Effect of an Interactive Computer-based Simulators Training Program onNurses' Performance Regarding Electronic Fetal Heart Rate Monitoring

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Background: Computerized birth simulator is a new interactive teaching strategy with high-fidelity that allows learners to develop, refine, and apply knowledge and skills to improve the quality and safety of care for women and their fetus. Electronic fetal heart monitoring EFHM is commonly used to assess fetal well-being during labor that reduce perinatal morbidity and mortality. It is highly dependent on accurate interpretation of fetal heart rate patterns. So, this study **aimed** to identify the effect of an interactive computer-based simulators training program on nurses' performance regarding electronic fetal heart rate monitoring. **Material and Methods**: It was an quasi experimental study, where a convenience sample of all available 200 Nurses were working in Saudi Arabia at antenatal and labor unit at King Abd El Aziz University and Maternity Hospital in Jedda has well as King Abd El Aziz hospital in Taif. The study subjects were randomly assigned equally into study and control group. Three validated tools were used to collect data; nurses' socio –demographic and academic characteristics questionnaire, nurses' knowledge as well as performance about electronic fetal heart monitoring. **The results** clarified that there is no significant difference between the study and control group before the implementation of the interactive computer-based simulators training program. While, nurses' knowledge and performance about the EFHM had significantly improved among the study than control group one and three months after attending the training program. Improvement was obvious in relation to: their role in external and internal fetal monitoring, interpretation of fetal heart monitoring strips, their ability to detect signs and causes of FHR deviation pattern that indicates fetal hypoxia and /or emergency interventions for FHR deviation pattern. **In conclusion**: interactive computer-based simulators training program was effective as it significantly improvethe nurses' knowledge and performance regarding electronic fetal heart monitoring.

1. Introduction

Computer- based simulators is an interactive teaching strategy with high-fidelity that refers to structured student learning experiences with the use of a technologically advanced computerized mannequin, having software designed to re-create a real-world (virtual reality), that confined to a computer screen display. It provides a practice-based instruction using simulated clinical scenarios to assist trainee in the acquisition of both knowledge and psychomotor skills. This technology offers new avenues for students to practice a procedure prior to their performance on a live patient, can critically think, solve problems, and care for diverse clients in a safe, non threatening environment that reflected on lived experience and practice. [1, 2]

Childbirth simulator is beneficial for doctors and nurses who will be engaged in labor. Simulation of labor using virtual reality can represent the mechanism of labor, monitor fetal heart rate with levels of interactivity and dynamics clearly. The experiential learning provided by the childbirth simulation is designed to support and enhance the information presented in the accompanying didactic courses. It presents opportunities for the students to review/learn a supportive information and skills relevant to the care of the childbearing woman.[2,3]

Labor is a short but critical period in the life of an expected newborn. The provision of high quality care in labor with fetal monitoring is important and should be a basic component of labor management. [4]Fetal heart rate can be monitored intermittently or continuously by using a fetal electrocardiogram (CTG) machine. This method is known as electronic fetal heart monitoring (EFHM). Intermittent auscultation may be appropriate in low risk women, but in high risk women a policy of continuous electronic fetal monitoring and fetal blood sampling is indicated. [5, 6]

Monitoring the fetal heartbeat is one way of checking fetal well-being in labor. It consists of a static assessment of fetal heart rate (FHR). [7] It provides information on the baseline heart rate (usually between 110 and 160 beats per minute), accelerations (transient increases in the fetal heart rate) and decelerations (transient decreases in the fetal

heart rate). [8]It is known that some aspects of labor will cause natural alterations in fetal heart rate patterns. For example, the fetus sleeping pattern is different from the pattern when the fetus is awake. External stimuli, like uterine contractions and the mother movements, can also cause fetal heart rate (FHR) changes. Some of these changes are quite subtle and can only be detected by continuous CTG e.g. baseline variability and temporal shape of decelerations. [9]

