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How to Prepare Obstetric Interns for Cardiotocography Interpretation?

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Abstract

Background/Introduction: Cardiotocography (CTG) is an important obstetric tool to assess fetal wellbeing. Interns are exposed to a lot of fetal heart traces during their internship. Knowledge on this is gained by (undergraduate) teaching and by working with clinicians. With this prospective cohort study we aim to investigate if introducing a CTG e-learning makes interns feel better prepared and more competent in interpreting CTG.

Methods: We evaluated a 1-hour CTG e-learning containing basic principles and interpretation skills. We used anonymous evaluation questionnaires. The answers of the questionnaires were entered in and examined with IBM® SPSS® statistics version 26.

Results: Students with access to the CTG e-learning felt better prepared (p=0.001), more competent (p=0.001) and were more satisfied with the education (p=0.000). Students with or without access to the e-learning scored the same on the knowledge test (p=0.504).

Conclusions: Providing a CTG e-learning at the start of the obstetrics/gynecology internship makes students feel more prepared and more competent on interpreting CTG's. They are satisfied with the education.

Keywords: Cardiotocography; e-learning; medical student; intern; competence

List of Abbreviations: CTG = Cardiotocography; EFM = Electronic Fetal Heart Rate Monitoring; FHR = Fetal Heart Rate

Background/Introduction

When interns start a new internship, they are confronted with a lot of new information, techniques and knowledge. One of these techniques in the gynaecology/obstetrics internship is electronic fetal heart rate monitoring (EFM) by means of a cardiotocograph (CTG). This is a ubiquitous obstetric tool to assess fetal condition in relation to uterine contractions. The main goal of fetal heart rate (FHR) monitoring is to detect fetal hypoxia intrapartum, so that a well-timed and appropriate intervention can be started to improve perinatal outcome. Interpretation of CTG is done by professionals, at least every hour during labour.

Students are exposed with many different FHR traces during their obstetric internship. They acquired some basic knowledge during lectures in their undergraduate years in the bachelor phase of their medical education. Interns acquire and expand their knowledge by reading books, protocols and working with physicians and clinical midwives. However, gaining knowledge during internships depends on how the student learns, the clinicians time and

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willingness to teach[1,2]. Students need basic knowledge on EFM to make the desired step towards clinical reasoning. An e-learning, providing the basic principles and interpretation skills on EFM, is a good and easily accessible resource for teaching the basics. E-learnings can stimulate an active learning culture[3]. It is a part of the blended learning strategy together with the clinical experience of an internship. An e-learning offers the students self-directed learning with control over learning pace, time and content. They can check and recheck the information whenever and how often they want.

A few articles have been published on CTG e-learnings for students. The studies evaluated the reactions of the students on the learning product and they evaluated if participants improved their knowledge. The e-learnings were judged useful and have positive effect on knowledge[4-8]. None of these articles evaluated the effects of a CTG e-learning on competence of CTG during an internship.

This prospective cohort study aims to investigate if providing a CTG e-learning at the beginning of the internship has a positive influence on interns CTG competence and feeling of readiness. By means of a questionnaire and knowledge test, this study aims to evaluate if students feel better prepared and more competent in the context of EFM during their internship.

Methods

We developed a 1-hour CTG e-learning on the basic principles and interpretation skills of EFM. The e-learning is hosted on the digital learning environment of the University of Amsterdam. The learning objectives of the e-learning are: explain the physiological backgrounds of fetal heart rate, structurally assess a CTG and recognize an abnormal fetal heart rate pattern. We used different learning theories to stimulate active learning[9-11].

We used the behaviorist theory and the constructivism theory. The e-learning is divided in two parts. The first part of the e- learning consists information on the physiological basis of fetal oxygenation, the technique behind CTG and interpretation and classification of fetal heart rate (including baseline frequency, variability, accelerations and decelerations). This material is broken down in smaller pieces with multiple choice questions for revision. The second part of the e-learning consists of CTG's where students have the opportunity to apply their gained knowledge and practice their interpretation skills. Participants were fifth-year medical students during their 8-week gynecological and obstetric internship at the Amsterdam UMC location AMC. Participation was completely voluntarily and anonymous. This is a pre- and post-implementation study. We compared two groups: a non-intervention group consisting of students with no availability to the e-learning versus an intervention group with students having unlimited access to the e-learning from the start of their internship. Besides availability of the e-learning for the intervention group, there were no other changes in the CTG education program. The standard CTG education is a short introduction of 10 minutes on EFM at the start of their internship. There is no other structural CTG education, besides lectures during their undergraduate years in the bachelor phase of their medical education. Evaluation questionnaires (see table 1) and a knowledge test (see supplementary information) were used for evaluation. All students were asked to participate in the evaluation and fill in the questionnaire and knowledge test at the end of their internship.

