be important in the health and treatment field, particularly the chemotherapy ward. Accordingly, the purpose of this study was to identify errors probable to occur during the chemotherapy process and assess the risks associated with such errors.

MATERIALS AND METHODS

This survey consists of different stages, including presence in the different shifts and monitoring the carried out tasks and familiarizing with the activities, interviewing with doctors and nurses in various stages of research and their purposes and justifying them, studying the particular. A team of three experts who are working in the human error from Hamadan University of Medical Sciences analyzed the results of the SHERPA Worksheets, the result presented of three people and the statistical procedures were computed with the software Excel.

First stage (HTA-Hierarchical Task Analysis): The hierarchical tasks of chemotherapy medical specialist and nurses, and general

practitioners monitoring in the ward are analyzed by HTA in order to identify sub-tasks. There are 5 oncologists and 20 chemotherapy nurses constantly in the chemotherapy ward. The general practitioners visit it to perform daily checks every morning and they are in on-call state in case of emergency. The treatment process is in this order include at first, each of physicians introduces those patients requiring chemotherapy to the ward. Then staff or receptionist, identifying emergency patients, puts clients in queue, and the patient's file is filled out by the secretary, and it is sent to the matron, after that patient's drugs are asked by HIS system. The delivery process of all chemotherapy drugs is done on the first day of hospitalization, and all chemotherapy drugs are kept in a ward refrigerator. Non-refrigerated medicines are delivered to the patient. Chemotherapy nurse should take care of the patient from entering the section to leaving it. These tasks are described in the form of HTA. The main advantage of HTA is to break down a task into smaller ones until it is needed. To ensure further, tasks and sub-tasks are checked and examined by consultation and under the supervision of the chemotherapy medical team

The second stage (Task classification): The tasks and subtasks obtained from the first stage are placed in one of five groups of Action, Retrieval,

Checking, Selection, and Communication information tasks. Researcher should train the total identification of tasks and errors to the physicians and nurses in the ward, addition to instruct methodology, he explains the purposes of study so that they can, safely and without worries, share their experiences of tasks and errors with research team; finally, the researcher classifies tasks and errors.

Third stage (HEI-Human Error Identification): Tasks are performed and the types of errors associated with each task are determined based on the classification (Table 1). This stage needs the researcher to be present inward in different shifts and to observe tasks in detail and errors, treatment method, and face-to-face interviews, and even to inquire of patients and their companions. To ensure the results and validate all of them, they are given to several nurses and physicians, under the supervising of whom final evaluation is performed.

Fourth stage (Consequence Analysis): Errors are categorized and the critical degree of each error is determined, and the consequences of the determined error should be fully specified.

Fifth stage (Recovery Analysis): The recovery potential of each detected error is determined in the fifth stage, so it should be investigated how errors can be prevented.

Table 1. 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

Sixth stage (Ordinal Probability Analysis): Any error is classified in one of five scales of frequently, often, sometimes, rarely, and never. If error has not been recorded, it is classified in low

classes, whereas it has sometimes occurred in the past, it is in moderate and if occurred repeatedly, it is in high ones (Table 2).

Seventh stage (Criticality Analysis):

Considering the intensity of occurring, errors are classified in four categories of catastrophic or unacceptable (death or losing systems), critical or undesirable (injuries, occupational diseases or damages to the system is high), borderline or acceptable, but need revising (injuries, occupational diseases or damages to the system is low), and minor

or accepted without revising (injuries, occupational diseases or damage to the system is too low) (Table 2).

Eighth stage (Remedy analysis): Error reduction solutions are presented. The solutions are suggested in the form of changes in the working system that can prevent errors.

Table 2. The matrix of assessing risk Level and risk criteria [26]

Probability of occurring	Catastrophic(1)	Critical(2)	Borderline(3)	Minor(4)
Intensity of risk				
frequently (A)	1A	2A	3A	4A
Often (B)	1B	2B	3B	4B
sometimes(C)	1C	2C	3C	4C
Rarely (D)	1D	2D	3D	4D
Never (E)	1E	2E	3E	4E

Red: Risk criteria:unacceptable
 Orange: undesirable (harmful) Yellow:acceptable with revising
 Green: Acceptable without revising

RESULTS

Overall, 122 tasks and 459 types of errors were identified (26 tasks: general practitioner, 39 tasks: chemotherapy specialist, 57 tasks: chemotherapy nurse). About 3.7 errors occurred per task. An example of HTA, diagrams provided for the physician and nurses' tasks is depicted in Fig.1. Of the all identified errors, 56.21% was action (Table 3). The physician and 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 [26]. Regarding the risk of errors, 48 errors (10.46%) were in unacceptable level of risk, 197 errors (42.92%) in undesirable risk level, 204 errors (44.44%) in acceptable level with reviews, and 10 errors (2.18%) in acceptable level risk without reviews (Table 4). Regarding retrieval errors, 45.31% of the errors were non-recoverable that including 52.89% action errors, 18.75% checking errors, 7.21% retrieval errors, 19.23% information communication errors and 1.92% selection errors (Table 5).

