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Effect of e-learning on quality of cervical-length measurements

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KEYWORDS: cervical length; e-learning; preterm birth

ABSTRACT

Objectives *To assess the effect of implementation of a newly developed e-learning module on the quality of cervical-length measurements.*

Methods *With the introduction of cervical-length (CL) measurement in a research setting, a CL measurement e-learning module (CLEM) was developed with the purpose to enhance the knowledge and skills of experienced ultrasonographers. CLEM was designed specifically for ultrasonographers who perform ultrasound in a general obstetrical practice but who do not regularly perform CL measurements. CLEM consists of five theoretical questions and three caliper-placement tests to learn the CL measurement technique. The quality of the CL measurements of CLEM participants was compared with images of non-participants using a CL measurement image score (CIS), defined as the sum of six items which assess the quality of the image. Each CLEM participant submitted five CL images and the images of non-CLEM participants were selected randomly from an ultrasound database.*

Results *The CIS of the CLEM participants (*n = *61) were significantly higher than those of non-CLEM participants (*n = *23) (164.9* vs *155.6, respectively;* P = *0.03). Visualization of the internal os and positioning of the calipers on the internal and external ora were found to have significantly higher CIS among the CLEM participants than among the non-CLEM participants (*P = *0.001 and* P < *0.001, respectively).*

Conclusions *Introducing CLEM may improve the quality of CL measurements obtained by trained and untrained sonographers. Copyright © 2014 ISUOG. Published by John Wiley & Sons Ltd.*

INTRODUCTION

Measurement of cervical length (CL) by transvaginal ultrasound in mid-pregnancy is a tool used to assess the risk of preterm delivery. CL measurement is accurate, highly reproducible and reported to cause a minimal degree of discomfort for women[1,2]. The reduction of prematurity has become an important goal of the global community as preterm birth was designated recently as one of the main causes of the global burden of disease[3]. The impact on public health of prematurity has resulted in extensive attention being given to this subject in scientific research.

Hands-on teaching by an experienced sonographer is a well-established method of education and training of ultrasonographic skills and measurements. However, e-learning, the delivery of a learning, training or education program by electronic means, is developing as a powerful tool[4,5]. It is used already as a training tool in disciplines that focus on imaging, such as radiology and rheumatology[6,7]. Some educators state that interactive computer programs are more powerful than are traditional lecture-based formats and in some cases may replace them[8].

Since cervical length is not measured routinely in low-risk settings such as community ultrasound centers and midwifery practices, the majority of sonographers do not perform this measurement regularly. A CL measurement e-learning module (CLEM) was developed with the purpose of improving the level of basic knowledge of CL measurement of experienced sonographers. Our goal was to improve the quality of measurements in order to perform a national multicenter prospective cohort study in conjunction with a randomized controlled trial (Preventing preterm birth with progesterone: costs and effects of screening low risk women with a singleton

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pregnancy for short cervical length, the Triple P study (NTR 2078)[9]).

The aim of this study was to assess the effect of implementing CLEM on the quality of CL measurements by ultrasonographers in asymptomatic low-risk pregnancies.

METHODS

Between January 2010 and May 2011, sonographers of seven university hospitals, 23 general hospitals and 29 ultrasound centers in The Netherlands were invited by e-mail to participate in the e-learning module. Furthermore, CLEM was promoted during several national meetings and conferences and was free of charge. Accreditation by the Dutch Society for Obstetric Sonographers could be obtained by successful completion of CLEM and submission of five CL images. Once certified, sonographers were allowed to measure CL for the Triple P study. The module can be accessed through the following link: https://www.medischonderwijs.nl/lessonid = 1483 or through the Triple P study website: www.studies-obsgyn.nl/triplep.

