ORIGINAL ARTICLE

A Qualitative and Quantitative Assessment of the Risk of Human Errors in Midwifery Tasks in Child Delivery Ward Using Engineering Approach (EA) and Predictive Human Errors Analysis (PHEA)

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ABSTRACT

Introduction: Maternity wards are of the highly sensitive wards in hospital. Errors in midwifery tasks can lead to life threatening risks for the mother and infant and higher medical costs. The present study is an attempt to qualitatively and quantitatively assess human errors in midwife staff using preventive human error analysis and engineering approach. **Methods:** The study was carried out as a case study in the maternity ward of Shoushtar Women Hospital. The participants were selected through convenient sampling and seven midwifery experts took part in the study. The work process in maternity ward was categorized into four categories of admittance, pre-labor, labor, and post-labor and the tasks and sub-tasks were determined based on hierarchical task analysis (HTA). Afterwards, human errors were quantified using EA technique and then, using PHEA technique a description of error in each tasks and error control solutions were provided. **Results:** The results clarified that the highest risks of human errors were in the tasks like cervix check, serum therapy, infant's body check, preparing delivery equipment, and wearing personal protective equipment. **Conclusion:** Since, midwifery tasks are rule base and regulations and they are performed at a higher level of awareness and cognition, preventing errors entails continuous presence of a midwife next to patient's bed along with an assistant midwife and codification of an infant examination checklist. Programming empowerment education including safety education to midwives is also recommended.

Keywords: Risk assessment, Human errors, Midwifery, Maternity ward

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INTRODUCTION

Human errors (HEs) include a set of actions that breach the predefined norms, limits, and standards and have a negative effect on the system (1). Studies have shown that human errors are the source of 90% of incidents in industries (2). Medical and hospital environments are among the highly complicated work systems prone to HEs due to diversity of tasks, heavy workload, fatigue, misprocessed information, and failure in decision making. Medical errors are among the most common health threatening errors that affect the care and treatment provided to the patient(1-3). Medical errors take place in different forms like errors in diagnosis, administered drugs, nursing services, surgery room, and the errors caused by lack of skills (3-4). Medical errors are not limited to a specific country and all around the world they increase mortality rate and medical costs. As suggested by statistics, more than 98000 deaths in the USA were due to medical errors (5). Studies have shown that reporting errors in medical care procedures brings in several advantages; however, most of the personnel fear the consequences or patients' responses (1-2). There are many techniques to assess reliability of human such as SHERPA, HEART, ATENA, and EA. Engineering approach (EA) is one of the quantitative assessment techniques to measure probability of human errors, which was first introduced by Zhigiang et al. (6-7). Another technique used in this study is predictive human error analysis (PHEA) where all HEs are identified and analyzed qualitatively. The main advantages of this technique are ease of use, systematic nature, and its reliance on hierarchical task analysis (HTA). The reason for using EA technique is that it ranks errors based on their probability in terms of education, level of experience, acquaintance with situation, accessibility of instruction, and time pressure. Through this, tasks with the highest possibility of errors are recognized and the PHEA would be used to describe the error and solutions to control it. There have been several studies on HEs in medical environment such as HEs in physicians, nurses, and clinical lab experts (8-10). Midwifery is characterized with a stressful work condition with tight schedule and high stress level (11-12). This creates to the ground for error in this job. Studies on human errors in midwifery are limited and we found only one study on human errors in maternity emergency ward (1-2). Some studies have provided a brief report of medical errors examined by forensic medicine authorities (13-14). In absence of a study on human errors by midwives at hospitals using a specific technique, given the fact that errors by midwives put the lives of mother and infant at risk and create heavy costs, and taking into account that no study have been conducted on this field using the special techniques of this field, the present study is an attempt to assess midwifery errors in the maternity ward of women hospitals using PHEA and EA techniques.

