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The impact of a computer assisted learning programme on the ability to interpret cardiotochography. A before and after study

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ABSTRACT

Objective: To evaluate if a computer assisted learning programme could bring about a higher degree of individuals who correctly classified cardiotochography (CTG) recordings in a non-selected population of midwives and physicians.
Study design: A before and after study.
Setting: Södersjukhuset, Stockholm, Sweden.
Subjects: One hundred and thirty midwives and 49 physicians at the maternity unit, September 2009–April 2010. A computer assisted learning programme for interpreting CTG patterns has been created. All 179 individuals included made the first interpretation and the 135 individuals also completing the education made the second interpretation. A third randomly selected interpretation was performed immediately following the second; permitting two participants to classify a CTG together. Comparison between the before and after-test was based on the Fisher exact test.
Main Outcome measure: The proportion of individuals who correctly classified CTGs before and after the training.
Results: Sixty four percentage of the individuals classified the CTGs correctly before and 66% after the training ($P = 0.76$). There was no difference between the two professional groups. Normal CTGs were correctly identified by 36% of the individuals before and in 80% after the training ($P = 0.065$). Corresponding figures for pathological CTGs were 83% and 85% ($P = 1.00$), respectively.
Conclusion: We found no improvement in the proportion of individuals who classified CTGs correctly after the completion of a computer assisted learning programme in fetal monitoring. The baseline level of competence was higher than expected.

Introduction

Fetal surveillance with cardiotochography (CTG), introduced during the 1970s, is widely used although the method is both non-specific and highly dependent on subjective interpretation. Thus the correlation between non-reassuring CTG and bad outcome is low and, in addition, the method is difficult to learn and the inter-observer as well as intra-observer agreement considerably low [1–4]. Additionally, the different CTG patterns seem to be variably difficult to interpret i.e. the inter-observer agreement is good for normal and pre-terminal patterns whereas for intermediary and pathological patterns, a disagreement of up to 50% exist between different interpreters [3,4]. A limitation of these reports is the small study population of selected senior obstetricians and midwives.

Studies on the effects of educational efforts made to improve knowledge on CTG interpretation among obstetric caregivers show positive results [5,6]. Others have compared learning by computers versus teacher-guided lectures in a strategy for teaching fetal monitoring, concluding that neither method is superior to the other [7]. To the best of our knowledge, no study has reported the effects on the ability to interpret CTG after having completed a computer

Abbreviations: CTG, cardiotochography; FIGO, The International Federation of Gynecology and Obstetrics.

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assisted CTG learning programme in a non-selected population representing both midwives and physicians, at all levels, in a large maternity unit.

A national intervention, Safe Delivery Project, aimed at improving patient safety at delivery, was initiated in September 2007 and is now engaging all maternity units in Sweden (http://www.patientforsakring.se/Saker-forlossningsvard.html). Among several measures of improvements the intervention includes the development and implementation of a computer assisted CTG learning programme. The purpose of this study was to evaluate if the CTG learning programme could bring about a higher degree of correctly classified CTG tracings among midwives and physicians all working at the same maternity unit.

Materials and methods

During the working process of the Safe Delivery Project, the need for a learning programme in fetal monitoring by CTG became obvious and a computer assisted programme for interpreting CTG patterns was therefore created. The programme, which constitutes theoretical information, interactive training and a final examination, intends to offer all physicians and midwives involved in fetal surveillance a possibility to improve their competence and skills. The training part covers basic fetal physiology and fetal monitoring with CTG, including classification and interpretation as well as clinical application. It also contains excerpts from authentic CTG recordings that can be scrolled back and forth as illustrations to the text. Moreover, the training part consists of a great number of CTGs with questions and answers about interpretation and clinical application. The examination part comprises questions about fetal physiology, development of fetal hypoxia and five interactive cases including several CTG recordings. To pass the examination, the programme requires 70% correct answers in the theoretical part as well as in the part with interactive cases. The programme was launched in September 2009 and is provided free of charge to all maternity units in Sweden, (http://www.ctgutbildning.se/Course/indexLogin.php). The study was executed at Södersjukhuset (South General Hospital), Stockholm, Sweden; a city hospital comprising about 7000 deliveries per year.