IBM® SPSS® statistics version 26 was used for statistical analysis. The free text data was examined and coded by two authors (S.V. and I.G.). The following statistical test were performed: Pearson's Chi-square, Mann Whitney U Fisher's exact, and T-test.

For the questionnaire we used a 10-point Likert scale because it gives more precision and students are well

Table 1: Questionnaire

Answer possibilities	
Where did you acquire your knowledge of CTG? (multiple answers possible)	· Physician/gynecologist · Bachelor study in medicine · Book · Introduction day of the internship · Fellow intern · Searched online · Hospital's protocol · Other, namely ……
I've made the CTG e-learning[$]	Yes/no
I think the e-learning is educational and why?[$]	Yes/no
I felt capable to interpret CTGs during my first shift at the obstetric department.	1-10*
During the internship I felt like I acquired enough knowledge to interpret a CTG.	1-10*
I felt like I had sufficient CTG education during my internship.	1-10*
I can explain the interpretation of an CTG to a fellow intern.	1-10*
I can explain the interpretation to a patient.	1-10*
I dare to call a resident/ gynaecologists about a CTG.	1-10*
I feel capable/competent interpreting a CTG.	1-10*

[$] only asked in the intervention group
* a ten-point likert scale (1= completely disagree to 10 completely agree)

acquainted with this scale, as they are assessed on this scale throughout their studies. In the statistical analyses we used cut off value of 7, as students are graded above 7 when they are function normally during their internship.

Ethical approval and consent to participate

The study was deemed exempt approval by the ethical commission of the Amsterdam UMC ('Medische Ethische Toetsingscommissie'), reference number W21_060. They also waived the need for written informed consent, as it concerned a completely anonymous evaluation.

Results

A total of 92 students from both groups, were asked to fill in the questionnaire and knowledge test, of which 80 returned their answers. This resulted in an 87% response rate.

The non-intervention group had a response rate of 94%: 44 of the 47 questionnaires were returned. Thirty-six of the 45 questionnaires returned in the intervention group (response rate 80%).

Besides the e-learning, students of both groups obtained knowledge and information in the same manner during their internship, (see table 2). Most students obtained knowledge from clinicians (70.0%) or they searched online (58.8%). Students indicated not to have obtained knowledge from fellow interns (2%) and only a few students recalled knowledge from their bachelor phase of their education (6.3%).

Not all students in the intervention group made use of the e-learning; 26 of the 36 (72.2%) students who returned their questionnaire made use of the e-learning. Reasons why they didn't used the e-learning were: the intern didn't know the e- learning existed (n=3), the intern made another e-learning (n=3), the intern couldn't find the e-learning (n=1), the intern experienced technical issues (n=1), the e-learning wasn't obligated (n=1), the intern rated his/her knowledge as sufficient without the e-learning (n=1).

The students in the intervention group preferred the e-learning. They thought it was educational with clear explanation and they liked the opportunity to practice classification of a CTG with immediate feedback. The also felt better prepared (p=0.001), experienced enough CTG education during their internship (p=0.005) and felt more competent about using CTG (p=0.001), (see table 3). There was no difference in feeling competent in explaining a patient about the CTG or asking a physician.

Both groups made the same knowledge test. There was no difference in test scores between the groups. (p=0.76). The mean score of the non-intervention group was 7.68 (standard deviation ±1.68 and mean score of the intervention group was 7.56 (standard deviation ±1.97). The highest possible score was 14.

Discussion

Results of this pre- and post-implementation study indicate that interns with unlimited access to a CTG e-learning feel better prepared and more competent in interpreting CTGs than interns with no availability to the e-learning. We found a significant difference in the educational experience: more students with access to the e-learning reported to experience sufficient education.