MATERIALS AND METHODS

The study was carried out as a case study. The place of study was the maternity ward of Shoushtar Women Hospital. Sampling method was convenient sampling and seven midwifery experts took part in the study. After making the required arrangements with the officials, midwives with at least one year of experience and clinical faculty board members of midwifery were interviewed and the tasks and sub-tasks were identified and categorized. Then, the HEs were quantified using EA technique (6-7) and a description of each error and solution to control were developed using PHEA and brainstorming. PHEA technique predicts human errors for each task or at any stage and prevents the predicted errors.

Engineering approach (EA) is a method for quantitative evaluation of human errors. The method was first used by Zhiqiang et al. (6). Based on this technique, each professional task is analyzed based on three behavioral styles of skill base, rule base, and knowledge base to obtain the probability of human error for each task. By skill base behavior we refer to the behaviors in which the activities are so frequently practiced that they are done automatically with no need for extensive awareness. With regard to rule base behaviors, activities are done with a higher level of awareness and cognition. For such tasks, people follow a set of rule and regulation introduced as instructions. Knowledge base behaviors have the highest behavioral level and they are demonstrated when the individual finds themselves in a new situation where solving problems needs innovation (7).

Engineering approach (EA) stages

1. Identifying performance shaping factor;

Dominant performance shaping factors (DPSFs) include education, experience level, acquaintance with the situation, availability of instruction, and time pressure.
Adjusting performance shaping factors (APSFs) include quality of instruction, number of concurrent objectives, work shifts, quality of human-machine interaction, vital metrics, environmental limitations, collaboration and interaction among personnel, organizational factors, and safety culture.

2. Estimating probability of HEs in the identified tasks;
3. Dominant performance shaping factors (DPSFs): Determining type and probability of behavioral styles.

The level of each DPSE and the behavioral style in each task were determined using Table I. Then, the risk of each behavioral style was estimate using the following formula:

$$PS=\frac{\Sigma S}{\Sigma S+\Sigma R+\Sigma K} \quad PR=\frac{\Sigma R}{\Sigma S+\Sigma R+\Sigma K} \quad PK=\frac{\Sigma K}{\Sigma S+\Sigma R+\Sigma K}$$

4. Adjusting performance shaping factors (APSFs): Weighing behavioral styles;

Here, the level of each APSE and the weight of behavioral style for each task is determined using Table II. Afterwards, the general weight (W) was estimated for each behavior style using the following formula:

$$Ws=\prod_{i=1}^{m} wi, \quad Wr=\prod_{i=1}^{m} wi, \quad Wk=\prod_{i=1}^{m} wi$$

$W_{S,R,K}$: Total weight Wi: weight i: APSF elements
m: number of APSF elements

5. AHEP : Estimating probability adjusted HE probability;

$AHEP_S = BHEP_S x W_s$, $AHEP_r = BHEP_r x W_r$, $AHEP_K = BHEP_K x W_K$
$BHEP_s$ (skill-based) $=5x10^{-4}$, $BHEP_r$ (Rule-based) $=5x10^{-3}$
$BHEP_k$ (Knowledge-based) $=7x10^{-2}$

Table I: Dominant performance shaping factors (DPSFs) A classifier for behavior modes partition

DPSF		LEVEL	behavior modes supported
Training level		High Appropriate Low	S/R/K R/K R/K
Experience level	Experience with the same tasks	Rich Appropriate Poor	S/R/K R/K K
	Experience with the familiar tasks	High Appropriate Low	S/R/K R/K K
	The time internal between two performances	Short Appropriate long	S/R/K R/K K
Familiarity with the situation		Very familiar Familiar unfamiliar	S/R R R/K
Availability of the procedure		Available unavailable	R S/K
Time pressure (the available time vs, the time required		High Appropriate Low	S/ K S/R/K S/R/K

S: skill-based R: Rule-based K: Knowledge-based

Table II: Adjusting performance shaping factors (APSFs) Weights to various levels of APSF elements under different behavior modes