The CTG recordings were selected in the following way. Firstly, we received 55 intrapartal CTGs from a CTG database (Neoventa Medical, Gothenburg, Sweden). The composition of the different subgroups was based on the finding that intermediary and pathological CTGs seem to be more difficult to interpret than the normal and preterminal ones and we therefore requested a selection of a larger proportion of the former [2–4]. Secondly, four experts (two obstetricians and two midwives) individually classified the 55 CTGs according to the Swedish modified version of the FIGO classification (Fig. 1). The 40 CTG recordings that were interpreted with a 100% inter-individual agreement were accepted as the gold standard and constitute the final CTG pool. Five of these tracings were assessed as normal, 13 as intermediary, 17 as pathological and five as preterminal.

We hypothesized that the learning programme would affect the ability to classify CTG. Therefore the sample size was calculated to allow for the detection of a 20 percentage point difference in the proportion of individuals who correctly classified CTGs before and after the training (specifically 50% before versus 70% after the training). A baseline of 50% correctly classified CTG-recordings has been reported previously [2–4]. A total of 103 individuals were

CTG classification	Baseline of fetal heart rate	Baseline variability/ Accelerations	Decelerations	Contractions
Normal	• 110-150 beats/min	• 5-25 beats/min • ≥2 accelerations/60 min	• No decelerations • Uniform, early decelerations • Variable, uncomplicated decelerations with a duration < 30 sec and amplitude < 60 beats	• 5 or less contractions /10 min
Suspicious	• 100-110 beats/min • 150-170 beats/min • <100 beats/min for ≤3 min	• <5 beats/min > 40 min without accelerations • >25 beats/min (saltatory pattern/increased variability) • <2 accelerations/60 min	• Variable uncomplicated decelerations with duration 30-60 min and/or amplitude > 60 beats	• >5 contractions/10 min
	With a combination of 2 or more suspicious/abnormal factors the CTG is classified as suspect pathological			
Pathological	• >170beats/min • <100 beats/min for > 3min	• <5beats/min for 60 min without accelerations • Sinusoidal pattern	• Variable complicated decelerations with duration > 60 sec • Uniform late decelerations • Combined decelerations	
Preterminal	No variability (<2 beats/min) without accelerations regardless of decelerations/heartbeat			

[2]FIGO= the International Federation of Gynecology and Obstetrics

Fig. 1. Swedish modified version to the FIGO classification.

Table 1
The proportion of individuals who made correct classifications of their randomly chosen CTG[a] recording, before and after the training.

Participants	Before	After	*P*-value
All, total % (*n*)	64 (115/179)	66 (89/135)	0.76
Physicians % (*n*)	63 (31/49)	75 (30/40)	0.23
Midwives % (*n*)	65 (84/130)	62 (59/95)	0.70

[a] CTG = cardiotochography.

required in order to detect this difference with 80% power at 5% significance level, two-tailed. In addition, we anticipated a dropout rate of 25% and a recruitment goal of a minimum of 137 participants was therefore established. We used Sample Power 2.0 to perform the sample size calculation which was based on the Fisher exact test.

The individuals studied were midwives (n = 132) and physicians (n = 49, in all n = 181) recruited from the Department of Obstetrics and Gynecology at Södersjukhuset, Stockholm, Sweden. The study was carried out between September 2009 and April 2010. The eligible population was all staff members with a length of service of at least the following 6 months. They were recruited in September 2009 when all obstetric staff participated in a mandatory meeting. After a short introduction to the computer assisted learning programme the midwives and physicians attending were asked to voluntarily participate in the present study.

Of the eligible 181 midwives and physicians, two did not carry out the first judgement of a CTG. Thus 179 individuals who consented to participate were requested to independently classify a single, randomly chosen paper-copy of a 40 min long CTG from the pool of CTG recordings and were given about 5 min to fill in the classification. Thereafter they gained access to the programme password and were encouraged to begin with their individual studies. The 135 (75%) midwives and physicians that completed the education and the final individual examination were asked to classify another randomly chosen 40 min long CTG recording from the pool. The second test was accomplished within approximately 1–32 days (evenly distributed) after the completion of the individual examination. An additional third interpretation test was performed immediately following the second. Two participants (midwife and midwife or midwife and physician) were allowed to scrutinize and classify a new randomly selected CTG together, (altogether 55 couples). Here, the participants were encouraged to discuss the interpretation and to reach consensus. Additionally, the participants were asked the question: ''How did you experience the process of classifying the CTG-tracing on your own compared to classifying it together with a colleague?'' All interpretations were made without access to the standardised classification guideline.

We used the Fisher exact test to compare the proportion of individuals who correctly classified CTGs before and after the training (i.e. to test the primary hypothesis). The results were regarded as significant if P was less than 0.05, two-tailed. PASW (SPSS) version 18.0 was used for the statistical analysis. The agreement in CTG classification within the expert group was 69%. One hundred and seventy nine individuals (130 midwives and 49 physicians) completed the first classification test. Of those, 135 (75%) accomplished the second test, after having completed the web-based training and examination. Those who declined participation claimed shortage of time during the stipulated period.

