Obstetric ultrasound education for the developing world: A learning partnership with the World Federation for Ultrasound in Medicine and Biology

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Abstract

The ultrasound techniques in pregnancy e-learning project is an online resource commissioned and supported by the Education Committee of the World Federation for Ultrasound in Medicine and Biology (WFUMB). This currently consists of 10 e-learning sessions aimed at midwives and other health workers in developing countries where WFUMB has Educational Centres of Excellence, and in particular at those based mainly in rural communities at considerable distance from urban training centres. The project covers all of the basics of obstetric ultrasound such as fetal and maternal anatomy, ultrasound techniques, assessment in both early and late pregnancy, prediction of pregnancy complications and identification of common abnormalities that might interfere with delivery. The e-learning project complements a wider training programme which covers operator skills and machine controls, in order to minimise the time that the professional has to leave their rural, often poorly staffed, workplace to attend classroom-based courses in the city. Each session outlines often complex concepts using simple diagrams, interactive exercises and cine clips. Tips, tricks and best practice guidelines are provided in simple terms.

Keywords: Diagnostic imaging, obstetrics, pregnancy, fetal anomaly, developing world, education

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Introduction

E-learning is the overarching term covering all aspects of computer-assisted learning. Online study is now extensively used in all aspects of education, from simply surfing the net to search for publications, using social media for sharing knowledge, attending virtual teaching sessions or webinars, viewing online PowerPoint presentations and learning with mobile apps.¹

The provision of a curriculum-based educational programme has only become possible with advances in computer technology, such as the ability to provide interactive exercises, the use of animations and the greater storage facility of more modern computers to allow the use of cine clips. Similarly, online supervision of students' progress has become possible through the prevalence of virtual learning environments and learning management systems. The development of a successful e-learning programme is heavily dependent on the programme design, and the success or failure of a programme will be determined not only by the accuracy of content but also the level to which the student is engaged in the process.² The rationale for e-learning

includes greater geographical reach, the ability to learn at any time and at a speed defined by the learner as well as cost effectiveness – a large audience can be reached with a single programme.¹

One of the largest and most ambitious efforts undertaken in e-learning is Health Education England's e-Learning for Healthcare programme.³ This programme was initially conceived by the Royal College of Radiologists and piloted for specialist training in radiology through a project known as the Radiology-Integrated Training Initiative (R-ITI). The educational design of the project relied on the concept that the first three years of radiology training could be underpinned by self-directed but structured learning. The R-ITI project has spawned curricula in many other specialties, including medical, dental, nursing and social care, and now extends to training across the spectrum of allied health professionals.

One of the drivers for the development of the radiology e-learning curriculum was to improve the efficiency of training at a time when the demand for an increase in trained radiologists exceeded the teaching resource within

the specialty. A blend of learning, including e-learning, simulation, traditional teaching and demonstration, would provide more efficient use of the trainers' time.⁴

The issues of training in healthcare within the developing world reflect those for which e-learning has been designed to address but on a much larger scale. Much of primary healthcare in developing countries is delivered in communities geographically remote from the major hospital centres; there is a critical shortage of trained staff and similarly a grave shortage of trainers.

Maternal mortality in sub-Saharan Africa is estimated at between 300 and over 1000 per 100,000 births, compared to 12 for the UK.⁵ Uganda's maternal mortality rate is 310.⁶ Neonatal mortality is 23 per 1000 live births compared to 3 within the UK.⁷ Uganda, in common with many African countries, has a large rural population and health clinics based in rural communities and are mainly staffed by nurses and midwives who, in many cases, have limited or no understanding of obstetric ultrasound. When requiring training, rural-based personnel must move, or travel to, the cities to train for weeks or months, often leaving a vacuum in the already limited facilities at their rural workplace.

The Millennium goals of the UN include the improvement of maternal health and reduction in child mortality. Timely ultrasound has the potential to improve outcomes in pregnancy affording earlier recognition of pregnancy complications. In response, the World Federation for Ultrasound in Medicine and Biology (WFUMB) commissioned the development of an ultrasound curriculum in an e-learning format to address training in limited obstetric ultrasound and to supplement other training opportunities provided by WFUMB.