Continuous electronic fetal heart rate monitoring (EFHRM) has revolutionized the caregivers in understanding the function of cardiovascular system of the fetus during labor. It identifies the fetus that may be compromised, or potentially compromised, by a shortage of oxygen (fetal hypoxia) and how the fetus responds to hypoxia. If the shortage of oxygen is both prolonged and severe, fetus is at risk of being born with a disability (physical and/or mental), or of dying during labor or shortly there after. So, Intrapartum fetal monitoring is essential for reducing perinatal deaths and hypoxic brain injury.[10.11]

EFHM is highly dependent on accurate interpretation of fetal heart rate (FHR) patterns, which has been shown to be commonly of a low standard in everyday clinical practice. Such an interpretation of cardiotocograms is difficult requires a considerable training experience andskills. [12, 13] When electronic monitoring is performed without appropriate training the results are well known: an increased rate of caesarean sections and increased litigation from avoidable intrapartum asphyxia. The Confidential Enquiry into Stillbirths and Deaths in Infancy (CESDI) have highlighted that errors in interpretations of CTG traces are one of a major contributor to infant morbidity and mortality. The most commonest avoidable factor contributing to these deaths being failure to recognize or react to an abnormal fetal heart rate traces. [14, 15]

Many studies concluded that better interpretation of and response to abnormal cardiotocograph was the principal method to decrease the risk of stillbirth in labor. [9, 10]They further recommended using computerized –based simulators that allows learners to develop, refine, and apply knowledge and skills in a realistic clinical situation as they participate in interactive learning experiences designed to meet their educational needs. The use of simulation as a teaching strategy can contribute to patient safety and optimize outcomes of care, providing learners with opportunities to experience scenarios and intervene in clinical situations within a safe, supervised setting without posing a risk to a patient. Moreover, there is a lack of research studying the effect of computerized – based simulators on nurses' knowledge, performance

regarding interpretation skills and interventions of deviating FHR Pattern. [16]

Aim of the Study

This study aimed to identify the effect of an interactive computer-based simulators training program on nurses' performance regarding electronic fetal heart rate monitoring.

Hypothesis:

Nurses who attend interactive computer-based simulators(ICBS)training program exhibit higher knowledge and skills in performing EFHM than those who don't attend it.

Operation definition:

Nursing skills here refers to their role in application of external fetal monitoring, prepare the equipment for internal fetal monitoring, interpretation, developing and implementing a reasonable emergency intervention for deviating FHR pattern.

2. Material and Methods

Design:

Quasi experimental study research design was followed.

Material

Setting:

The study was conducted in antenatal as well as labor units at King Abd El Aziz University hospital and Maternity hospital in Jeddah as well as King Abd El Aziz hospital in ElTaif.

Subjects:

The study comprised a convenience sample of all the available 200 nurses working in the above mentioned unites in the three hospitals. These 200 subjects were randomly assigned equally into either study or control group.

Tools:

Three tools were used for data collection.

*Tool I: Nurses' General and Academic Characteristics questionnaire :*This was designed and used by the researchers to collect data about: age, level of education, position and years of experience.

***Tool II: Nurses' knowledge about Electronic Fetal Heart Monitoring* questionnaire:** It was developed by the researcher to assess nurses' knowledge in relation to electronic fetal heart monitoring and its deviating pattern. It comprised of 25items in7 main groups of questions about: General knowledge (3 items),external fetal monitoring (4 items), internal fetal monitoring (2 items), application of CTG (2 items), interpretation the finding of fetal heart monitoring strips (3 items), types, causes and signs of FHR deviation pattern that indicate fetal hypoxia (6 items)& Emergency intervention for FHR deviation patterns (5 items).

Subjects' response to each item was varied between incorrect answer (1), correct but not complete (2), correct and complete (3).