For CLEM, text with theoretical background, links to scientific papers and useful sections of textbooks were offered. Furthermore, CLEM contained five theoretical questions (Table 1). In addition, three caliper-placement tests were employed to acquire the skill of the CL measurements on three different cervical images (Figure 1). Image recognition and caliper placement were practiced on ultrasound images. After completing CLEM, a grade was generated by the module. This grade is an absolute score, calculated as the quotient of the questions answered correctly and the total number of questions, normalized between 0 and 10 and rounded to one decimal place. Definitions of a correct answer are given in Table 1. After completion, the CLEM participants automatically received an e-mail with their results expressed as a grade (0–10). The CLEM participants were required to have answered at least 60% of the questions correctly to receive the certificate.

The software from the e-learning provider was capable of producing data on the number of participants that attempted to finish the module, the time spent by a participant to complete the module, percentage of participants that answered correctly and incorrectly per question, and the grade generated by the module for each participant. The grades of the CLEM participants who supplied images in order to receive a certificate were compared with the grades of CLEM participants who did not request a certificate.

To explore whether CLEM contributed to qualitatively better CL measurements, two groups of ultrasound images were compared. The first group of CL images were submitted by CLEM participants after completing the e-learning module in order to receive a certificate. These sonographers worked in primary, secondary and tertiary care institutions, and were required to be certified to participate in the Triple P study[9]. Therefore there was some time pressure to complete this training. The second group of CL images (control group) were randomly selected from a database of ultrasound images obtained by sonographers from primary, secondary and tertiary care institutions who had the same degree in basic ultrasonography as the CLEM participants but who had not undertaken the e-learning module.

The outcome measure consisted of a CL measurement image score (CIS) that was generated to assess the quality of the images (Table 2). The CIS contained six items concerning the quality of the image and each item was assigned one, two or three points, depending on a poor, moderate or good result, respectively. The assessment of five images from each sonographer was performed

Table 1 Theoretical questions and caliper-placement tests of cervical-length (CL) measurement e-learning module undertaken by 354 sonographers

Question	*Question composition*	*Type of question*	*Definition of positive score*	*Participants answered correctly (%)*
1	Risk assessment of a preterm birth with short cervix of 25 mm	Scale question	Scale posted within or on boundary of correct range	46
2	Image recognition of CL measurement performed correctly	Picture labeling	All labels placed in correct location	77
3	Image recognition of too much pressure on probe, with recognition of overestimation of CL	Fill in blanks, with selection list	More correct answers than wrong answers	66
4	Image recognition of the external os, internal os, funneling and endocervical canal	Picture labeling (identification of structures)	All labels placed in correct location	89
5*	Caliper-placement exercise	Scale question	Scale posted within or on boundary of correct range	77
6*	Caliper-placement exercise	Scale question	Scale posted within or on boundary of correct range	68
7*	Caliper-placement exercise	Scale question	Scale posted within or on boundary of correct range	48
8	Percentage assessment of inter- and intraobserver difference between two measurements	Fill in blanks, with selection list	More correct answers than wrong answers	53

*Questions 5–7 were caliper-placement exercises in which a different cervical length was used for each question.

