Physiological

CTG Interpretation

Guía de monitorización fetal intraparto basada en fisiopatología

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Esta guía describe la interpretación de registros cardiotocográficos (RCTG) desde el punto de vista fisiopatológico. Ha sido desarrollada por un comité basándose en la experiencia adquirida en salas de partos donde la reducción de la tasa de cesáreas urgentes y/o la mejora de los resultados perinatales ha sido demostrada después de la implementación de la interpretación de RCTG basada en fisiopatología.

Es importante remarcar que la lectura del RCTG es solamente una parte de la evaluación clínica global de la madre y el feto y que tiene como objetivo único la detección de hipoxia fetal. Ésta guía debe ser usada en un contexto global, teniendo en cuenta otras causas no hipóxicas que causan lesiones fetales. Esto es particularmente importante en casos de evolución rápida y que requieran de intervenciones al margen del RCTG.

Esta guía está basada en la evidencia científica disponible en el momento de la creación de este documento, las referencias bibliográficas pueden encontrarse al final del documento. Somos conscientes que es imposible que ninguna guía cubra todos los escenarios clínicos posibles, por tanto es recomendable usarla aplicando la experiencia clínica y la lógica, así como buscar una segunda opinión si fuera necesario.

Agradecimientos

Nos gustaría aprovechar esta oportunidad para expresar nuestra gratitud al *Fetal wellbeing team* y a todo el personal de las maternidades de St George's Hospital, Lewisham y Greenwich NHS Trust y Kingston Hospital. Esta guía se ha elaborado con la experiencia, contribución y trabajo adquirida por todos. Dedicamos esta guía a ayudar a mejorar la situación de las madres y bebés en todo el mundo.

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Comité revisor

El Comité editorial quiere agradecer al panel internacional de expertos de 14 países que han adoptado el manejo fisiológico para la interpretación de RCTG en su práctica diaria asistencial. Nos honra tener entre ellos al profesor Sir Arulkumaran como revisor experto especial. Aprovechamos esta oportunidad para agradecer su inmensa contribución a la interpretación de registros cardiotocográficos y especialmente, por diseminar el conocimiento de la respuesta fisiológica fetal al estrés hipóxico intraparto en sus múltiples publicaciones.

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Glosario de abreviaturas

CQC	Commission of Quality Control
FCF	Frecuencia cardíaca fetal
FCFb	Frecuencia cardíaca fetal basal
FIGO	International Federation of Gynaecology and Obstetrics
FSE	Fetal Scalp Electrode
GCP	Good Clinical Practice: No hay evidencia robusta, es una opinión de consenso
IUGR	Intra-Uterine Growth Restriction / Feto con retraso de crecimiento
LCF	Líquido céfalo-raquídeo
Lpm	Latidos por minuto
MFEC	Monitorización Fetal Electrónica Continua
NICE	National Institute of Clinical Excellence
NCC-WCH	National Collaborating Centre for Women's and Children's Health
OMS	Organización Mundial de la Salud
RCTG	Registro cardiotocográfico
PE	Pre-eclampsia
RPM	Rotura premature de membranas
SAM	Síndrome de Aspiración Meconial
STAN	ST-segment Analysis
TENS	Transcutaneous Electrical Nerve Stimulation
W	Semanas de gestación (weeks)

Introducción

Ésta es la primera *guideline* de monitorización fetal que se centra únicamente en interpretación basada en fisiopatología para el asesoramiento del bienestar fetal. Las guías que se han creado anteriormente se han basado sobre todo en patrones de reconocimiento. Nuestro objetivo es presentar los cambios patofisiológicos que explican cómo el feto se defiende de los insultos hipóxicos intraparto y destacar los signos que sugieren descompensación.

El propósito de la vigilancia intraparto es en general, detectar a tiempo a los bebés que pueden estar padeciendo hipoxia. Y de esta forma poder aplicar tests adicionales de bienestar fetal o bien finalizar la gestación de forma urgente mediante una cesárea o parto instrumentado y prevenir así morbilidad o mortalidad perinatal/neonatal[NICE 2014, FIGO 2015]

Como resultado de un mayor entendimiento e incorporación de la fisiopatología a la interpretación de los registros esperamos ver una reducción de intervenciones innecesarias así como disminución de lesiones por hipoxia cerebral, muertes intraparto y neonatales precoces.