The total score ranged between 25-75
Subjects' knowledge was ranked as follows:
-poor for total score of ≤ 41
-Fair for total score of 42-58
-Good for total score of ≥ 59

Tool III: Nurses' performance of Electronic Fetal Heart Monitoring check List: It was developed by the researcher to assess nurses' performance in relation to the application, interpretation and interventions of deviating FHR Pattern. It consists of 5 main groups of questions about: Application of external fetal monitoring (2), role of nurses in internal fetal heart monitoring (2), interpretation of the findings of fetal heart monitoring (5), identifying the FHR deviation pattern that indicate fetal hypoxia (3) Emergency intervention for FHR deviation patterns (3). It comprised totally 15items.

Each item was scored the total score ranged between 15-30and checked by the researched as follows:

Done= score 2
Not done =scored 1
The level of performance was classified into:
Satisfactory ≤ 15
Unsatisfactory >15

Methods

-Official permission was obtained from responsible authorities of the study sittings to conduct the study, after explaining its purpose.

-The study tools was developed by the researchers after a thorough review of literature. It was validated by a jury of 5 experts in the related field.Toots reliability accomplished by split half reliability technique. The instrument showed high internal consistency (r= 0.811 for tool II &0.932 for tool III).

-A pilot study was carried out before embarking on the actual study, in order to assess the clarity and applicability of the study tools. It was conducted on 20 nurses working at antenatal clinic after obtaining their oral consent. It served to ensure clarity, applicability, time of administration for the tools of data collection. Based on the pilot results; there was no need for amendment in the tools. The subjects of the pilot were excluded from the main study sample.

1. The study was conducted through three phases:

I-**Pre assessment phase**:

All study subjects were asked to respond to tools II as pre- test assessment for subjects' knowledge in relation to electronic fetal heart monitoring and its deviating pattern. This was done as a self report on an individual basis, and in the presence of the researcher. On the other hand, each nurse was observed only onceby the researcher using tool III to assess her performance (skills) in relation EFHM.

II-**Program development phase**:

Interactive computer based-simulators training program was developed by the researcher after a thorough review of the literature [13-17] It aimed to improve nurses' knowledge and performance regards electronic fetal heart monitoring. Its content entails two main parts :

a-Theoretical part (didactic):included definition of EFHM, types, indication, benefits advantage and disadvantage of each type, steps of application of external fetal monitoring, nurses role in internal fetal monitoring, causes and signs of fetal hypoxia, interpretation of main finding obtained by CTG and interventions that applied in case of deviating FHR Pattern.

b- Clinical part (Simulated Clinical Environment SCE) :It includes
-Computer-based childbirth simulators
- Fetal cardiotocogram(CTG)
-Software labor scenarios that prepared by the researcher which included normal and deviation FHR pattern cases as well as interventions for these deviations. It applied to computer program attached to simulator that responsible for the operation of simulator.
- Instrument for internal FHM
-Questions for learner preparation
-checklist to assess the practice of the trainer tool III

Phase III: **Implementation phase**:
Subject preparation:

The 200 subjects were be randomly assigned to either study or control group. The studied group was further assigned randomly into six subgroups, three groups, in each setting, each group containing 15-18 nurses.

-The purpose of the study was explained to all s:udy subjects and oral consent to participate in the study was obtained. They were also reassured that all research data will be confidential and used only for the purpose of the study. Clarification to any point of the study was provided to the participants if needed. Participants were also informed about their right to withdraw from the study at anytime without giving a reason.

1-**For the study group**

The program was implemented in 4 weeks by the researchers.12 sessions were scheduled 3 session /week in the morning(3hours each). The training course reflected a 9-hour (didactic) with a 27-hour clinical experience at simulated clinical environment SCE. All didactic content in the course was

front-loaded followed by simulation and/or fetal cardiotocogram. The program sessions was done as follow :

-**Session (1-5):-**included a (didactic) part about EFHM followed by demonstration the steps of internal or external application of CTG and nurses role in internal fetal monitoring using SCE after introducing the study group to SCE environment and resources available. Then the trainees re-demonstrate the procedures using documentation and labor case scenarios to distinguish between cases which need internal or external.