Table 6 presents an example of errors related to the tasks of a physician and nurses using

worksheet SHERPA. Half of errors cannot be identified, the consequences of which are evident in individuals' deaths, and can be considered as deadly as cancer. The most important tasks of the general practitioner are to lead team in emergency, and follow up counseling, and register and examine conducted measures. The most important tasks of medical oncologist are to diagnose and then to prescribe treatment. Most of the errors are associated with determining the duration of chemotherapy periods and with prescribing the chemotherapy drugs, classified in the group of catastrophic errors. The most important tasks of chemotherapy nurses include preparation and administration of chemotherapy drugs and taking them, preventive measures, recording the reports of activities, counseling, and clinical and paraclinical actions. Most errors of general practitioners and chemotherapy specialists are associated with patients' safety. These errors cause damages to patients themselves, while the most important errors of nurses in preparation stage cause severe damages to nurses, then to the safety and health of patients and others.

Table 3. Frequency of the risks of treatment cadre errors depending on the type of error

Error type	Functional		checking		retrieval		communicative		selective		Total	
	Number	percent	Number	percent	Number	percent	Number	percent	Number	percent	Number	percent
personal												
General practitioner	51	44.35	18	15.65	9	7.28	32	27.83	5	4.35	115	25.05
Chemotherapy specialist	73	48.03	31	20.40	9	5.92	26	17.10	13	8.55	152	33.12
Chemotherapy nurse	134	69.80	26	13.54	4	2.08	15	7.81	13	6.77	192	41.83
Total	258	56.21	75	16.34	22	4.80	73	15.90	31	6.75	459	100.00

Table 4. Risk level, separately for each type of errors

Error type	Functional		checking		retrieval		communicative		selective		Total	
	Number	percent	Number	percent	Number	percent	Number	percent	Number	percent	Number	percent
personal												
Unacceptable	31	64.58	2	4.17	1	2.08	8	16.67	6	12.5	48	10.46
Undesirable	109	55.33	29	14.72	14	7.11	35	17.77	10	5.07	197	42.92
Acceptable, with reviews	108	52.94	44	21.57	7	3.43	30	14.71	15	7.35	204	44.44
Acceptable, without Reviews	10	100	0	0.00	0	0.00	0	0.00	0	0.00	10	2.18

Table 5. Errors without recovery

Task Type	Task Error types	Chemotherapy Specialist		Chemotherapy Nurse		General Practitioner		Total	
		Number	percent	Number	percent	Number	percent	Number	percent
	Total errors	152	33.12	192	41.83	115	25.05	459	100.00
	Total errors without recovery	92	44.23	68	32.69	48	23.07	208	45.31
functional	The number without recovery	47	42.73	48	43.64	15	13.63	110	52.89
checking	The number without recovery	17	43.59	10	25.64	12	30.77	39	18.75
retrieval	The number without recovery	6	40.00	2	13.33	7	46.66	15	7.21
communicative	The number without recovery	18	45.00	8	20.00	14	35.00	40	19.23
Selective	The number without recovery	4	100.00	0	0.00	0	0.00	4	1.92

Table 6. An example of a table of errors related to the tasks of a nurse (worksheet SHERPA)

No.	Occupational task	Error type	Error description	Consequences of error	B	Risk level	Controlling measures
1-7	Record of action reports	A8	No records of actions	Causing legal problem for physicians incomplete followin up the record of diseases	File content	3D	compiling the checklist of registering cases Controlling file and reminding by the technical man, and matron and supervisor and nurse
		A9	Registering measures incompletely	Causing legal problem for physicians incomplete followin up the record of diseases	File content	3C	compiling the checklist of registering cases Controlling file and reminding by the technical man, and matron and supervisor and nurse
		A6	Registering actions wrongly	Causing legal problem for physicians incomplete followin up the record of diseases	File content	2D	compiling the checklist of registering cases Controlling file and reminding by the technical man, and matron and supervisor and nurse
2-1-3	Diagnosis of Cancer type	I2 R2	Misdiagnosis (getting incorrect information)	The treatment process goes based on wrong diagnosis, its irrecoverable effects, coma and death of patient	File content	1D	Compiling instructions, and checklist, other doctors' monitoring the treatment process, holding seminars and meeting about the new of chemotherapy