WFUMB has an extensive network of training centres – or Centres of Excellence – in developing countries around the world including Uganda, Bangladesh and Indonesia. These centres already provide various types of training opportunities, including traditional lectures, tutorials and hands-on experience, supported by visiting lecturers and support for trainees to visit educational institutions both at home and abroad.

In early 2013, the e-learning module was evaluated at two sites. First, it was used as an educational adjunct for teaching Community Health Officers in a Surgical Training programme at Masanga Hospital in Sierra Leone, and subsequently a formal evaluation of content and usability was undertaken at the WFUMB Centre of Excellence – ECUREI (Ernest Cook Ultrasound Research and Education Institute) – in Kampala, Uganda. ECUREI has been hosting a number of pilot programmes in recent years in an effort to find creative ways to provide an ultrasound training programme without adding to this vacuum.

Pilot design

The pilot of the e-learning programme commenced in March 2013, with a small cohort of trainees based at ECUREI led by Dr Michael Kawooya, with the e-learning programme forming part of a wider range of educational activities over an eight-week period. The ECUREI pilot was designed to provide support for this group of trainees both at the urban and the rural sites. Trainees would travel to the urban centre to undertake lessons in theory along with some practical experience (see Figure 1). They would have access to the e-learning at the urban centre through the use of desktop computers, equipped with internet access (see Figure 2). The e-learning sessions were designed with the

Figure 1 ECUREI Training Centre, Kampala, Uganda (reproduced with permission from Dr Michael Kawooya)

Figure 2 ECUREI computer suite (reproduced with permission from Dr Michael Kawooya)

expectation that the computers used to access them would be of a low-technical specification and that internet access speeds would be slow; images and cine clips were compressed so that pages would load quickly. Some of the content in the sessions (for example interactive animations) rely on Adobe Flash Player to function, but it was confirmed prior to development that this software was installed on ECUREI computers. The e-learning was delivered on an open website link as well as on memory sticks in case of problems with internet access.

Some visiting lecturers would attend at the rural centres to provide hands-on training using portable ultrasound machines. The e-learning could also be accessed at the rural centre using laptops provided by ECUREI, which would provide the e-learning on memory sticks due to the lack of reliable internet access in rural areas. In the event, the cost of travel and accommodation, backfilling of midwifery posts and adequate supervision exceeded the budget available for the pilot. It was determined, therefore, that the efficacy of the e-learning module and its usability could be evaluated using healthcare workers based within ECUREI. These were post high-school students who were ultrasound naïve. They received limited educational support from staff within the centre but had access to the internet within a local university setting.

E-learning content design

The development of the 10 e-learning sessions was based on educational design reflecting the diagnostic needs of practitioners in remote communities. Key learning outcomes were outlined, which were designed to determine normality of the pregnancy and to identify women where earlier

referral to a specialist centre might lead to an improved outcome and the avoidance of complications.

The educational programme was designed to address the performance of ultrasound in communities of limited resource, while encouraging the practitioner to use the technology to engage with women in the hope and expectation that the use of ultrasound would serve not only as a diagnostic tool but also an incentive to increase early uptake of obstetric services. Each e-learning session is therefore designed to be image-rich and engaging.

The sessions cover a wide range of topics such as early pregnancy, scanning techniques in the second and third trimesters, foetal measurement, foetal abnormality and multiple pregnancy. The curriculum was developed based on a review of the current literature addressing provision of ultrasound in resource-limited communities. Content design drew heavily on two publications: *Manual of Ultrasound in Resource-Limited Settings*⁸ and *Ultrasound – A Practical Approach*.⁹ Ten sessions were defined to introduce sonographic technique, foetal and uterine anatomy and the identification of normal and abnormal pregnancies. Thus, the sessions included discussion of the normal and abnormal first trimester, assessment of gestational age, evaluation of the placenta, multiple pregnancy and gross foetal abnormality that might interfere with delivery.

A full list of the e-learning sessions is provided below:

1. Transabdominal ultrasound of the normal female pelvis.
2. Ultrasound in normal early pregnancy.
3. Abnormal early pregnancy part I.
4. Abnormal early pregnancy part II.

5. Scanning in the second and third trimesters: An introduction to technique.
6. Fetal measurement: Gestational age.
7. Fetal measurement: Assessment of growth.
8. Ultrasound assessment of placenta and amniotic fluid.
9. Fetal abnormality.
10. Multiple pregnancy.