APSF	LEVEL	W_S skill-based	W_R Rule-based	W_K Knowledge-based
Quality of the available procedure	Good	1	0.5	1
	Appropriate	1	1	1
	Poor	1	5	1
Number of simultaneous goals	Fewer than capacity	0.8	0.8	0.5
	Matching current capacity	1	1	1
	More than capacity	1.5	1.5	3
Duty time	Day	1	1	1
	Night	1.2	1.2	1.2
Quality of human-machine interface	Supportive	0.5	0.5	0.5
	Adequate	1	1	1
	Inappropriate	1.5	1.5	3
State and tendency of critical parameters	Very dynamic	1	2	4
	Dynamic	1	1	1
	Static	1	1	1
Ambient environment	Advantageous	0.8	0.8	0.8
	Compatible	1	1	1
	Incompatible	2	2	2
Cooperation and communication among operators	Very efficient	1	0.5	0.5
	Efficient	1	1	1
	Deficient	1	2	2
Organizational factors and safety culture	Very good	1	1	1
	Good	1.5	1.2	1.5
	bad	3	2.4	3

6. AHEPT: Estimating probability of the total HE for each task (7-8).

$AHEPT = PS \times AHEP_s + PR \times AHEP_r + PK \times AHEP_k$

Steps of PHEA technique

1. Predicting errors and the outcomes (performance errors, information transfer errors, check and control errors, retrieval errors, choice errors, sequence errors, programming errors).
2. Determining the equipment and facilities needed to recover the identified HEs
3. Introducing control policies to prevent HEs (9-10).

RESULTS

At first, midwives' tasks in maternity ward were analyzed using HTA. The tasks were categorized based on four major stages including admit, pre-labor, labor, and post-labor. The admit stage includes five main tasks and 11 sub-tasks; pre-labor stage includes six tasks and 15 sub-tasks; labor stage includes three main tasks and 13 sub-tasks; and post-labor stage includes five main tasks and 15 sub-tasks. Totally, there were 19 main tasks and 54 sub-tasks.

Determining the type and probability of behavioral styles

Type and probability of behavioral styles were determined for the four stages of midwifery tasks. In the case of "admit" stage, 50% of the tasks were of skill-based behavioral style; in Pre-labor stage, 52% of the tasks were of rule based behavioral style; in labor stage, 57% of tasks were rule based behavioral style; and in post-labor stage, 68% of the behaviors were of rule base behavioral style. Totally, 51.3% of the tasks were of rule based behavioral style, 38.5% were of skill base behavioral style, and 10.3% were of knowledge base behavioral style.

Probability of HEs in all tasks

Based on the results about probability of HEs, the highest risk of HEs in admit stage was in cervix check (0.092); and in the case of pre-labor stage, the highest risk of HEs was in serum therapy (0.092)). At labor stage, the risk of HEs could be examined from two perspectives; i) probability of errors that causes risks to the labor agent (midwife) such as providing labor equipment and wearing personal protective equipment (PPE) (0.095%) and ii) probability of errors that cause risk to the health of patient (mother and infant) such as errors in checking contractions (0.070%). At post-labor stage, the highest probability of error was about physical examination of the infant's body (0.081). In general, the highest probability of errors was in providing labor equipment and using PPE and the lowest probability of errors was about educating mothers after the delivery (Table III).

PHEA

All the 19 main tasks and 54 sub-tasks were qualitatively analyzed using PHEA. Based on PHEA technique on cervix check at admit stage, errors were most probable in determining labor time and position of the fetus. In the case of pre-labor stage and serum therapy, the most probable error was about choosing the right time of injection of syntocinon injection and the proper dosage. As to child labor equipment and wearing PPE, the most probable error was in using PPE by the midwife. In terms of the pre-labor measures and contraction check, the most probable error was about identifying the right symptoms like severity and period of pain. The most probable error in post-labor stage was in physical check of infant's body and failure to identify problems if any (Table IV).