Results

In total, 64% of the individuals classified their randomly chosen CTG-recording correctly before and 66% after the computer assisted learning programme (P = 0.756). There was no difference between the two professional groups (i.e. midwifes and physicians; Table 1).

Table 2 illustrates correct/incorrect classifications in the separate categories before and after education within the studied population. Normal CTGs were correctly identified in 36% (8/22) before and in 80% (16/20) after the training (P = 0.065) whereas the corresponding figures for suspect, pathological and preterminal CTGs were 44% (25/57), 83% (64/77) and 70% (16/23) before and 38% (18/47), 85% (45/53) and 67% (10/15), respectively. The respective P-values were all non-significant (P = 0.76, 1.00 and 1.00). The participant classifying the first CTG made correct classifications in 54% (24/44). 66% (89/135) of the participants fulfilling the education made correct classifications of the first CTG. The difference was non-significant, (P = 0.209).

One hundred and ten randomly selected individuals, including 32 mixed professionals and 23 pairs with two midwives took part in the third part of the test. The median years of experience among the participants within this subgroup were 11 (range 1.5–36) and nine (range 2–36), respectively. In total, 79% of the couples classified the CTGs correctly. In the group of two midwives, 70% (16/23) made a correct classification and in the group with one midwife and one physician the proportion was 85% (33/39), non-significant, P = 0203. In answer to the question raised, 91% of the participants expressed more positive judgement in classifying the CTG together with a colleague as opposed to doing it alone.

Discussion

There was no significant difference in the proportion of individuals who correctly classified CTGs among a non-selected population of midwives and physicians before and after having gone through the computer assisted learning programme in fetal monitoring. We designed the study to detect an increase of 20 percent-

Table 2
Classifications made before and after education in relation to the correct classifications. Bold numbers indicate correct classification.

Classification	Correct classification of CTG tracings *n* (%)				Total *n* (%)
	Normal	Suspicious	Pathological	Preterminal	
Before education					
Normal	**8 (36)**	7 (12)	1 (1)	0	16 (9)
Suspicious	11 (50)	**25 (44)**	5 (7)	1 (4)	42 (24)
Pathological	3 (14)	25 (44)	**64 (83)**	6 (26)	98 (55)
Preterminal	0	0	7 (9)	**16 (70)**	23 (13)
Total	22 (100)	57 (100)	77 (100)	23 (100)	179 (100)
After education					
Normal	**16 (80)**	10 (21)	0	0	26 (19)
Suspicious	4 (20)	**18 (38)**	5 (9)	1 (7)	28 (21)
Pathological	0	19 (40)	**45 (85)**	4 (27)	68 (50)
Preterminal	0	0	3 (6)	**10 (67)**	13 (10)
Total	20 (100)	47 (100)	53 (100)	15 (100)	135 (100)

age points after the training among all the individuals rather than letting a few individuals interpret many CTG recording. Instead of the estimated 103 individuals we managed to include 135, but the baseline level was higher than expected (64%) with a non-significant increase after the test (66%). Both when considering other reports and the comparatively low 69% inter-observer variability noted in the group of four experts the baseline level seems high. There was no difference in the ability to classify the CTGs between the two professional groups, also indicating a high standard of knowledge. This study was performed at one city hospital with a relatively large number of deliveries putting high demands on the professionals involved. This amount of deliveries does not represent the average in Sweden thus complicating generalisation of our results. Moreover, we have found no other reports of this kind evaluating educational efforts in CTG interpretation in a non-selected population. We believe that the choice of a large, mixed study population mirrors clinical reality and should therefore be of interest.

Based on other studies we estimated that the four subgroups would not be equally successfully interpreted and we therefore chose more of the ones reported to be more difficult i.e. the suspect (intermediate) or pathological tracings [3,4]. Our results showed that before the training, the higher proportion of successfully identified CTGs were the pathological and preterminal (83% and 70%, respectively), whereas the normal and suspect tracings showed a lower success rate (36% and 44%, respectively). Since abnormal CTG is associated with increased risk of asphyxia it is reassuring that the ability to identify pathological and preterminal tracings seems satisfyingly high, and although non-significant, notable that the ability to correctly classify the normal tracings increased from 36% before to 80% after the training. A reduced number of false positive CTGs might have a positive impact on unnecessary medical interventions during labour and delivery. In a comparative study of obstetric interventions and outcomes in low-risk pregnant women in an in-hospital birth centre and the standard care unit at Södersjukhuset, a lower incidence of medical interventions, including caesarean sections for imminent asphyxia, with the same neonatal outcome was reported [8].