3-1-2-3 Separating Refrigerated and non-refrigerated drugs	A2	No timely diagnosis	Disease progression Irreparable consequences, death	File content	1D	Preparing instructions, checklists, dealing with offenders
	I2 R2	No diagnose metastases (getting incorrect information)	Causing unnecessary treatment and loss of time	File content	1C	Preparing instructions, checklists, others' monitoring
	C1	No attention to the drug brochure	Perhaps the lack of proper maintenance of medication and determination of doses, Risk of irreparable consequences	-	1E	Compiling instruction, Compiling the cases checklist, completing it daily, monitoring supervisor and matron, providing important and new points on how to prepare and store medicines in the ward, holding relevant meeting
	A8	not put refrigerated drugs in the refrigerator	Corruption of medicines, drugs being unusable	Observing and corrupting drugs	1E	Compiling the cases checklist, completing it the daily, monitoring of supervisor and matron, providing important and new points on how to prepare and store medicines in the ward, holding relevant seminars and training course, dealing with offenders.

DISCUSSION

Work-related injuries in hospitals are more common than in industrial settings, accordingly, hospitals can be regarded as an unsafe environment for both patients and practitioners. About 4%-17% of medical errors lead to permanent disability or patients' death [28]. 80.5% of medical incidents are harmful and 36.2% of them are preventable (near miss), 13% is deadly (sentinel event) [29].

Safety standards in hospitals include 1) patient's safety, 2) the safety of personals and clients, 3) the safety of equipment, 4) the safety of facilities. Ignoring these standards causes irreparable damages to life and property. This study aimed at investigating the safety of staff and patients. So far, SHERPA method has not been used to determine human errors in the process of chemotherapy, so the results of this study cannot be compared with other studies. However, the most prevalent and the least prevalent errors were associated with the functional type and the selective type in emergency ward, respectively, which is similar to functional errors of this study and it can justify the difference of treatment cadre tasks in the emergency ward and chemotherapy ward [24].

In a study [25] on ophthalmologists, among 57 identified tasks, 50.94% and 26.64% of errors were announced, respectively, as functional errors and checking errors, which are consistent with the results of this study. In a study [30], 159 errors were identified among 89 tasks for the nurses of the infectious ward, most of them were of functional

type (74.21%) and the least prevalent type was selective (0.63%). Moreover, 5.66% of errors were unacceptable, and 38.36% of the errors were on the harmful level of risk. In this study, 29.69% of errors were medication ones. 69.9% of medication errors (24.7% injection errors, 19.2% errors in determining the dose, 8.2% errors in the equipment, 17.8% errors in the doctor's orders) were directly related to the nurses [31].

Medication errors were identified [32, 37] nurses as the last shield to prevent medication errors, and the role of nurses could not be ignored in managing medicines, receiving prescribed medicine, computing, checking, assessing patient, documenting and training, regarding the high rate, and the frequency and nature of errors, nurses play an important role in preventing errors.

Errors are the result of the interaction of several factors, including workload, the level of skills and experience of individuals, and the number and characteristics of patients detected as factors influencing the rate of errors [33].

In the present study, the role of nurses is significant due to a large number of errors, and control measures are suggested, including the creation of reporting systems, surveillance systems, training and checking the number of nurses, avoiding heavy workloads. Computerizing the medical orders and treatment process of patients could eliminate many errors during chemotherapy [34]. This innovative strategy is used to minimize errors in the work of nurses, physicians, and

pharmacists. Another strategy is to form a team to check the instructions of chemotherapy, medicine type and its doses, the exact date and time of its injection; it can be a complete and examined solution. In this study, the order of placing errors for both chemotherapy nurses and chemotherapy specialists were quite similar, it is because of significance of similar tasks in the complex process of chemotherapy, and general practitioners should communicate with patients while checking and with a nurse during emergency conditions, as a significant task.

Medical errors can occur anywhere in the healthcare process. Managerial and organizational

factors, the complexity of tasks, environmental conditions, and work instructions are considered as the factors able to influence human errors. In the healthcare cadre of chemotherapy ward, there is also the experience of severe psychological pressure, shifts with heavy workload[38], biological disruptions and insufficient sleep and rest, lack of social support, inexperience, fatigue, the small number of treatment staff compared to a large number of patients. Considering the undeniable impact of working conditions on occurring errors, working conditions, and environment must also be updated based on the standards and principles of ergonomics and safety.