Other studies were CTG e-learning was introduced were also successful. Catanzarite et al. introduced a computer aided instructional system for medical students during their internship. Students commented the system as a valuable teaching aid and recommended to keep it in the curriculum[4]. The studies other studies evaluated also knowledge and the students with extended teaching scored significantly better. Keegan et al. added computer assisted learning to traditional reading assignment. And Wilson et al. compared computer assisted learning alone to computer assisted learning with additional tuition (lecture) in two articles. The students with most extended teaching in these articles scored significant better on knowledge tests. The students were also satisfied and judged the computer assisted learning as usefull[5,7,8].

Table 2: Obtainment CTG knowledge

	Total (n=80)	Non-intervention group (n=44)	Intervention group (n=36)	p
Physician/midwive, n(%)	56 (70.0)	33 (75.0)	23 (63.9)	0.281$
Bachelor of Medicine, n(%)	5 (6.3)	2 (4.5)	3 (8.3)	0.653*
Book, n(%)	12 (15.0)	10 (22.7)	2 (5.6)	**0.032$**
Introduction-day, n(%)	37 (46.3)	21 (47.7)	16 (44.4)	0.770$
Fellow intern, n (%)	2 (2.5)	2 (4.5)	0 (0.0)	0.499*
Searched online, n (%)	47 (58.8)	28 (63.6)	19 (52.8)	0.326$
Hospital's protocol, n (%)	24 (30.0)	15 (34.1)	9 (25.0)	0.377$
E-learning, n (%)	26 (32.5)	0 (0.0)	26 (72.2)	**0.000$**

$ = Pearson chi-quare
* = Fishers exact

Table 3: Questionnaire results, Likert Scale cut off ≥7

	Total (n=80)	Non-intervention group (n=44)	Intervention group (n=36)	p
I felt capable to interpret CTGs during my first shift at the obstetric department, n (%)	39 (48.8)	14 (31.8)	25 (69.4)	**0.001$**
During the internship I felt like I acquired enough knowledge to interpret an CTG, n (%)	67/79 (84.8)	32/43 (74.4)	35 (97.2)	**0.005$**
I felt like I had sufficient CTG education during my internship, n (%)	33/79 (42.3)	9/43 (21.4)	24 (66.7)	**0.000$**
I can explain the interpretation of an CTG to a fellow intern, n (%)	70/79 (88.6)	35/43 (81.4)	35 (97.2)	**0.028***
I can explain the interpretation to a patient, n (%)	69/79 (87.3)	36/43 (83.7)	33 (91.7)	0.239*
I dare to cal/ask a resident/gynecologists about a CTG, n (%)	70/79 (88.6)	36/43 (83.7)	34 (94.4)	0.170*
I feel capable/competent interpreting an CTG, n (%)	65/79 (82.3)	30/43 (69.8)	35 (97.2)	**0.001$**

$ = Pearson chi-quare
* = Fishers exact

Where these other studies found better results on knowledge test in the group with extended teaching, this study had the unexpected result of equal scores on the knowledge test in both groups. Not all our participants made use of the e-learning. But even when comparing the students who didn't used the e-learning (n=54) and who did use the e-learning (n=27), there

were also no significant difference in test scores (9.36±2.30 standard deviation vs. 10.02±2.08 standard deviation, p=0.220). There was no data collected to explain the equal scores on knowledge test. The information/answers on the questions in the test, were all in the e-learning. There are different hypotheses for possible explanation of the equal results on the knowledge test. The obstetric weeks were at the beginning of their eight-week internship, this is the period where they used the e- learning and their knowledge. Possible they forgot part of information given by the e-learning at the end of their internship, when they made the test. Another explanation: the students without the e-learning acquired the same knowledge in other ways (clinicians, books or protocols) just as they indicated in the questionnaire, (see table 2).

However, the main goal of this study was getting students feeling better prepared and more competent in interpreting CTG's. Our students, with access to the e-learning, self-assessed feeling more prepared and competent in interpreting CTG's. These results are in agreement with other studies on self-reported competence after e-learning. Iqbal et al. added an e-learning to a one-time live demonstration of a dental procedure. The dental students felt more competent in performing the skill-based procedure[12]. McGann et al. evaluated an e-learning for basic surgical skills for medical students. They found a significant increase in average self-reported confidence on knot tying and suturing[13]. These results are not only found for students but also for health care professionals in general. Meiser et al. evaluated an e-learning on communication breast and ovarian cancer patients about genetic testing. The oncology professionals reported higher self-rated competence in communication with patients about genetic testing[14]. Berg et al. performed a systematic review on online communication skills training on cancer and palliative care for health care professionals. Learners self-assessed improved confidence on communication[15]. This study has strengths and limitations. A strength of this study is the response rate. The average response rate of 87% has to be considered very good[16,17]. Another strength is the implementation and evaluation of a straightforward intervention. It is very easy for other hospitals and departments to use the results in the development and evaluation of their current and future education.