- **Session (6-12)** included a (didactic) part about interpretation of FHR and its deviating patterns. An emergency interventions that applied in case of deviating FHR Pattern.

-Then the computer –based childbirth simulator operated at SCE with the characteristic sounds to the fetal heartbeat to make the situation very lifelike. The study group were exposed to a variety of labor management scenarios that emphasized assessment and interpretation of normal and different deviating FHR pattern with as well as fundamental intervention for these deviation.

-Each scenario ran for approximately 15 to 20 minutes, during which time the nurses were able to ask questions, perform assessment and interpret FHR finding that appear on the computer screen.

-The trainee re-assess and interpret normal and different deviating FHR pattern a well as re-demonstrate nursing intervention for these deviation.

-Teaching methods and aids includes:

demonstration& re demonstration using labor simulator carditocogram, Lectures, group work & discussion, case scenario, reading.

-Illustrated handout about EIFHM knowledge was distributed after implementation of the program as a reference.

2-**For control group**: they were lifted to the routine in-service training program prepared by each hospital which entail only orientation about how to operate the machine and way of application of external monitoring.

Evaluation of the effectiveness of EFHM training program:

Nurses' knowledge was reassessed twice after one and three months following the training program using tool II. while Clinical performance was assessed by observing each subject in hospital during their application of 2 external fetal monitoring, prepare the equipment for internal fetal monitoring, interpretation of at least 3 randomized fetal heart monitoring strips, and on developing and implementing a reasonable emergency intervention for deviating FHR pattern using the tool III.

Statistical analysis:

1. Statistical analysis was performed using SPSS version 16.0 for windows. Frequency &percentage were used for describing and summarizing categorical data.
2. Monte Carlo test and Chi-Square test *significant at $P \leq 0.05$ to compare the nurses level of knowledge, interpretation and interventions of deviating FHR Pattern before a training program implementation and after one and three months from the program.

3.Results

Table (1) indicates no significant differences between the study and control groups in their age, level of education, years of experience and nationality. Where, more than half of both study and control groups (60%&54%) & (54%&60%) respectively had a diploma in nursing and had 5years experience or more. Also more than half (58%) of the study group were less than thirty years old compared to70 % of the control group.

Table (2) illustrate the percent distribution of nurses' knowledge regarding (EFHM) before and after one and three months from program implementation. It was noted that there is no significant difference between the study and control group before the implementation of the program. While there is a high statistical significant difference recognized between study and control group in favor of study group regarding their knowledge after one and three months of program implementation. A significant marked advance was observed among 64%,&95% of the study compared to only(4%&3%) of the control group respectively had correct & complete answer one and three months after program implementation to identify emergency intervention for deviating FHR patterns. A gradual improvement in the knowledge was noticed among (74% & 87%) and (63%,84%) of the study group compared to only (2%&3%) and (3%&3%)of control group respectively regarding interpretation of fetal heart monitoring strips and identifying signs of deviating FHR pattern that indicate fetal hypoxia had correct and complete answer after one and three month of program implementation. The study subjects pointed out a significant gradual progress regarding steps of application of external fetal monitoring 68%&75% of study group compared to 17%&11% respectively of control group have correct & complete answer after one and three months of program implementation.

Table (3) reflects percent distribution of the nurses regarding their total score of knowledge about electronic fetal heart monitoring over time. only (7% and 8% respectively) of the study and control groups had correct and complete answer regarding EFHM before the intervention with no statistically significant difference between them. One month after the intervention, there was a statistically significant

difference (*P*<0.0001) between the study and control groups in favor of the study group. Yet, as much as 77% of the study group had correct and complete answer compared to non of the control group three months after the training program, there was a statistically significant difference ([MC]*P*<0.0001) between them in favor of the study group.