In each of the sessions, the student is required to address certain key questions:

- Is there a pregnancy?
- How many babies are there?
- Is it (are they) alive?
- What is the foetal lie and how does this relate to the placental position and subsequent delivery?
- Is the foetus grossly normal?
- Are there any features that require rapid onward referral?

Simplicity was key throughout the development. The intention was to address several of the UN Millennium Goals¹⁰ by preventing, for example, delayed diagnosis of intra-uterine death, to reduce the incidence of obstructed labour consequent upon serious foetal abnormality and to attempt to identify early those women at risk of peri-partum haemorrhage.

The first activity undertaken was to consider the scope of each session and translate it into a series of learning objectives. The learning objectives form the basis of every e-learning session as they list in a specific and measurable way what the learner should be able to realistically achieve after completing an e-learning session. Four to five learning objectives were specified in each of the 10 e-learning sessions, and a sample of these is given below:

- Describe the patient preparation required to perform the best examination possible.

- Identify the normal female pelvis anatomy and common normal variations.
- Provide the differential diagnosis of different ultrasound features of early pregnancy problems and recognise the need for onward referral.
- Describe the relationship between measurement of biparietal diameter (BPD) and gestational age.
- Interpret gestational age charts and correctly date a pregnancy from foetal measurement.
- Recognise major foetal abnormality.
- List the effects of foetal abnormality on infant delivery/survival.
- Identify the number of foetuses in a multiple pregnancy.
- Describe the ultrasound appearances of different types of twin pregnancies.

Once each session in the project had been planned in detail, the detail of the content was gathered, along with clinical images, diagrams and cine clips, and handed over to be designed in an e-learning format.

With an aim to keep session development costs as low as possible, various free sources of e-learning development software were explored. A highly comprehensive and sophisticated piece of software was eventually chosen, called eXact Packager by eXact learning solutions. Access to the software and its associated e-learning templates was kindly provided free of charge by Health Education England's e-learning for Healthcare programme. Sources of free-of-charge copyright-free anatomy diagrams and other images were also required by the project. In some cases, these were also provided by e-Learning for Healthcare, with the remainder coming either from copyright-free stock libraries or a small proportion that was designed bespoke for the project.

The sessions are designed for the adult learner, based on clean lines and an uncluttered layout (see Figure 3). They are also designed for the visual learner, with an emphasis on engaging images, diagrams and cine clips with plenty of

Figure 3 A typical page in an e-learning session – with rich imagery and interactivity

Figure 4 A typical question in an e-learning session

interactivity. A variety of question styles is used, with feedback provided at every opportunity in order to reinforce learning points (see Figure 4). However, questions are provided for reflective learning only and are not scored.

Prior to release, a robust review process ensured that all sessions were peer-reviewed by members of the WFUMB Education Committee, as well as by a small team of midwives, sonographers and radiology trainees based at Plymouth Hospitals.

Pilot outcomes

The pilot was formally evaluated at ECUREI using a set of 20 mostly closed-ended questions including several based on a five-point Likert scale. Initial questions were designed to garner basic demographic information, e.g. the role of the learner, and this was followed with questions on the usability of the package as well as the nature of the content itself. Subsequent questions included open-ended questions, for example to gather recommendations for further topics to be designed. Three example closed-ended questions are provided below.

Q. Please rate each of the following aspects of usability. (Five-point rating – Excellent Good/Acceptable/Needs Improvement/Don't Know)

- Page loading speed
- Image loading speed
- Cine (video clip) loading speed
- Ease of navigation inside a session
- Design and layout
- Reliability (e.g. freezes or crashes)

Q. Please rate your overall impression of the e-learning sessions you have completed in terms of the following. (Five-point rating – Excellent Good/Acceptable/Needs Improvement/Don't Know)

- Ease of use
- Language (i.e. clarity and simplicity)
- Quality (e.g. is the content up to date, consistent and accurate)

(continued)

Continued

- Usefulness (e.g. does the content add value to your learning)
- Duration (e.g. length of sessions)
- Assessments (e.g. are assessments useful)
- Balance between introduction, information and self-assessment
- Breadth of topics covered
- Depth of detail
- Logical order of sessions
- Granularity (e.g. are sessions broken into appropriate chunks of information)

Q Please rate the following aspects of the e-learning sessions, focusing on the detail of the content. (Five-point rating – 5 (Completely) to 1 (Not at all))

- Was the balance between early pregnancy and later pregnancy right?
- Were the videos valuable in preparing you for hands-on ultrasound procedures?
- Were the measurement and chart plotting exercises useful?
- We have tried to use more pictures and fewer words. Have we got the balance right?
- Is the feedback for the self-assessment questions helpful?