A limitation of this study is the relatively small sample size. This can result in a type II error; failure to reject a null hypothesis that is actually false. However, this is the first study to perform evaluation in terms of feeling better prepared, more competent and experiencing sufficient education in context of CTG during their internship. Therefore, it was not possible to calculate a sample size. Given the high response rate, there is a low chance on selection bias.

Another limitation is that this study didn't evaluate personal CTG education given during the internship by clinicians. Hypothetically, there could be a difference in education by the various clinicians. It is almost impossible to investigate this and to correct for this. However, the internship didn't differ between the intervention and non-intervention groups and there is a great willingness within our department to teach students. Since the students in the non-intervention and intervention group had equal scores in the

knowledge test, we believe that the education in the obstetric department by clinicians didn't differ between the groups and didn't influence the results.

A last limitation; this study didn't compare an e-learning with another teaching strategy, for example a lecture. Other research isn't clear if e-learning is the best way to educate. Studies comparing different teaching strategies reporting on knowledge have contradictory results for e-learnings. Murray et al. compared a CTG e-learning versus a CTG lecture with the same content. All nursing students improved their test scores. Lecture time (235 minutes) was significantly longer than time spent on the e-learning (132,5 minutes)[6]. Golchai et al. found better test scores in e-learning versus lecture in a histology course [18]. Contrary, Pourghanznein et al. found lower test scores for e-learning vs lecture in nursing education[19]. There aren't any publication on comparing different teaching strategies and students feeling better prepared and more competent. There are some studies about student confidence. Davies et al. compared e-learning versus near-peer teaching in electrocardiogram education for medical students. The students in both groups increased their confidence in electrocardiogram interpretation[20]. Nathan et al. compared a virtual classroom, a non-interactive video and face-to-face teaching in basic surgical skills for medical students. Suturing confidence improved in all three groups[21].

This study evaluated in the same range as self-reported confidence. Our-learning made students feel more prepared and feel more competent in interpreting CTGs. The e-learning gives the students flexibility; they can learn at their own pace and they can repeat the e-learning as often as they want. It provides them basic knowledge to build on during their internship. The e- learning did not replace the support and expertise from the clinicians during their internship. Our participating students indicated to obtained knowledge from clinicians during their internship, regardless of having access to the e-learning. Students experience the teachers' expertise as an important part for the acquisition of knowledge, skills and competences[22]. Providing an e-learning gives students the possibility to learn the way they can learn most successfully: learning in different ways, with and without clinicians. Just as Seltz et al. concluded in their qualitative study. Students learned different depending on the presence or absence of an attending physician at ward rounds[23].

The study findings regarding feeling prepared and competent in interpreting CTG's after introducing a 1-hour e-learning are very positive. The results are accessible for the development and evaluation of future education. Future research should focus on changing workplace learning and alignment with an e-learning, to optimize students' learning, using of skills, confidence and satisfaction[24]. It is very easy for other hospitals and departments to use the results of this study in the development and evaluation of their current and future education.

Conclusion

Providing an e-learning on the basic principles and interpretation skills of EFM at the start of the obstetrics/ gynecology internship makes students feel more prepared and more competent on interpreting CTG's. They are more satisfied with the education during their internship. We judge the implementation of the e-learning, which made the clinical experience with CTG of our students better, as successful. We recommend other hospitals and departments to use these results in the development and evaluation of their education.

Declarations

The study was deemed exempt approval by the ethical commission of the Amsterdam UMC ('Medische Ethische Toetsingscommissie'), reference number W21_060. They also waived the need for written informed consent, as it concerned a completely anonymous evaluation. We followed the principles outlined in the Declaration of Helsinki. We didn't register any personal information. Students were given information about the purpose of the evaluation. If they wanted to participate, they filled in the questionnaire voluntarily.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing interest

The authors declare that they have no competing interests.

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Authors' contribution

Authors S.V. and I.G. had major contribution in all stages of the study: setting up the evaluation, performing the evaluation, analyzing and interpreting the data and writing the manuscript. Author P.B. had major contributing in interpreting the data and writing the manuscript.

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