Table (4) donates a percent distribution of the nurses according to their performance before and after the ICBS training program. According to the used significant tests results, there were no statistically significant differences between the study and control groups in their performance before the training program. One and three months after the training program, there was a statistically significant improvement in all skills needed for the performance of EFHM among the study than the control group. Where, the majority (88% and 91%) of study group compared to 22% & 25% respectively of control group had satisfactory skills one and three months after the program regarding application of external electronic fetal monitoring. 79% and 82% of study group compared to 16% & 13% of control group respectively had satisfactory skills regarding the preparation of woman and equipment for internal fetal

monitoring one and three months after the program. Satisfactory skills regarding interpretation of fetal heart monitoring strips was reported by the majority (75% and 80%) of study group compared to 20% & 17% respectively of control group. Identify signs of deviating FHR pattern that indicate fetal hypoxiaand Emergency intervention for deviating FHR patterns reported by majority (79% and 87%) and (75% and 78%) of study group compared to only (19% & 20%) and (18% & 15%) respectively one and three months after the implementation of the program.

According to table (5) the majority 86% and 82% of the study and control groups, respectively had unsatisfactory performance regarding EFHM before the program. One and three months after the implementation of training program, there was a statistically significant difference (*P*<0.0001) between the study and control groups in favor of the study group.

Where, the majority of the study (82% and 83%) compared to only (15% and 20%) of control group one and three months respectively after the implementation of training program had satisfactory skills regarding EFHM. The difference was statistically significant (*P*<0.0001).

Table (1): Percent distribution of the nurses according to their general characteristic

General characteristic	Study (n=100)	Control (n=100)	Significant test (*p* value)
	%	%	
Age (years): <30 30-40 >40	58 26 16	70 18 12	X^2=3.151 *p*=0.207

Level of education:
    Bachelor
    Diploma
    Master
	34
	60
	6
		40
		54
		6
			X^2=0.802
			p=0.670

Years of experience: <5 ≥ 5	46 54	40 60	X^2=0.734 *p*=0.391
Nationality: Saudi Non Saudi*	38 62	44 56	X^2=0.744 *p*=0.388

[MC]**P: Monte Carlo test; X^2: Chi-Square test; *significant at *P*≤0.05;**
*for example: Philippines, Indonesia

Table (2) Percent distribution of nurses' knowledge about electronic fetal heart monitoring before and after one and three months from the implementation of ICBS training program

Nurses' knowledge		Pre program		After one month (n=100)		After 3 months (n=100)		Sig1	Sig2	Sig3
		Study (n=100)	Control (n=100)	Study (n=100)	Control (n=100)	Study (n=100)	Control (n=100)			
		%	%	%	%	%	%			
EFHM General knowledge about EFHM	CC	17	17	52	16	62	15	X^2= 0.632 *p*=0.729	X^2= 45.13 *P*<0.0001*	[MC] *P*<0.0001*
	CI	48	53	42	43	35	40			
	W	35	30	6	41	3	45			

		Study	Control	Study	Control	Study	Control	Sig1	Sig2	Sig3
Steps of application of external fetal monitoring	CC	11	16	68	17	75	11	X^2= 1.960 P=0.375	X^2= 55.184 P<0.0001*	MC P<0.0001*
	CI	35	39	21	41	25	50			
	W	54	45	11	42	0	39			
Preparation of woman and equipment for internal fetal monitoring	CC	4	9	69	8	61	4	X^2= 2.078 P=0.354	MC P<0.0001*	MC P<0.0001*
	CI	13	13	30	7	32	10			
	W	83	78	1	85	7	86			
Interpretation of fetal heart monitoring strips	CC	5	7	74	2	87	3	X^2= 1.938 P=0.3792	MC P<0.0001*	MC P<0.0001*
	CI	12	18	18	12	13	25			
	W	83	75	8	86	0	72			
Causes of FHR deviation pattern:	CC	5	0	71	4	75	4	MC P=0.090	MC P<0.0001*	MC P<0.0001*
	CI	17	18	21	37	17	37			
	W	78	82	8	59	8	59			
signs of deviating FHR pattern that indicate fetal hypoxia	CC	5	8	63	3	84	3	X^2= 1.896 P=0.388	MC P<0.0001*	MC P<0.0001*
	CI	35	41	27	39	12	46			
	W	60	51	10	58	4	51			
Emergency intervention for deviating FHR patterns	CC	8	5	64	4	95	3	X^2= 4.338 P=0.114	MC P<0.0001*	MC P<0.0001*
	CI	10	20	28	8	4	23			
	W	82	75	8	88	1	74			

