Cardiotocograph interpretation

Introduction

Cardiotocographs (CTGs) are a form of electronic fetal monitoring (EFM) used both in the antenatal period and during labour to provide a guide to fetal wellbeing. CTG traces are a continuous recording of fetal heart rate (FHR) combined with a recording of uterine activity. The basic principle of EFM is to detect developing fetal hypoxia with the aim of preventing subsequent acidaemia and cell damage.

CTGs were introduced into the UK in the early 1970s with the expectation that the EFM provided by them would reduce hypoxia-induced intrapartum perinatal mortality. This has not occurred and the role of EFM in labour has been questioned (Neilson, 1993). In addition, reports from the Confidential Enquiry into Stillbirths and Deaths in Infancy (CESDI) have highlighted problems related to its use and interpretation (Maternal and Child Health Research Consortium, 1998, 1999, 2000). It is therefore essential that those assessing CTGs are familiar with normal patterns and interpretation of deviations from the norm. CESDI recommend that all units using EFM should provide a teaching programme for all professionals involved in its interpretation (Maternal and Child Health Research Consortium, 2001).

Assessment of risk

Before interpreting the CTG you must put the trace in context. It is essential that you know whether the fetus and/or mother are high or low risk for pregnancy complications. It is also important that you appreciate whether the CTG is antenatal or intrapartum. In the antenatal setting computerized CTG analysis can be used which is discussed in more detail later.

Dr Melissa K Whitworth *is Clinical Lecturer in Obstetrics in the Department of Reproductive and Developmental Medicine, and* **Dr Leanne Bricker** *is Consultant in Fetal and Maternal Medicine in the Department of Obstetrics, Liverpool Women's NHS Foundation Trust, Liverpool L8 7SS*

Correspondence to: Dr MK Whitworth

Systematic cardiotocograph assessment

The patient's name, date of birth, date and time of the recording, pulse rate and temperature should always be checked before looking at the actual recording. The Royal College of Obstetricians and Gynaecologists (RCOG) recommends that the settings on CTG machines should be standardized (RCOG, 2001). Altering the settings will significantly alter the trace which you are presented with. It is therefore important to check that the recording you are looking at was recorded using the following parameters:

- Paper speed set to 1 cm/min
- Sensitivity displays set to 20 beats per minute (bpm)/cm
- FHR range displays of 50–210 bpm.

Before looking at any individual features of the CTG as outlined below you must look at the overall recording quality. Ideally both tocograph and cardiograph tracings should be complete and without gaps. An example of a reassuring CTG is shown in *Figure 1*.

The tocograph

This is probably the most overlooked aspect of the CTG and therefore will be considered first. The quality of the tocograph trace is dependent upon the tension and positioning of the monitoring belt. Uterine contractions appear as 'peaks' on the CTG. The size of each peak can be altered by adjusting the tension of the belt and is not an indication of contraction strength. The frequency of contractions should be expressed as the number occurring in 10 minutes, e.g. three in ten.

The cardiograph

The cardio part of the CTG has four easily definable features: baseline rate, variability, accelerations and decelerations. Those of who have in the past struggled with electrocardiograph interpretation should be reassured that CTG interpretation is generally considered to be significantly easier. This article will now run through CTG interpretation assuming that the monitor being used is not one which will provide a computerized analysis.

Baseline rate

This is determined by drawing a line through the midpoint of the 'wiggliness' which represents the most common, stable rate after accelerations and decelerations are excluded. It is determined over a period of 5 or 10 minutes and is expressed in bpm. Baseline rate definitions can be found in *Table 1*. Preterm fetuses tend to have a baseline rate which is towards the upper end of the normal range. It must be noted that a trend to a progressive rise in the baseline is very important as well as the absolute values.

Variability

Long-term baseline variability is the minor fluctuation in baseline FHR which occurs at three to five cycles per minute. It is determined by estimating the difference in bpm between the highest peak and lowest trough of fluctuation in a 1-minute segment of CTG. This can be

Figure 1. Reassuring cardiotocograph obtained during labour. bpm = beats per minute.