DISCUSSION

The results about the probability of HEs in midwifery personnel showed that 51.3% of tasks were of rule base behavioral style, 38.5% were of skill base behavioral style, and 10.3% were of knowledge based behavioral style. Thereby, the majority of midwifery tasks are rule based -i.e. tasks at a higher awareness and condition

Table III: Results of HTA and EH technique

HTA			DPSF			APSF			$AHEP_T$
stage	TASK	SUB TASK	PS	PR	PK	AHEPs	AHEPr	AHEPk	
admit	Primary measure	Checking medical history	0.3684	0.3158	0.3158	0.1260	0.0072	0.0009	0.0490
		Attaching peripheral venous catheter	0.3750	0.2500	0.3750	0.1680	0.0120	0.0012	0.0665
		Taking blood sample	0.3684	0.3158	0.3158	0.0630	0.0036	0.0005	0.0245
		Checking vital signs	0.3684	0.3158	0.3158	0.0630	0.0036	0.0005	0.0245
	Checking infant's heartbeat	Checking infant's heartbeat	0.3529	0.3529	0.2941	0.0063	0.0002	0.0002	0.0023
	Examinations	Checking bleeding	0.1818	0.3636	0.4545	0.2520	0.0144	0.0018	0.0519
		Examining the pelvic	0.3889	0.2778	0.3333	0.0840	0.0060	0.0006	0.0345
		Cervix check	0.3529	0.3529	0.2941	0.2520	0.0072	0.0018	0.0920
	Reporting	Preparing nursing report	0.3077	0.3077	0.3846	0.1260	0.0036	0.0009	0.0402
		Reporting to physician	0.2000	0.4000	0.4000	0.1260	0.0072	0.0009	0.0284
	Measure	Implementing physician's order	0.3529	0.2941	0.3529	0.1260	0.0072	0.0009	0.0469
Pre-labor	Primary measure	Checking medical history	0.3684	0.3158	0.3158	0.1260	0.0072	0.0009	0.0490
		Checking vital signs	0.3684	0.3158	0.3158	0.0630	0.0036	0.0005	0.0245
		Checking contractions	0.2500	0.4375	0.3125	0.2520	0.0144	0.0018	0.0699
		Serum therapy	0.3529	0.3529	0.2941	0.2520	0.0072	0.0018	0.0920
	Measures about the infant	Checking infant's heartbeat	0.3750	0.3125	0.3125	0.0063	0.0002	0.0002	0.0025
		Oxygen therapy	0.3529	0.3529	0.2941	0.1260	0.0072	0.0009	0.0473
		Monitoring infant's heartbeat	0.2941	0.4118	0.2941	0.1260	0.0072	0.0009	0.0403
	Examinations	Checking bleeding	0.3158	0.3684	0.3158	0.0672	0.0024	0.0002	0.0222
		Pelvic check	0.3889	0.2778	0.3333	0.0840	0.0060	0.0006	0.0345
		Cervix check	0.3125	0.3750	0.3125	0.2520	0.0072	0.0018	0.0820
	Report	Preparing nursing report	0.3077	0.3077	0.3846	0.1260	0.0036	0.0009	0.0402
		Reporting to physician	0.2941	0.3529	0.3529	0.1260	0.0072	0.0009	0.0399
	Measure	Implementing physician's order	0.3125	0.3750	0.3125	0.1260	0.0072	0.0009	0.0424
	Trolley check	Emergency trolley check	0.0909	0.4545	0.4545	0.2520	0.0144	0.0018	0.0303
		Blood pressure trolley check	0.0769	0.5385	0.3846	0.1260	0.0072	0.0009	0.0139
Labor	Primary measures	Communicating with patient	0.1538	0.4615	0.3846	0.2520	0.0144	0.0018	0.0461
		Contraction check	0.2500	0.4375	0.3125	0.2520	0.0144	0.0018	0.0699
		Checking infants' heartbeat	0.3750	0.3125	0.3125	0.0063	0.0002	0.0002	0.0025
		Disinfection	0.3529	0.3529	0.2941	0.1260	0.0072	0.0009	0.0473
	Preparing labor equipment	Preparing resuscitation equipment of infant	0.0833	0.5000	0.4167	0.1260	0.0036	0.0009	0.0127
		Nelaton catether	0.3529	0.3529	0.2941	0.1575	0.0090	0.0023	0.0594
		Put surgical drapes	0.3333	0.3889	0.2778	0.1260	0.0072	0.0009	0.0451
		Wearing PPE	0.3529	0.3529	0.2941	0.2520	0.0144	0.0018	0.0946
	Labor measures	Labor maneuver	0.3529	0.3529	0.2941	0.1260	0.0072	0.0009	0.0473
		Episiotomy	0.3750	0.3750	0.2500	0.1260	0.0070	0.0009	0.0501
		Cutting umbilical cord	0.3529	0.3529	0.2941	0.1260	0.0072	0.0009	0.0473
		Placenta removal	0.3529	0.3529	0.2941	0.1260	0.0072	0.0009	0.0473
		Turning on the warmer	0.3529	0.3529	0.2941	0.1260	0.0072	0.0009	0.0473
Post labor	Primary measure for the infant	Bulb syringe	0.3529	0.3529	0.2941	0.0420	0.0030	0.0003	0.0160
		Oxygen therapy	0.3529	0.3529	0.2941	0.1260	0.0072	0.0009	0.0473
		Vitamin k injection	0.3333	0.3889	0.2778	0.1260	0.0072	0.0009	0.0451
		Attaching bracelet	0.3158	0.3684	0.3158	0.1260	0.0072	0.0009	0.0427
	Physical check	Checking anus	0.3333	0.3889	0.2778	0.1260	0.0072	0.0009	0.0451
		Complete body check	0.2941	0.4118	0.2941	0.2520	0.0144	0.0018	0.0806
	For the mother	syntocinon injection	0.3529	0.3529	0.2941	0.1260	0.0036	0.0009	0.0460
		Episiotomy treatment	0.3529	0.3529	0.2941	0.0630	0.0036	0.0005	0.0236
		Nelaton catheterization	0.3529	0.3529	0.2941	0.1575	0.0090	0.0023	0.0594
		Using sterile gauze (Tampon)	0.1538	0.4615	0.3846	0.1260	0.0072	0.0009	0.0231
		Checking bleeding	0.3529	0.3529	0.2941	0.1260	0.0072	0.0009	0.0473
	Education for the mother	Education	0.0769	0.5385	0.3846	0.1260	0.0072	0.0009	0.0139
	Discharging the patient to the ward	Checking patient's condition	0.3529	0.3529	0.2941	0.1260	0.0072	0.0009	0.0473
		Making sure all information is taken before discharging the patient	0.2941	0.4118	0.2941	0.1260	0.0072	0.0009	0.0403
		Accompanying the patient to the ward	0.2000	0.4667	0.3333	0.1260	0.0072	0.0009	0.0289

