

Chapter X

Computerizing the Cardiotocogram (CTG)

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ABSTRACT

During pregnancy the fetus requires an adequate supply of oxygen and clearance of carbon dioxide which is a waste product of metabolism. In fetal life, the placenta provides this function. After birth the lungs are aerated and perform this. If there is a failure to transport these chemicals across the placenta, the fetus can become hypoxic and acidotic, which can lead to permanent brain damage. In the neonate this can manifest in a number of ways, but most seriously cerebral palsy. Assessment of the fetal heart rate has been shown to identify fetuses where this maybe occurring. However the inter observer variation amongst clinicians assessing the heart rate monitoring is high and interpretation skills are often not good. Computer assessment of the fetal heart rate has been used and developed. Expert system techniques have been used to develop a system. The systems developed have been shown in studies to perform better than humans and to be able to identify subtleties not seen by the human eye. Future research is further assessing the value of these systems.

INTRODUCTION

The cardiotocogram (CTG) is a graphical display of a series of numbers representing fetal heart rate and uterine contraction frequency. The potential to computerize and analyze these signals has been almost irresistible to generations of obstetricians with an interest in mathematics, computers or

modelling. Approaches used range from simple archiving of the digital record to highly complex analysis and systems vary from stand alone programs to decision support systems where CTG information is only one of multiple inputs to aid clinical management. This chapter will review the current status of computerization and the CTG.

THE NEED

There is no doubt about the clinical need to standardize and improve clinical use of information contained in the CTG. The aim of recording the fetal heart rate (FHR), however that is done, has always been to detect FHR changes that could indicate that the fetus was at risk of death or damage from oxygen lack so that intervention to rescue the fetus could occur. Continuous recording of the FHR directly from an electrode applied to the fetal scalp or indirectly through the maternal abdomen using the Doppler principle was introduced into clinical practice in the late 1960s and early 1970s. Despite initial optimism that the CTG would prevent intrapartum fetal death and reduce long-term neurological handicap that promise has been difficult to realise. Starting in the late 1970s repeated randomized trials have shown that use of the CTG was associated with an increase in rates of both operative vaginal delivery and caesarean section, especially for deliveries where presumed 'fetal distress' was the indication. The only benefit appears to be a reduction in neonatal seizures (Alfirevic, Devane, & Gyte, 2006). In the early 1980s a number of studies reported large intra- and inter-observer differences in CTG interpretation and by the 1990s there was evidence that interpretation of CTG changes was a major problem in clinical practice. In the United Kingdom the Confidential Enquiry into Stillbirths and Deaths in Infancy reported that nearly 75% of deaths of healthy babies during birth were avoidable and two thirds of intrapartum and early neonatal deaths were attributed to asphyxia (oxygen lack with tissue damage). Most errors were related to interpretation of electronic fetal monitoring traces (*Confidential enquiry into stillbirths and deaths in infancy (CESDI). Fourth Annual Report, 1 January - 31 December 1995.*, 1997). The most frequent criticisms from the Confidential Enquiries have related to delays in recognising or responding to CTG abnormalities (frequently over several hours), failure to appreciate the urgency or severity

of the situation by the obstetric team and lack of senior accountability (CESDI 1997-2000). Other studies have reported similar problems and where examples of abnormal CTGs have been provided it is clear that the abnormalities are severe and the lack of recognition or response is bewildering (J. A. Westgate, Gunn, & Gunn, 1999). It is not surprising that many of these cases become the focus of litigation (Johanson, Newburn, & Macfarlane, 2002) which is immensely stressful for those involved and has significant financial implications for health services.

Closely aligned with these factors is the dramatic rise in caesarean section rates seen worldwide. The reasons for this are not clear but undoubtedly fear of litigation contributes to defensive clinical practice. Mothers themselves are choosing caesarean sections for a number of reasons but fear of labour, loss of confidence in the system of care and fear of bad outcome for mother and baby are all factors which contribute to this growing trend.

It is now recognised that CTG interpretation and management is actually a complex task which requires knowledge of FHR patterns, fetal physiology and labour management applied to the specific clinical aspects of each mother, fetus and labour. Not only is the task difficult, but it is often performed in highly stressful circumstances. High workload, tiredness from long hours or shift work, emotional pressure from dealing with women and families in painful and stressful situations, worries or concerns in their personal lives or the working environment are just some examples of factors which affect the ability of clinicians to function optimally. For example, there is evidence that perinatal mortality or morbidity related to intrapartum asphyxia in low risk pregnancies is more common at night (Heller, Misselwitz, & Schmidt, 2000; Heller, Schnell, Misselwitz, & Schmidt, 2003; Stewart, Andrews, & Cartlidge, 1998; J. Westgate & Gunn, 2001). In one study (Stewart et al., 1998) there was an excess of asphyxial deaths during months when annual

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