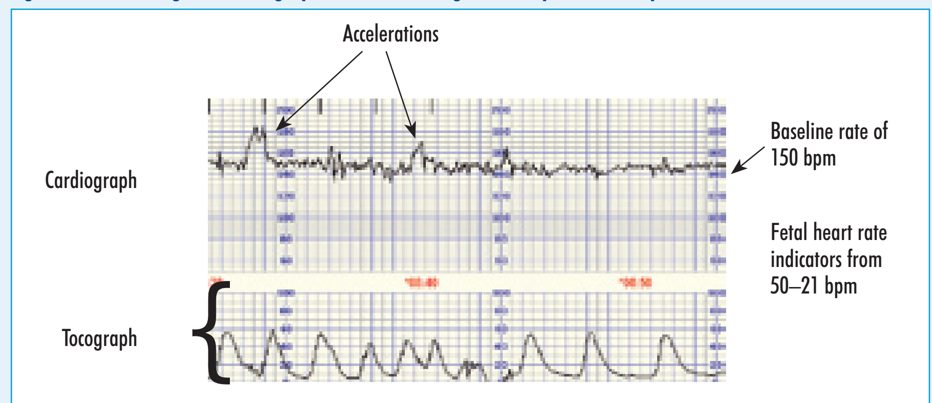

Table 1. Interpretation of baseline rate

	Bpm
Normal baseline	110–160
Moderate bradycardia	100–109
Moderate tachycardia	161–180
Abnormal bradycardia	<100
Abnormal tachycardia	>180

bpm = beats per minute

classed as normal (greater than or equal to 5 bpm between contractions); non-reassuring (variability less than 5 bpm for 40–90 minutes); abnormal (variability less than 5 bpm for 90 minutes or more). Short-term variability cannot be determined by the naked eye but is an important feature of computerized CTG analysis.

Accelerations

These are transient increases in the FHR of 15 bpm or more which last for 15 seconds or more. The significance of no accelerations on an otherwise normal CTG is unclear although accelerations are generally considered as a reassuring feature on a CTG.

Decelerations

Decelerations are transient episodes of slowing of FHR below the baseline level of more than 15 bpm and lasting 15 seconds or more (RCOG, 2001). They can be subdivided into early, late, variable, atypical variable and prolonged.

Early decelerations

These are a uniform, repetitive, periodic slowing of the FHR which has its onset early in the contraction and returns to baseline by the end of the contraction. These are often the result of head compression during labour and as a result are not always pathological. *Figure 2* shows an example of early decelerations.

Late decelerations

Late decelerations are a uniform, repetitive, periodic slowing of the FHR which has its onset mid to end of the contraction and nadir more than 20 seconds after the peak of the contraction (*Figure 3*). They end after the end of the contraction and should be considered as suspicious. It must be noted that in the presence of a non-accelerative trace with baseline variability less than 5 bpm, i.e reduced, the definition includes decelerations which are less than 15 bpm. Such decelerations are often referred to as 'shallow'.

Variable decelerations

As their name suggests these are variable in their shape and timing and are an intermittent periodic slowing of the FHR with rapid onset and recovery. Their time relationship with the contraction cycle is variable and they may occur in isolation. Sometimes resemble other types of deceleration patterns in timing and shape.

Atypical variable decelerations

These are variable decelerations with any of the following additional components:

- Loss of primary or secondary rise in baseline rate
- Slow return to baseline FHR after the end of the contraction
- Prolonged secondary rise in baseline rate
- Biphasic deceleration
- Loss of variability during deceleration
- Persistent reduction in baseline rate.

Prolonged decelerations

These require immediate medical attention. A prolonged deceleration is defined as an abrupt decrease in the FHR to levels below the baseline that lasts at least 60–90 seconds. If they last more than 3 minutes these decelerations become pathological.

Other atypical findings on a CTG tracing include a sinusoidal pattern which is characterized by a regular oscillation of the baseline long-term variability which resembles a sine wave. This smooth, undulating pattern, which should last at least 10 minutes, has a relatively fixed period of three to five cycles per minute and an amplitude of 5–15 bpm above and below the baseline. In a true sinusoidal episode, which is pathological, baseline variability is absent.

Each element of the cardiograph must be assessed in turn, i.e. baseline, variability, accelerations and decelerations. An overall opinion as to whether the CTG is normal, suspicious or pathological as per the International Federation of Gynecology and Obstetrics (FIGO) classification system (*Table 2*).

The RCOG recommends that in cases where a CTG falls into the pathological category, conservative measures should be used and fetal blood sampling carried out where appropriate or feasible (RCOG, 2001). In situations where fetal blood sampling is not possible or appropriate then delivery should be expedited. Therefore in cases where you feel the CTG is pathological a senior obstetrician must be made aware of the case and an appropriate plan put in action.

Computerized CTG analysis

Given advances in information technology and the difficulties which often surround interpretation of CTGs it is of little surprise that computerized CTG analysis has been developed. As early as 1977 Professors Dawes and Redman from Oxford University, UK developed a system of computerized analysis. This was initially based on a database of 8000 outcome-linked traces. The database has now expanded to over 70 000 and computerized systems are commonly used in the antenatal setting. A typical compu-

Figure 2. Cardiotocograph illustrating early decelerations. bpm = beats per minute.

