The Role of Portable Ultrasound in a Global Setting

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Abstract

Approximately 289,000 women worldwide die each year during pregnancy or childbirth as a result of preventable conditions. Early detection of many of these conditions would facilitate timely management. Ultrasound can provide detailed information on fetal wellbeing and maternal conditions thus, identifying high risk pregnancies and enabling decisions regarding place and mode of birth. Lower cost, easy to use portable devices, accompanied by basic training programmes, could impact on maternal and fetal mortality and morbidity in low resource settings, where ultrasound use is currently limited.

Keywords: Ultrasound; Portable devices; Birth

Introduction

In 2013, the World Health Organization (WHO) estimated that 289,000 women died during pregnancy or childbirth, with 99% of deaths occurring in developing countries [1]. Primary causes of maternal mortality in low-resource settings include haemorrhage (27%), pre-eclampsia (14%), sepsis (11%), obstructed labour (9%) and unsafe abortion (8%) [2]. The vast majority of these pathologies are treatable with clinical intervention, however, early detection is required to allow sufficient time for clinicians to respond. One way of promoting earlier detection is increasing the availability of obstetric ultrasound.

The World Health Organization (WHO) has described ultrasound as a safe, high-impact and adaptable imaging device capable of relaying important information in a cost-effective and efficient manner [3]. In the obstetric environment, ultrasound is able to quickly provide accurate information on key pregnancy markers and allows clinicians to make fast and informed diagnoses. Its applications are comparable to other types of imaging, such as MRI and CT, but costs are significantly reduced and prices continue to decrease [4]. Ultrasound is also durable and suited for use in harsh rural environments and uses minimal radiation exposure which is difficult to control in low-resource settings [5]. It is for these reasons that ultrasound is highly suitable for use in low-resource environments.

As skilled birth attendants are increasingly present at births in the developing world (53% in 1990 to 63% in 2008), healthcare workers would be available to offer ultrasound if training and devices were accessible [6]. However, use of ultrasound is limited due to the expense of purchasing and maintaining the devices, their cumbersome size prohibiting efficient transport, and the high level of training required to operate the complex machines. However, if a less expensive, transportable and user-friendly alternative was available in conjunction with basic training; ultrasound assessment could be available at every antenatal visit and throughout labour.

Portable ultrasound

The introduction of portable ultrasound could circumvent many of these problems. The devices can be a small fraction of the cost of traditional ultrasound (approximately £5,000 versus often over £25,000) and can be as small as the size of a large smart-phone. The portable devices are increasingly more robust and are resistant to heat, water, and dust which are often encountered during rough travel in rural areas. They are battery powered with short recharge time and can easily be recharged via solar energy, vehicle battery and gas generators similar to the ubiquitous mobile phone chargers. The use of olive oil or liquid paraffin in place of ultrasound gel has also been proposed, enhancing applicability to low-resource rural environments [7]. There is therefore potential for portable ultrasound to be brought to rural villages by designated healthcare workers for antenatal clinics or at-home visits.

Training

Although capable of a wide-range of clinical applications, including Doppler measurement, some of the most useful functions of ultrasound are the most basic and easily taught. It would not be difficult to train healthcare workers to a suitable standard to enable clinical utility and cause a reduction in maternal mortality. Multiple studies have reported a high level of agreement between healthcare workers with basic training and highly trained professionals when assessing fetal biometry measurements [8,9]. Additionally, if a hospital does not have the appropriate facilities to manage the complex pathologies that are able to be diagnosed using sophisticated ultrasound, then the benefits of using such machines may not outweigh the cost. Thus it is arguable that the use of less complicated devices and basic levels of training could have a significant health benefit in low-resource settings and be cost effective.

Potential benefits

A portable ultrasound device could be valuable in earlier antenatal care to establish viability and gestational age, especially as LMP recall may be poor in low-resource areas [10]. Doing so would allow accurate assessment of EDD which is particularly necessary in the proper management of pre-term and post-term infants. Multiple pregnancies can also be accurately diagnosed. High risk pregnancies can be transferred to appropriate facilities for more appropriate management. Similarly, the ultrasound is able to monitor key pregnancy markers such as amniotic fluid volume, placental position and fetal presentation. All of these signs have management pathways that could reduce maternal deaths occurring in developing countries [1].

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Received: November 10, 2014; Accepted: April 06, 2015; Published: April 08, 2015


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and fetal morbidity or mortality, including directing place of birth, external cephalic version, and elective delivery. Identifying high-risk pregnancies through the use of ultrasound allows hospital referrals to occur well in advance. Shah et al. reported that upon introduction of an ultrasound program in Rwanda, 43% of cases had management changed as a result, and 48% of these occurred upon discovery of fetal or placental malpresentation or previously undetected multiple gestations [11]. The diagnosis of fetal death can also be challenging and portable ultrasound would be a useful adjunct to clinical assessment.

As well as directly reducing maternal mortality by identifying preventable pathologies, increased availability of ultrasound may have indirect effects on positive health outcomes. For instance, portable ultrasound may attract skilled medical workers and decrease the percentage who travel abroad to seek employment thereby increasing the labour workforce capable of providing antenatal care. Similarly, as portable ultrasound may allow a woman to visually connect with her fetus, in some settings its use may encourage more women to attend antenatal appointments. Traditional ultrasound devices also require women to travel to the facility, potentially incurring significant cost and time. This is especially true when a patient is not mobile, such as in labour, where there is a lack of monitoring available during the costly transfer. Portable ultrasound offers a solution to these problems.

Potential harm

It is important to note that the WHO has cautioned against allowing inadequately trained personnel to perform ultrasound scans [3]. However, the guidance reflects use of ultrasound across specialties encompassing a spectrum of morphologies and pathologies. In the case of obstetric ultrasound, where a finite number of fetal biometrics is assessed, training is likely to be much simpler and the potential for misdiagnosis is less. As technologies for medical distance learning are already in place throughout much of the developing world [12], it may be possible that such a platform could be used to maintain competency. Furthermore, it may be argued that more harm may result from maternal complications arising from undiagnosed pathology than from misdiagnosis by incorrectly used ultrasound.

Conclusion

With approximately 800 women dying per day of pregnancy and childbirth related complications in the developing world [1], portable ultrasound offers great potential for preventing both maternal and fetal deaths. It is important to remember that without addressing the complex social, economic and cultural contributions to unacceptably high death rates, an intervention such as portable ultrasound will have minimal impact. The three delay model described the multi-layered causes of maternal deaths [13]: delay in decision to seek care, delay in reaching care and delay in receiving adequate care. However, the introduction of portable ultrasound may encourage care seeking and community triage (first delay), and facilitate diagnosis and timely management once care has been reached (third delay). Before the impact of portable ultrasound in low-resource environments can be assessed, it is necessary to validate the device for obstetrical use. Only once it has been confirmed that informally trained individuals can accurately measure key pregnancy markers is it possible to ascertain the full effect portable ultrasound may have in the developing world. Technical advances and reduction in costs now make this a real possibility.

References