Table IV: Results of PHEA technique

Main task	Sub-task	Error	Recovery	Outcome of error	Control approach		
					Instruction	Education	Equipment
Admit	Cervix check	Wrong estimate of labor time or position of the fetus	Reexamination by an experienced midwife	Failure to make decision and make preparations in a timely manner	Supervision of skillful and experienced personnel	Performing accurate examination	
	Reporting to the physician	Recording wrong or incomplete information of patient's condition	Checking the report by supervisor	Wrong diagnosis- wrong therapeutic measure		Reporting education	
Pre-labor	Serum therapy	Administration of cento serum in wrong time and failure to determine the right dosage	Continuous check by midwife	Delay in labor, oxygen shortage, fetus asphyxia, uterine rapture		Continuous present of midwife	
	Cervix check	Wrong estimate of labor time	Continuous check by midwife	Delayed or early labor	Presence of an experience midwife	Education and reeducation	
Labor	Contraction check	Wrong diagnosis of symptoms like severity and period of pain	Recheck and supervision of a second midwife	Failure to determine labor time and early labor		Education and reeducation	
	Wearing PPE	Failure to use PPE	Continuous patient check to avoid emergency situations	Higher risk of infectious diseases for the patient and labor agent, exposure of the eyes to secretions and risk of infection	Presence of an assistance midwife	Safety education	
After labor	Complete physical check	Failure to check the patient thoroughly and missing symptoms	Supervision by another midwife or a specialist	Failure to spot congenital disorders and take timely measures, failure to diagnose congenital problems	Codification of a checklist for checking the infant	Education and reeducation	
	Checking patient's condition	Failure to examine vital signs or incomplete check; failure to provide required post labor education to the mother	Checking by a resident midwife in the ward	Risk of emergency or hazardous situation for the mother such as bleeding, unconsciousness and the like	Codification of an examination instruction and supervision by two experts	Education and reeducation	