Definiciones

Para mayor simplicidad, se han usado las definiciones que constan debajo. Estas definiciones fueron desarrolladas por otros estamentos y guías y se han referenciado como corresponde.

Características de los RCTG

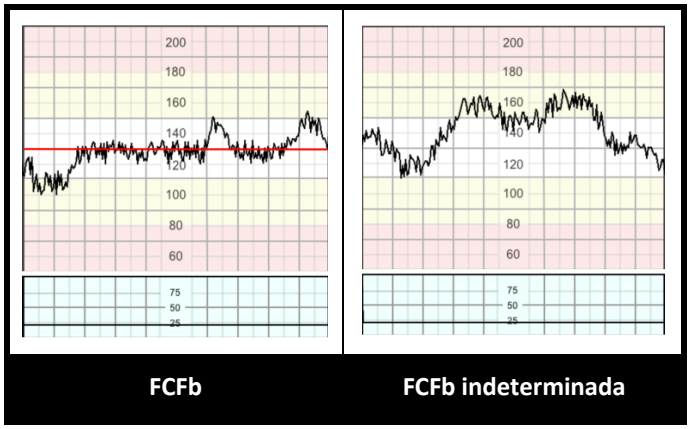
1- **Frecuencia cardíaca fetal basal (FCFb)**: Se trata de la media de la frecuencia cardíaca fetal, que se aproxima a incrementos de 5 latidos por minuto y durante un periodo de 10 minutos. Se excluyen las aceleraciones, deceleraciones y periodos de variabilidad marcada. Para considerarla debe durar un mínimo de 2 minutos en un segmento de 10 minutos. En caso contrario, se describe como *FCFb indeterminada*. [Macones et al. 2008]

   En registros en que no se pueda definir la FCFb por ser inestable, habría que revisar segmentos previos; para determinarla puede ser necesario evaluar periodos más largos. [FIGO 2015]

   - **FCFb normal:** Un valor entre 110 y 160 lpm. Los fetos pre-término tienden a tener valores en el límite alto de este rango y los post-término en el límite bajo. Algunos expertos consideran los valores de normalidad a término entre 110-150 lpm. [FIGO 2015] Es importante averiguar la FCFb normal para cada feto en particular revisando RCTG previos del mismo si existieran o apuntes en la historia clínica. [GCP]

   - **Taquicardia**: FCFb por encima de 160 lpm durante más de 10 minutos.

   - **Bradicardia**: FCFb por debajo de 110 lpm durante más de 10 minutes. Valores entre 90 y 110 lpm pueden objetivarse en fetos normales, especialmente en gestaciones post-término. Es vital confirmar que no se está registrando el latido materno y que la variabilidad está conservada. [NICE 2014] En este caso será necesaria la supervisión de un adjunto senior para clasificar el registro como normal. [GCP]



2- Variabilidad: Se refiere a la oscilación de la señal de la FCF, que corresponde a la media de la amplitud de banda en un segmento de 1 minuto; [FIGO 2015] las fluctuaciones deberían ser regulares en amplitud y frecuencia. [Macones 2008] La variabilidad se expresa en latidos por minuto (lpm).