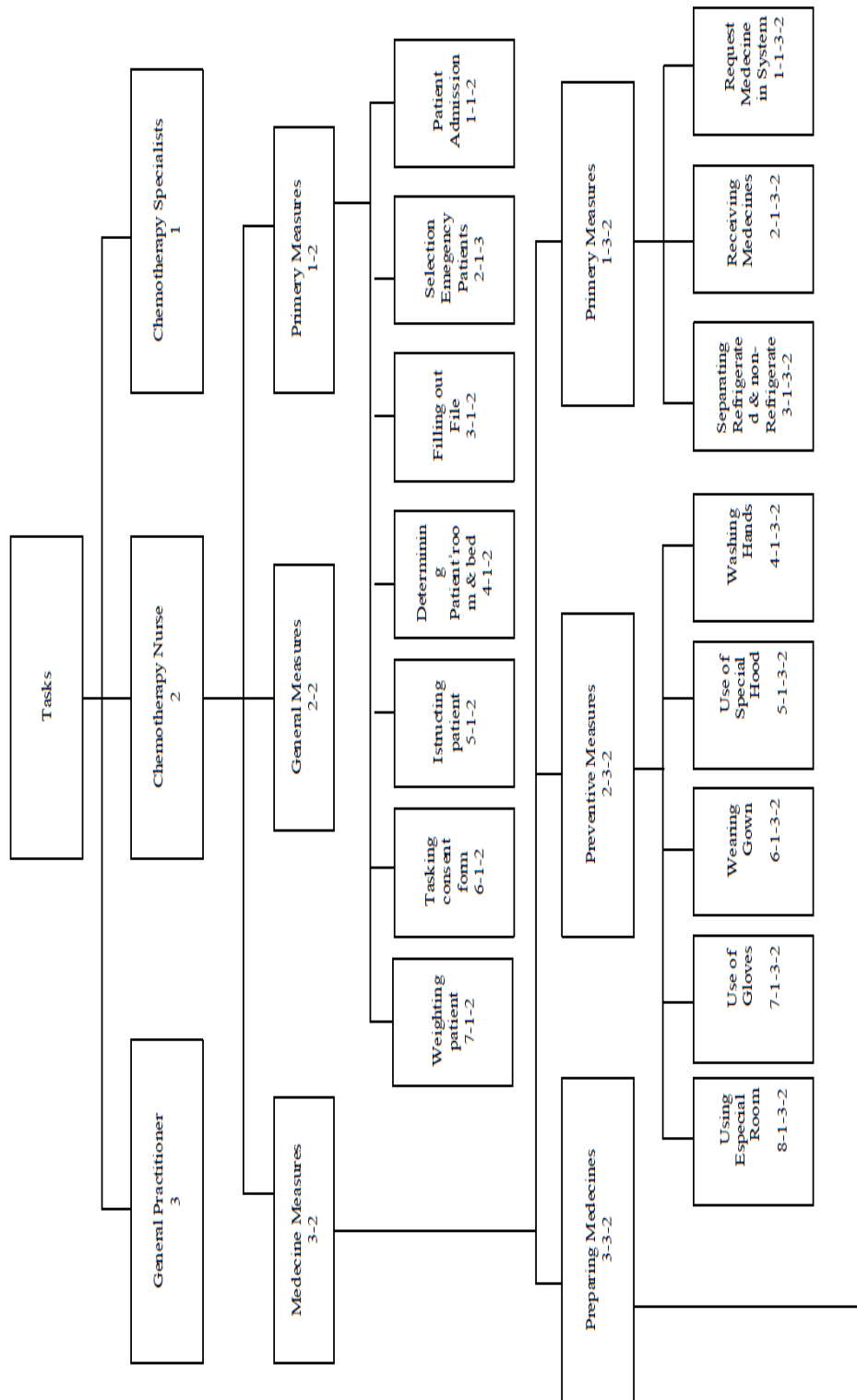


Fig. 1. An example of hierarchical analysis

CONCLUSION

About 3.7 errors were detected for every studied task given in chemotherapy ward. Considering the high level of errors, with the sensitivity and the difficulty of patients' status, it is mandatory to implement medical error management systems. This study is one of the few studies in Iran that investigated the errors in the treatment field, and human errors have been estimated by systemic methods for the first time in the chemotherapy ward. Unfortunately, in the country, there is no real and accurate estimation of the errors occurred in the health centers, and the importance of these errors is normally neglected. It is highly recommended to redesign treatment protocols and medical procedures based on principles of human factors and ergonomics (HFE) to enhance the quality of services, improve patient safety and reduce medical errors. SHERPA technique can be a useful tool for identification and assessment of medical errors.

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