level. That is, the midwives followed a set of rules and laws in the form of instructions. Inconsistent with our findings, Habobi et al. used EA technique to study HEs in the process of issuing work certificates in petrochemical industry and among the behavioral styles the highest and lowest probabilities were about knowledge base behavioral style (60% probability) and skill based behavioral style (7.14% probability) respectively. The inconsistent results can be explained based on the differences in work nature between industry and hospital (7). Based on EA technique, the highest probability rate of errors was in preparing labor equipment and wearing PPE (0.095%) and the lowest probability rate was in educating the mother after labor (0.013%). Fateme Tanha et al. assessed HE risk in maternity emergency ward using risk industrial standardized analysis technique and reported that the lowest rate of error was found in sub-task "working with serum pump apparatus" (0.055%) and the highest rate of error was found in sub-task "injection of blood products"(0.780%) (1). With regard to the tasks like preparing labor safety equipment and wearing PPE, there is a need for safety education to elaborate on the necessity of using such equipment and also to assign an assistant midwife to control the emergency situation. To decrease the probability of error at providing labor and personal protective equipment, assigning more personnel to each ward -i.e. increasing the midwife/patient ratio- and lowering the workload gives enough time to the personnel to prepare the equipment and PPE and decrease the risk of error consequently. It is notable that labor stage is featured with extreme time pressure and alleviating this pressure leads to a notable decrease in error. Assigning on-call midwife for peak hours is a measure to lower the workload and the risk of error. According to the result of assessing HEs risk in labor emergency ward of hospital, the main causes of error were stress and complicate tasks, which are rooted in heavy workload, inadequate time, and the necessity to implement a highly accurate management and coordination among personnel (1). Midwifery tasks were categorized into four stages and the highest probability of error in each stage was determined. At admit stage, the midwife determines the labor time thorough cervix check and there is a risk of HE (failure to predict the accurate labor time) due to heavy workload or lack of experience. Alayoubian et al. studied frequency and causes of midwifery errors based on filed cases with forensic medicine department in five years. They reported that the total reported errors due to negligence was 39% and 44.4% due to breaching laws (e.g. inducing early labor) (12). Probability of HE at labor stage can be approached to from two perspectives; safety errors that risk the agent (midwife) and the errors that threaten the patient (mother and infant). In emergency situation like early labor, the midwife does not have the time to use PPE and limit the safety equipment only to gloves. Failure to wear goggles and scrubs might expose the midwife to liquids and secretions from the mother's body and create a risk of infection or other diseases caused by exposure of the eyes with blood or other body secretions. Among the errors that negatively affect patient's (mother and infant) health is error in contractions check. The midwife needs to examine severity and time period of pains to estimate the delivery time. This task is highly prone to error as any wrong assessment can be projected in other measures that affect the mother and infant's health. The time pressure and special condition at labor stage increase the risk of error in contraction checks(1). On the other hand, risk of error in doing other tasks of labor stage is lower given the special educations given to midwives. In addition, presence of midwife next to the mother during labor stage attenuate the risk of errors not to mention that the midwife can seek help from gynecologist and more experience colleagues if needed (1). The fact that contraction checks for several mothers might be done by one midwife increases the risk of error(4). The highest risk of HEs at pre-labor stage was with serum therapy. This measure includes using two types of serum including standard serum and syntocinon injection. The latter is used to promote contractions and facilitate labor process. The serum dosage is determined based on the mother's condition and the process of calculating the proper dosage is prone to risk. Gorgich et al. studied medical errors and solutions from nurses and nursing students' viewpoints. They reported that the most common reasons of medical errors by nurses were heavy load of work and mistakes in computing dosage in the case of nursing students (4). Cheraghi et al. (2013) reported about the drug errors in nurses in