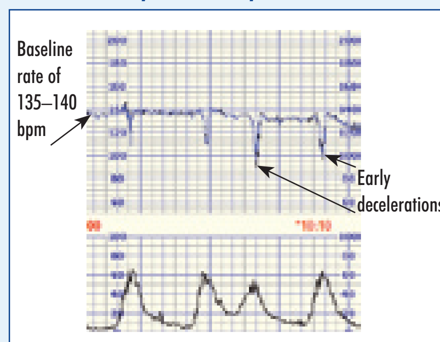

Figure 3. Cardiotocograph illustrating late decelerations. bpm = beats per minute.

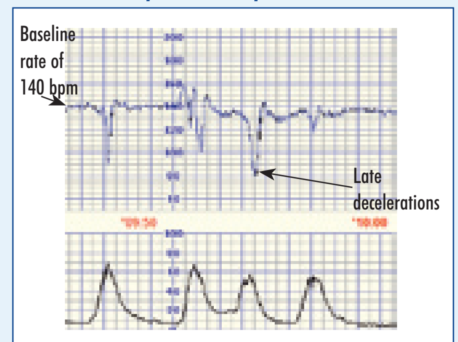

Table 2. International Federation of Gynecology and Obstetrics (FIGO) classification of cardiotocographs

Normal	Baseline 110–150 bpm
	Baseline variability 5–25 bpm
Suspicious	Baseline 100–110 bpm or 150–170 bpm
	Baseline variability 5–10 bpm for > 40 minutes or > 25 bpm
	Variable decelerations
Pathological	Baseline < 100 bpm or > 170 bpm
	Baseline variability < 5 bpm for > 40 minutes
	Severe variable decelerations
	Severe repetitive early decelerations
	Prolonged decelerations
	Late decelerations
	Sinusoidal pattern

Note: some maternity units classify cardiotocographs as reassuring, non-reassuring and abnormal but the definitions are the same as above. bpm = beats per minute. From International Federation of Gynecology and Obstetrics (1987)

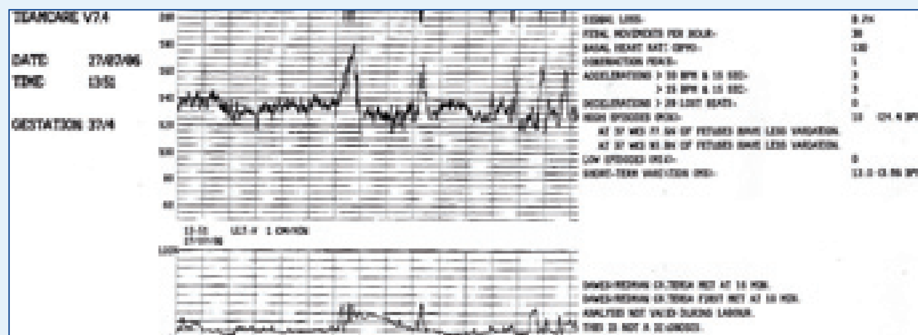

Figure 4. Dawes–Redman computerized cardiotocograph trace – antenatal.

Table 3. Criteria used by computerized fetal monitoring to classify a cardiotocograph as normal

Short-term variation of 3 ms or greater
No evidence of a sinusoidal rhythm
At least one episode of high variation
No large or repeated decelerations
Accelerations and/or fetal movements
No evidence of a baseline misfit
A normal basal heart rate (if the trace is short)

Table 4. Special circumstances

Multiple pregnancy	Special monitors exist which allow the simultaneous recording of two or more fetal hearts. You must always ensure that the traces obtained differ in shape, i.e. you are not recording the same baby twice
Prematurity	The baseline fetal heart rate is on average higher than in a term baby
Drugs	A variety of medications affect the fetal heart pattern. In particular opioids and psychotropic medications may result in decreased variability

terized printout is shown in *Figure 4* and criteria for computerized CTG analysis are listed in *Table 3*. Computerized CTGs for intrapartum monitoring are still being researched and are not available for clinical use at present. When interpreting CTGs there are special circumstances (*Table 4*) which need to be considered, but details of these are beyond the remit of this article. **BJHM**

The authors would like to thank Dr Helen Scholefield, Consultant Obstetrician, Liverpool Women's Hospital, for advice about accessing and publishing cardiotocograph traces and the women of Liverpool who allowed us to use their cardiotocograph traces for figures.
Conflict of interest: none.

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KEY POINTS

- Always check the patient details and set the cardiotocograph in context.
- Assess cardiotocograph quality.
- Approach interpretation systematically.
- Computerized analysis is not valid in the intrapartum setting.
- If in doubt ensure that a senior colleague reviews the trace.