Sig1: test of significance between the study and control group before the program; Sig2: test of significance between the study and control group after one month of the program; Sig3: test of significance between the study and control group after three months of the program;
^{MC}P: Monte Carlo test; X^2: Chi-Square; *significant at P≤0.05; CC: correct complete answer; CT: correct incomplete answer; W: wrong answer

Table (3): Percent distribution of nurses regarding their total score of knowledge about electronic fetal heart monitoring before and after one and three months from the implementation of ICBS training program

Total score of knowledge	Before intervention		After one month of intervention		After three months of intervention	
	Study (n=100)	Control (n=100)	Study (n=100)	Control (n=100)	Study (n=100)	Control (n=100)
	%	%	%	%	%	%
Good	7	8	68	2	77	0
Fair	16	21	28	19	20	21
Poor	77	71	4	79	3	79
Significance (p value)	X^2=0.986 P=0.611		MC P<0.0001*		MC P<0.0001*	

^{MC}**P: Monte Carlo test; X^2: Chi-Square test; *significant at P≤0.05**

Table (4) Number and percent distribution of nurses' performance about electronic fetal heart monitoring before and after one and three months from the implementation of ICBS training program

Nurses' performance regarding EFHM		Pre program		After one month		After 3 months		Sig1	Sig2	Sig3
		Study (n=100)	Control (n=100)	Study (n=100)	Control (n=100)	Study (n=100)	Control (n=100)			
		%	%	%	%	%	%			
Application of external electronic fetal monitoring	Satisfactory	13	22	88	22	91	25	X^2= 2.805 P=0.094	X^2= 88.000 P<0.0001*	X^2= 89.409 P<0.0001*
	Unsatisfactory	87	78	12	78	9	75			
Preparation of woman and equipment for internal fetal monitoring	Satisfactory	18	10	79	16	82	13	X^2= 2.658 P=0.103	X^2= 79.579 P<0.0001*	X^2= 95.459 P<0.0001*
	Unsatisfactory	82	90	21	84	18	87			
Interpretation of fetal heart monitoring strips	Satisfactory	15	22	75	20	80	17	X^2= 1.625 P=0.202	X^2= 50.231 P<0.0001*	X^2= 79.452 P<0.0001*
	Unsatisfactory	85	78	25	80	20	83			
Identify signs of deviating FHR pattern that indicate fetal hypoxia	Satisfactory	26	20	79	19	87	20	X^2= 1.016 P=0.313	X^2= 72.029 P<0.0001*	X^2= 75.699 P<0.0001*
	Unsatisfactory	74	80	21	81	13	80			
Emergency intervention for deviating FHR patterns	Satisfactory	9	17	75	18	78	15	X^2= 2.829 P=0.093	X^2= 65.300 P<0.0001*	X^2= 79.771 P<0.0001*
	Unsatisfactory	91	83	25	82	22	85			

Sig1: test of significance between the study and control group before the program;
Sig2: test of significance between the study and control group after one month of the program; Sig3: test of significance between the study and control group after three months of the program; X^2: Chi-Square test*significant at P≤0.05

Table (5): Number and percent distribution of nurses regarding their total score of performance about electronic fetal heart monitoring before and after one and three months from the implementation of ICBS training program

Total score of performance	Before intervention		After one month of intervention		After three months	
	Study (n=100)	Control (n=100)	Study (n=100)	Control (n=100)	Study (n=100)	Control (n=100)
	%	%	%	%	%	%
Satisfactory	14	18	82	15	83	20
Unsatisfactory	86	82	18	85	17	80
Significance (p value)	X^2=0.595 P=0.440		X^2=89.861 P=0.0001*		X^2=79.452 P=0.0001*	