Iran and the most common type of reported errors was about administered dosage and the main cause was using abbreviated version of drugs name. In addition, the main cause of medical error was lack of pharmacological knowledge (2). According to Kermani et al. about assessment of HE in emergency ward nurses using SHERPA technique, the most common error was performance error and the least common type of error was communicational errors (10). Given that the main midwifery errors happen at different stages of labor and in doing tasks that need computation, attention, and concentration (e.g. serum therapy and contraction check), continuous checks, permanent presence of midwife next to the patient and supervision by experienced colleagues and gynecologist to ensure accurate implementation of examinations are recommended. To attenuate the risk of cervix check error that needs concentration and experience, the examinations need to be done in a peaceful environment by experienced personnel or under their supervision. Cheraghi et al. showed that organizational factors with priority effective in midwifery errors, according to the midwives' viewpoint, included high workload, occupational stressors, and lack of mental security. Their findings are consistent with our findings (14). Densely crowded and noisy ward decrease the attention and concentration of personnel. Providing specialized education routinely can help empowerment of midwives. Another study by Ayoubian et al. showed that the majority of errors by midwives were in the form of neglecting the state regulations. To improve and develop personnel's knowledge about legal matters, holding educational workshops was recommended. Through this, more extensive knowledge and occupational hygiene are ensured. Moreover, the experienced and knowledgeable midwives shall be evenly distributed in medical facilities (15). Errors in the infant's body check in post-delivery stage had the highest probability. There is a risk that the midwife fails to physically check the infant accurately and possible abnormalities are missed. Among the main reasons of this lack of attention is the prolonged labor process where fatigue after long hours drains the energy and attenuate accuracy and diligence of personnel. To control such errors, an instruction and checklist of infant examination are needed. Edere et al. studied patient safety and reported that good professional relationships (e.g. between midwives and physicians) can be an effective way to create a positive environment at work. Of other key factor in patient safety are knowledge, safety, more educational courses, and written instructions. In addition to education for improving knowledge of the personnel, many midwifery personnel use simulation technologies to improve their skills. Experiencing critical situations through simulation not only lowers the risk of error in critical situations and attenuates the outcomes, but also helps the personnel to control their fears and boost their self-confidence. Group's interdisciplinary education using simulation can lead to better results (16). The results of PHEA technique in terms of admit stage and cervix check showed that permanent presence of the midwife next to the patient can lead to lower error rate. As to using safety equipment for labor process and using PPE by the personnel, there was a need for better safety education and assigning an assistant midwife. With regard to pre-labor and contractions check, controlling errors through empowerment education was found essential. Finally, as to pos-labor and physical check of the infant, codification of a physical check checklist was recommended.

CONCLUSION

Human error is an intrinsic feature of any occupation including midwifery. Attempts to attenuate the rate of HEs in midwifery services entail using a systematic approach to check and control the factors effective in such errors. According to the findings of EA, cervix check, serum therapy, infant's body check, using safety equipment and PPE were the main areas of HEs. Knowing that workload on midwives is too high, there is a high risk of HEs in this profession. As the results showed, the risk of HEs is higher in the tasks where the agent needs to decide based on the patient's situation and condition (e.g. estimating labor time, drug dosage). The control approaches as recommended by the findings are education and reeducation, presenting educational material as wall signs, codifying instructions for the tasks for which no instruction has been given before, monitoring vital signs, permanent presence of a midwife next to the patient, communicating with patients, providing communicational skills educations to the personnel, taking into account the principles of psychology, and checking and monitoring infant's heartbeat continuously.

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