The results were gathered by ECUREI, tabulated and anonymised to show feedback per learner. As the learners were interacting with ECUREI tutors, general feedback was also provided by Dr Kawooya as to how they performed in lectures and clinical scenarios, suggesting the e-learning was a helpful starting point in their learning experience.

Whilst 85% of those surveyed at ECUREI suggested overall satisfaction with the e-learning content, the same percentage felt that page loading and cine clip loading speeds were too slow. In response to the open-ended questions, several commented that network speeds and connectivity issues should be improved, which had affected the overall learning experience. Further constructive feedback suggested edits would be welcome to reduce the detail of the content and to reduce the speed of some of the cine clips. This feedback has been carefully recorded by the

project team, and changes to the sessions are planned pending a further review from the WFUMB Educational Committee.

Discussion

The challenge of providing ultrasound education and training in resource-limited environments is huge. Establishing the level of complexity requires an understanding of the enormous variety of practice. Some performing ultrasound will be specialist doctors in referral centres including radiologists and obstetricians whose knowledge and skills will match those in the developed world. There are few, if any, sonographers but the vast majority of primary healthcare will be delivered by healthcare practitioners such as nurses, doctor's assistants, midwives, etc. While detailed curricula are appropriate for trainee radiologists and obstetricians, there is potentially much to be gained from simple point-of-care ultrasound, not only in obstetrics but also for other applications.

Whilst the potential of the e-learning programme is established, it has yet to be trialled in the environment at which the educational content is aimed. This will require cooperation between educational establishments, government departments and industry to ensure that practical skills can also be learnt and that equipment is available for the practitioners to deliver ultrasound diagnosis. There is a need for resource to provide travel and accommodation if the trainees are to apply their knowledge to the development of practical skills, and there is also the need to address issues of continuous support once skills are learnt.

Next steps

Following the pilot, it is envisaged that the e-learning programme will be further reviewed and updated accordingly. It will then be disseminated to other WFUMB Centres of Excellence around the world, with due consideration to any technical barriers which may exist at these other sites. Early talks are also taking place between the project team, industry and other educational bodies to improve access to the programme.

Work has also now commenced on an ultrasound physics module together with sessions on ultrasound safety and infection control to supplement the obstetric ultrasound

curriculum, covering theoretical aspects but also practical tips and guidelines.

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REFERENCES

1. Romiszowski A. How's the e-learning baby? *Educ Technol* 2004;**44**:5–27
2. Ruiz J, Mintzer M, Leipzig R. The impact of e-learning in medical education. *Acad Med* 2006;**81**:207–12
3. Health Education England. *E-Learning for Healthcare*. See www.e-lfh.org.uk (last checked 26 November 2014)
4. Dubbins P. Radiology academies. *Clin Radiol* 2011;**66**:385–8
5. UNICEF. *Maternal Mortality*. See http://www.unicef.org/specialsession/about/sgreport-pdf/09_MaternalMortality_D7341Insert_English.pdf (last checked 26 November 2014)
6. WHO. *Uganda – Maternal and Perinatal Health Profile*. See http://www.who.int/maternal_child_adolescent/epidemiology/profiles/maternal/uga.pdf?ua=1 (last checked 26 November 2014)
7. The World Bank. *Mortality Rate, Neonatal (Per 1,000 Live Births)*. See <http://data.worldbank.org/indicator/SH.DYN.NMRT> (last checked 26 November 2014)
8. Shah S, Price D, Bukhman G, et al. *Manual of Ultrasound in Resource-Limited Settings*. Partners in Health, 2011. See <http://www.pih.org/library/manual-of-ultrasound-for-resource-limited-settings> (last checked 17 December 2014)
9. Marks WM. *Ultrasound: A Practical Approach*. North Carolina: CreateSpace, 2012
10. United Nations. *UN Millennium Development Goals*. See www.un.org/millenniumgoals (last checked 26 November 2014)