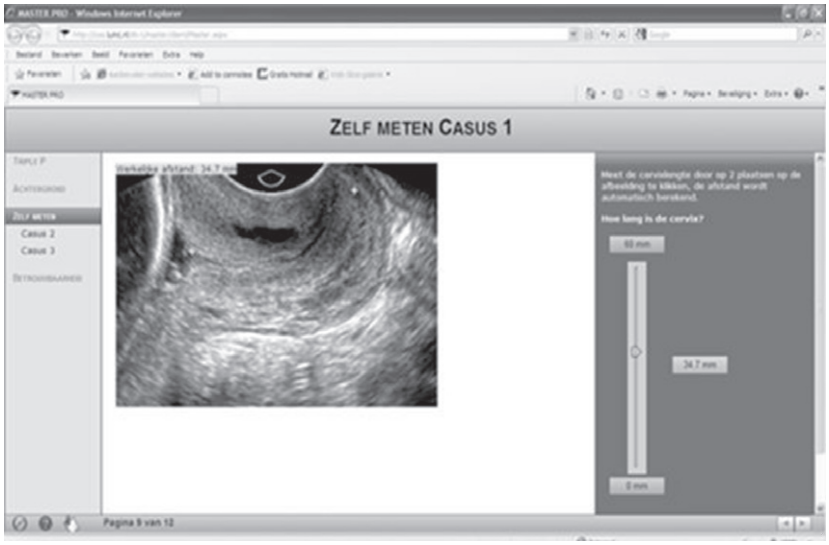

Figure 1 Demonstration, on a web page of the e-learning module, of caliper placement during cervical-length measurement.

Table 2 Items assessed and scored on cervical-length images using the cervical-length measurement image score (CIS)

CIS item	*Poor*	*Moderate*	*Good*
1 Visualization of endocervical mucosa	1	2	3
2 Visualization of empty bladder	1	2	3
3 Visualization of internal os	1	2	3
4 Visualization of external os	1	2	3
5 Positioning of calipers on internal and external ora	1	2	3
6 Pressure on probe	1	2	3

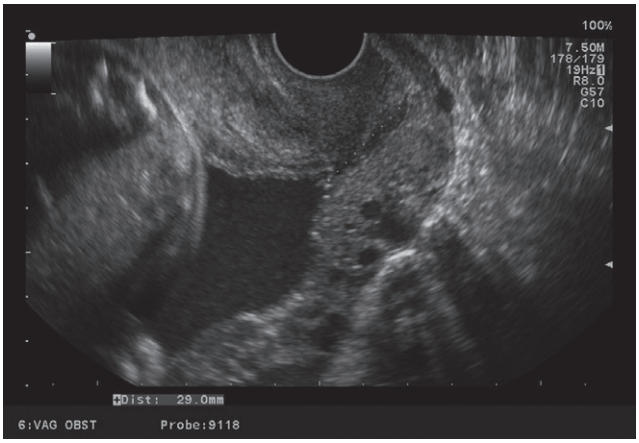

Figure 2 Ultrasound image of cervical-length measurement with correct placement of calipers on internal and external ora.

independently by two senior ultrasound supervisors (M.H. and E.P.). The CIS was validated by comparing the scores given by M.H. to those of E.P. The examiners were blinded to the origin of all images. Figures 2–4 demonstrate correct and incorrect CL measurements. The maximum score per image was 18 points, thus with five images scored, the maximum total score that could be obtained was 90 points per sonographer. The scores

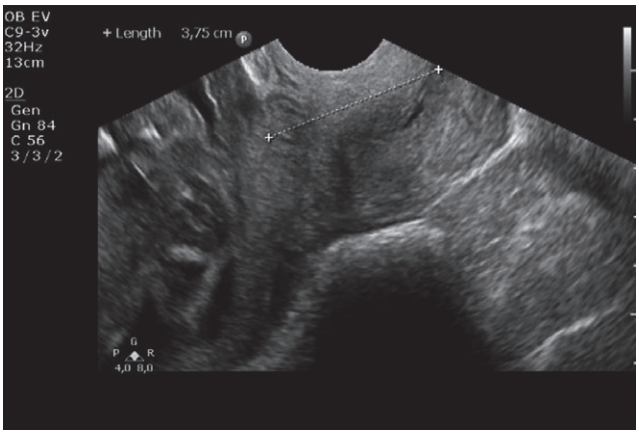

Figure 3 Ultrasound image demonstrating incorrect cervical-length measurement. The endocervical mucosa is not completely visible and the internal and external ora are not visible because the ultrasonographic plane is not completely midsagittal, resulting in incorrect caliper placement.

Figure 4 Ultrasound image demonstrating incorrect cervical-length measurement. Too much pressure is applied to the probe, causing the endocervical mucosa to be incompletely visible and the calipers to be placed incorrectly.

awarded to each sonographer by the two supervisors were added together, thus the maximum total score was 180 per sonographer. The scores of the two groups of sonographers were compared to assess whether the e-learning module contributed to better quality images.