X^2: Chi-Square test; *significant at P≤0.05

4.Discussion

Interactive computer- based simulations (ICBS) is a teaching strategy that provides a trainers an interactive, practice-based instructional to assist them in the acquisition of both psychomotor and critical thinking skills. A virtual reality child birth Simulators was incorporated into a variety of continuing training programs in obstetric field to improve the quality and safety of care for women and their fetus that in turn contributing to increased perinatal safety. [2,18] Electronic fetal heart rate monitoring is highly depends on accurate interpretation of fetal heart rate (FHR) patterns that is requiring a considerable training, experience and skills which are difficult to acquire and maintained. [15,19]

As regarding the study nurses' knowledge about the EFHM. The findings of the present study revealed that there is no significant difference between the study and control group before the implementation of the ICBS training program. While there is a high statistical significant difference was noticed between study and control group in favor of the study group regarding their knowledge after one and three months of program implementation. Lack of nurses' knowledge before the program may be attributed to the fact that training courses for nurses before enrolling them in their occupation did not contain issues about this topic while the nurses gain little information later during orientation to the clinical area or through in-service training. This result is congruent with Macintosh M(2001)[20] who found that, there is a lack of standardization in the FHR tracing interpretation. Other studies [21,22] added that, education programs about EFHM will reduce care providers mistakes which resulting in fewer serious complications such as stillbirth and disability. While others added that simulator is an Effective educational strategy that captures the learners' aptitude with and desire to use technology as they gain and apply necessary skills and knowledge. It also offers a creative teaching modality that allows transference of textbook knowledge into a real-life situation. [18-23]

Concerning the effect of an interactive computer-based simulator tainting program on nurses' knowledge about general information on EFHM, application of external fetal monitoring and nurses role in internal fetal monitoring. The results of the present study revealed that there is no significant difference between the study subjects before the program. This may be attributed to the fact that, educational curriculum in Saudi Arabia may not properly contain issues about EFHM and also may be attributed to the minor role that nurses play in IFHM.

While after the program there is a significantly improvement among the study than control group regarding previous items. This result was supported by Harris *et al.*(1995)[24] who mentioned that, improved education in FHR deviation pattern will reduce mistakes made by health professionals. Hicks *et al.* (2009)[1] also noticed that students may retain knowledge longer when they attending a simulated training program compared to the traditional lecture. A recent literature review of computerized simulation in health care teaching indicated that skills and/or knowledge acquisition by students occurred in 75% of the studies reviewed. [25]

Before the program the majority of nurses had poor knowledge regarding interpretation of FHR findings (CTG strips), causes of FHR deviation pattern and/ or signs of FHR deviation that indicate fetal hypoxia. Yet, after the implementation of the ICBS training program there was a significant improvement in the level of knowledge of study than control group regarding the above topics. This result was supported by Lin-Lin *et al.* (2007)[10] who stated that, subjective andincorrect interpretation of cardiotocographic data is acommon finding in intrapartum event-related asphyxia. Kheddar*et al.* (2004)[3] added that labor simulator is used to demonstrate fetal heart tones, changes in fetal status (exhibited by the fetal heart rate monitor) and changes in maternal fetal condition. They added that simulation scenarios provide a bridge between theory and clinical practice so; students are able to visualize physiological responses that may be difficult to understand simply through didactic classes or readings. Recent research added that, [23, 25] simulation

is designed to support and enhance the information presented in the accompanying didactic courses.