Lack of difference may be true but may also be explained due to the baseline knowledge of interpretation being good. A type II error, with an in fact successful effect of the learning programme, but a random error making the results negative, cannot be excluded. It could be argued that the study design with the sole interpretation of one single CTG-tracing before and after an education is too simple compared to ''real-life'' where you always have access to more detailed information of the fetal status and its relation to stage of labour. However, according to the power analysis, the number of individuals participating in the study is large enough to detect a significant difference in the proportion of correctly identified CTGs before and after the learning programme. Even if the finding of the sub-analysis cannot be reliably generalized because of the small sample, we find it interesting that the results seem to improve if CTG-tracings were classified in pairs. In a national study based on claims filed with the Patient Advisory Committee concerning severe delivery-related asphyxia during the period 1990–2005, the most common reasons for substandard care during labour were found to be insufficient fetal monitoring (98%) and neglecting signs of asphyxia (71%) [9]. Among 313 infants born with a low Apgar score, and in a corresponding number of healthy controls in the Stockholm area 2004–2006, 62% and 36%, respectively, had been subjected to some form of substandard care during labour. In half of the cases, and in 12% of the controls, CTG was abnormal for $\geqslant$45 min before birth. It was estimated that up to 42% of the cases could have been prevented by avoiding substandard care [10]. Thus it is clear that improvements in fetal monitoring are essential. In this context we want to emphasise that other parts of the computer assisted learning programme, such as fetal physiology and clinical applications, have not been analyzed in this survey and need to be further evaluated.

Abnormal CTG is a known risk factor for asphyxia but the high prevalence of non-reassuring CTG during delivery is a challenge in fetal surveillance. Educational efforts are obviously needed as well as further studies on implementation. Although the study did not indicate any improvement in CTG classification, we are aware of the low-specificity of CTG as such, which perhaps makes it hard to reach a higher level of competence in a large, unselected group of professionals. Guidelines for a structured classification are generally used when teaching CTG interpretation and a modified Swedish guideline was used in the computer assisted learning programme [11]. To what extent this standardized thinking is practiced in the everyday clinical situation is unknown. Factors like relations between team members, hierarchy and intra-personal factors such as variations in cognitive abilities are likely to affect the judgment however this is still insufficiently studied [12,13]. Maybe it is impossible to obtain a higher level of competence in a non-selected professional population. Perhaps the next step in developing safer fetal surveillance includes systems that help correct human imperfection and that combines a number of known improvement facilitators such as continuous training and testing of knowledge, co-pilots, expert systems, check lists as well as a no blame culture (Steer, personal communication). Recent research indicate that people tend to perform better in groups than alone [14]. It has been suggested that obstetric staff can most effectively utilize CTG if they speak a common language when describing the CTG patterns. The value of a common language is that everyone involved has the same understanding of the CTG patterns, thereby increasing patient safety by decreasing the risk of miscommunication [15]. This lead us to the supplementation of pair-wise testing, simulating team-work, directly after the second individual one. The finding that the highest proportion of correctly classified CTG (85%) was obtained by a midwife and a physician working together implies that having a co-pilot is an advantage when performing complex tasks. The vast majority of the participants in this part of the study expressed satisfaction in assessing the CTG together. This supplementary test, however, was made only after the training and it is therefore unknown whether the training affected the results or not. In conclusion, in a non-selected population of midwives and physicians, the proportion of individuals who correctly classified CTG recordings was not significantly improved by a computer assisted learning programme in fetal monitoring. The baseline level of competence was higher than expected. The finding of the highest level of correctly interpreted CTGs when scrutinised pair-wise by a midwife together with a physician is encouraging and needs to be evaluated further.

Disclosure of interests

There are no conflicts of interest. The providers of the computer software played no part in the study design, data analyses, data interpretation or writing the report. C.M.L. and H.P. had full access to all data in the study and the final responsibility and decision to submit for publication was shared by all authors.

Contribution to authorship

The study was planned by all authors. C.M.L. collected all the data and carried out the main part of the analyses and drafted the manuscript. C.G. and H.P. assisted in the interpretation of the results and all authors took part in the revisions of the manuscript. The final version was approved by all authors.

Details of ethics approval

The study was approved by the Research Ethics Committee at Karolinska Institutet (No. 2010-1603 31-4).

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