Furthermore, the CIS and the CLEM-generated grades of the participants were compared to assess whether there was a correlation between the results of the e-learning module and the quality of the images obtained.

Statistical analysis

Statistical analysis was performed using SPSS 21 (SPSS Inc., Chicago, IL, USA). To compare the results of the CLEM participants and the sonographers who did not participate in CLEM, the Mann–Whitney *U*-test was used. To assess whether there was an association between the results of CLEM and CIS, a Pearson's linear regression test was used.

RESULTS

Between 1 January 2010 and 5 May 2011, 354 sonographers trained themselves with CLEM (Figure 5). The response rate cannot be calculated because CLEM is freely accessible to anyone via the internet. The sonographers spent an average of 17 min per completed session. The total number of sessions completed was 1118, or 3.16 sessions per sonographer.

Of the 354 CLEM participants, 61 submitted five images in order to receive a certificate. The mean grade generated by the module for the CLEM participants who submitted images was significantly higher than the grade of the CLEM participants who did not ($n = 293$) (6.9 *vs* 5.7; $P < 0.01$).

Of all questions answered in CLEM, Questions 1 and 7 (Table 1) were most often answered incorrectly. Question 1 concerned an estimation of the chance of preterm delivery for women with a CL of 25 mm at 23 weeks of gestation. The correct answer of this scaled question was a range between 4 and 6%[10]. An answer with the correct range was given in only 46% of the 354 participants; 36% overestimated and 18% underestimated the chance of preterm delivery. Question 7 concerned the actual measurement of CL by placing calipers on a high quality ultrasound image of a cervix in a midsagittal plane. Correct placement was performed by 48% of the sonographers, while 35% overestimated and 17% underestimated the CL. Results of all CLEM questions are shown in Table 1.

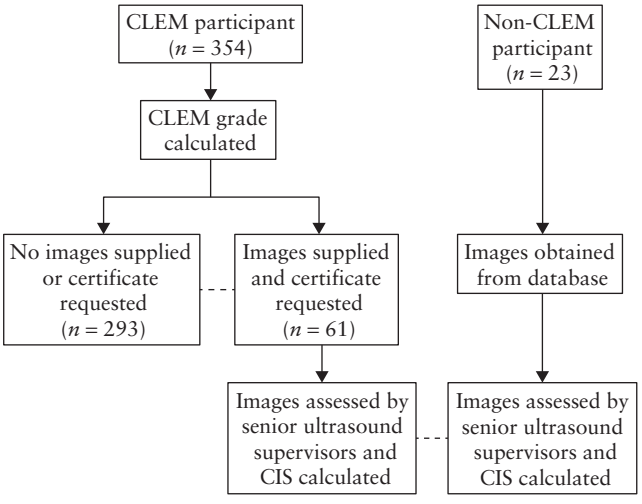

Figure 5 Study flowchart of participants completing a cervical-length e-learning module (CLEM). Comparisons (- - - -) were made between CLEM-generated grades and cervical-length measurement image score (CIS).

Table 3 Mean cervical-length measurement image scores (CIS) of each item for participants who undertook the cervical-length e-learning module (CLEM) and controls who did not

	CIS		
Item number	*CLEM*	*Controls*	P
1	27.7	26.8	0.26
2	27.0	26.9	0.19
3	28.7	26.9	0.001
4	27.6	24.6	0.06
5	26.9	23.2	< 0.001
6	27.0	27.2	0.67
Total score	164.9	155.6	0.03

Maximum score possible = 180.

CL measurements on the five images that were supplied by the 61 CLEM participants and on images from the database of the control group that did not participate in CLEM ($n = 23$) were assessed using CIS. The CIS of the CLEM participants was significantly higher than the CIS of the control group (164.9 *vs* 155.6; $P = 0.03$). The six items of the CIS were analyzed separately. Item 3 (visibility of the internal os) and 5 (positioning of the calipers on internal and external ora) were scored significantly higher by the CLEM participants than the control group ($P = 0.001$ and $P < 0.001$, respectively). Item 4 (visibility of the external os) and 5 (positioning of the calipers on internal and external ora) scored poorly in the control group (Table 3).