Nurses' knowledge regarding emergency intervention for deviating FHR patter was significantly improved from poor before the program to good or fair after the implementation of the ICBS training program among the study than control group. This result was in line with Macintosh M(2001) [20] who stated that, health care workers felt unable to offer guideline on the management of specific FHR deviating patterns due to their lack of knowledge about underling pathophysiology of FHR variation in case of hypoxia. It also agrees with Parer*et al.* (2007)[26] who found that when abnormal features are present, obstetricians and midwives should be competent to recognize and interpret CTG correctly and decide on the appropriate management. According to Rhodes M (2005) [17] the use of simulation is a valuable teaching modality as it allow the student to provide accurate client assessment and make decisions about complex patient care management in a timely manner and participate in planning the management of adverse obstetric conditions. They also mentioned that simulation seems to be an accepted method for team training in emergency situations in obstetrics.

The level of nurses' performance regarding their role in the application of external fetal monitoring, & internal fetal monitoring (IFHM) was unsatisfactory before the implementation of ICBS training program. While after the implementation of the program there was a significant improvement in the study than control group. This result may be due to the fact that, nurses believed that IFM is an invasive procedure applied only by the doctor. Yet, after the implementation of the program they realized their role in this procedure. This result is in line with the study of Daniels*et al.*(2010)[25] they stated that, the program about EFHM will enhance the training and performance of staff resulting in fewer serious complications happening such as stillbirth and disability, which in turn will lead to less medical litigation costs in obstetrics. It is also congruent with the study of Bambini*et al.* (2009)[27] who stated that simulation was an essential tool for practicing routine and critical events, and improving technical proficiency and teamwork. Simulation can serve as a strategy for improving procedural and behavioral skills, potentially mitigating and adverse perinatal events.

Nurses' performance regarding interpretation of FHR strips(CTG findings), detecting signs of FHR deviation that indicate fetal hypoxia were significantly improved for the study than control group after the implementation of ICBS training program. This results is in line with that of Bambini *et al.*(2009)[27] who found in their study that the use of computerized

labor simulation is effective to assist nursing students in the acquisition of both psychomotor and critical thinking skills such as monitor physiologic parameters, fetal heart tone controller,contraction controller to train the student to rescue the pregnant woman whom in the dangerous situation.It also congruent with the study of Haws *et al.*(2009)[22] who reported that, his program evaluations about EFHM rendered a very positive score from physicians and nurses regarding interpretation, guidelines for FHR patterns. Macones*et al.*(2008) [7] found that their applied workshop was effective in increasing nurse knowledge and skills about FHR pattern, classification, interpretation and management for FHR deviation.

Nurses' performance regarding their role in emergency interventions for FHR deviation pattern in this study was significantly improved among the study than control group one and three months after the ICBS training program. This results is supported by Daniels *et al.*(2010)[25] they mentioned that the simulation lab, allows students to improve their ability to perform an accurate assessment and to create/implement a plan of care for both normal as well as abnormal fetal status. Moreover, nursing literature demonstrates increased support for the use of computerized labor simulation to assist nursing students in the acquisition of both psychomotor and critical thinking skills to performs nursing interventions for deviation heart sound. [23,27]

Conclusion And Recommendations
Conclusion

Based on the finding of the present study,it can be concluded that there is no significant difference between the study and control group before the implementation of the program regarding their knowledge or performance about the EFHM. In spite of this fact a significant improvement in nurses' knowledge and performance were observed among the study than control group after one and three from the implementation of the interactive computer-based simulators training program regarding all items of EFHM such as :their role in external or internal fetal monitoring (IFHM), interpretation of CTG findings, their ability in detecting signs and causes of FHR deviation that indicate fetal hypoxia and their role in developing and implementing emergency interventions for FHR deviation pattern.

Recommendations
Based on the finding of the study the following recommendations are suggested:
-   Incorporating (ICBS) training program in the basic nursing curriculum to help professional

nurse acquire the essential knowledge and skills to adopt EFHM in their daily nursing practices.

- Conduct In service (ICBS) training program for all nurses regarding EFHM.
- Standardization for FHR tracing interpretation should be developed by expert in obstetric field.
- Areas for future needed research should investigate the main factors that interfere with accurate interpretation of CTG flinging should be done

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