The CLEM-generated grades and CIS of CLEM participants were compared. No correlation was found ($r = 0.17$; $P = 0.19$) and a linear relationship between the grades and quality scores could be assumed.

DISCUSSION

In this study, we showed that CLEM might improve the quality of CL measurements. The quality of the measurements by sonographers who completed CLEM was significantly better than the quality of measurements by sonographers who did not. The items that had the largest statistical difference when comparing the trained and non-trained groups were visualization of the internal os and positioning of the calipers on internal and external ora. These aspects were well addressed in CLEM. The mean grade generated by the module was higher for the CLEM participants who submitted images compared with random users of CLEM who did not. There was no

correlation found between the CLEM-generated grades and CIS of CLEM participants.

This new e-learning module was developed to focus on the practical exercises of caliper placement and image recognition. This module was developed instead of using the existing CL e-learning module of the The Fetal Medicine Foundation, whose main focus is theoretical, explaining the technique of measuring CL and the clinical applications of this measurement. The major difference between the two courses is that ours has a greater emphasis on practical exercise.

The fact that the mean grade generated by the module for the CLEM participants who submitted images was higher compared with random users who did not submit images might have been expected given the higher initiative and motivation of the sonographers who wanted the certificate and the fact that they were required to answer at least 60% of the questions correctly to receive the certificate. Certification was a requirement for participation in a randomized clinical trial, so it was not completely voluntary.

The discrepancies between the CLEM-generated grades and the CIS of the CLEM participants might be explained by the fact that the CLEM grade was based on a combination of theoretical questions and caliper-placement tests practicing measurement technique, while the CIS only assessed the technical execution.

Previous studies have focused on image recognition through e-learning modules. Marks *et al.* compared the accuracy of image recognition by asking students to score standard neonatal renal ultrasounds before and after viewing a web-based e-learning module[11]. Cuca *et al.* tested an e-learning program for lung ultrasound[12]. The results of a multiple choice questionnaire on the basics of lung ultrasound before and after completion of the e-learning program were compared with the results of the questionnaire after 1 day of custom classroom training. Both studies found that e-learning was highly effective in the improvement of image recognition and the e-learning results equaled the results of classroom-based training[11,12].

E-learning is a new way of educating and requires the student to take a more active approach to acquire knowledge and skills compared with traditional types of education. An active attitude combined with the ability to choose the moment of participation may improve learning efficiency. Wutoh *et al.* reviewed the effect of interventions with internet-based continuing medical education on the performance of physicians and healthcare outcomes[13]. The results demonstrated that internet-based continuing medical education programs are just as effective in imparting knowledge as traditional formats of continuing medical education. Other reviews and meta-analyses have reached similar conclusions[14].

The strength of this study is that it explored the effect of e-learning in a setting of daily routine ultrasonography. The images were assessed blindly by the supervisors, who used a validated quality instrument with a good interobserver score. A limitation of the study is the potential selection bias: the self-enrolment to an e-learning module might select better performing sonographers. A second limitation is that the images of the control group were selected from a database to prevent the control group from improving their skills because they would know that their images were being investigated. However, with this design the comparability of the groups cannot be fully determined. The groups were made as comparable as possible by choosing images achieved by sonographers with the same level of education as the CLEM participants. The results, therefore, should be interpreted bearing these limitations in mind.

The purpose of CLEM was to enhance the knowledge and skills of ultrasonographers. Free availability on the internet and the immediate broad usage made randomization impossible. In conclusion, an e-learning course might be an appropriate way to train experienced sonographers in the skill of ultrasonographic CL measurement. To investigate further the effect of e-learning on the quality of ultrasound images, more research and the use of other study designs may be necessary.

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