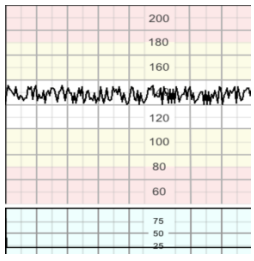
- **Normal**: amplitud de banda de 5 − 25 lpm.
- **Reducida**: amplitud de banda por debajo de 5 lpm durante más de 50 minutos en la línea basal, o de más de 3 minutos durante desaceleraciones. [FIGO 2015, Hamilton et al 2012]
- **Variabilidad ausente (silente)**: Amplitud de banda indetectable, con os sin desaceleraciones. [Macones 2008]
- **Variabilidad aumentada (Patrón saltatorio)**: amplitud de banda que supera los 25 lpm durante más de 30 minutos. La patofisiología de este patrón no se comprende completamente, pero podría estar en relación con desaceleraciones recurrentes, cuando la hipoxia/acidosis se desarrolla rápidamente. Se cree que puede ser causada por inestabilidad/hiperactividad autonómica del feto. [FIGO 2015] En caso de identificarse durante la segunda fase del parto o durante desaceleraciones es probable que se requiera de actuación pronto. Un patrón saltatorio que dure más de 30 minutos puede indicar hipoxia incluso en ausencia de desaceleraciones.
- **Patrón sinusoidal:** Se trata de una ondulación regular y suave que recuerda a una onda sinusoidal, con una amplitud de 5−15 lpm y una frecuencia de 3-5 ciclos en 1 minuto. Este patrón dura más de 30 minutos y requiere ausencia de aceleraciones.

  La base patofisiológica del patrón sinusoidal no está completamente filiada, pero se sabe que ocurre en asociación a la anemia fetal severa, pues puede verse en casos de isoinmunización anti-D, hemorragia materno-fetal, Síndrome de transfusión feto-fetal y rotura de vasa previa. También ha sido descrito en casos de hipoxia fetal aguda, infección, malformaciones cardiacas, hidrocefalia y gastrosquisis. [FIGO 2015]

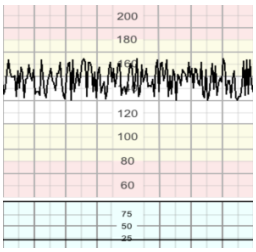
- **Patrón pseudo-sinusoidal:** Es un patrón similar al sinusoidal, pero con una forma más angulada y picuda similar a unos “dientes de tiburón”. Su duración raramente supera los 30 minutos y suele ser precedido y continuarse por un registro normal. [FIGO 2015]

  Algunas autoridades consideran que el patrón “pseudo-sinusoidal” es aquél sinusoidal con presencia de aceleraciones. Y llaman “Patrón sinusoidal atípico” al patrón más puntiagudo en forma de dientes de tiburón o “Poole shark-teeth pattern” . Éste es causado por hipotensión fetal secundaria a una hemorragia materno-fetal aguda y condiciones como la ruptura de la vasa previa. [Yanamandra and Chandraharan 2014] Este patrón ha sido descrito después de la administración de analgésicos a la madre, durante periodos en que el feto chupetea un dedo y otros movimientos bucales del feto.

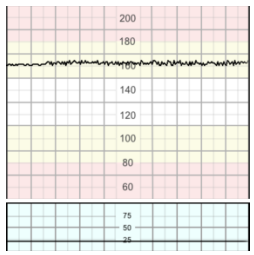
  A veces es difícil diferenciar el patrón pseudo-sinusoidal del auténtico sinusoidal, siendo la corta duración del primero la variable más importante para discriminar entre los dos. [FIGO 2015]



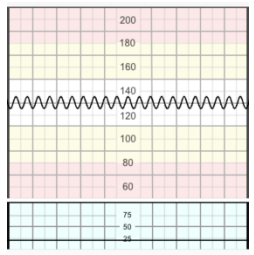
Variabilidad normal



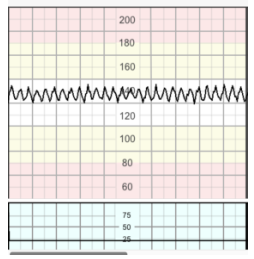
Patrón saltatorio



Variabilidad reducida



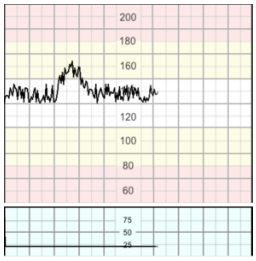
Patrón sinusoidal



Pseudo-sinusoidal

3- **Acceleraciones:** Incremento abrupto de la FCF (del inicio al pico en menos de 30 segundos), de más de 15 lpm de amplitud y que dura más de 15 segundos pero menos de 10 minutos. Antes de las 32w la amplitud y duración de las aceleraciones puede ser menor (10 segundos y 10 lpm de amplitud). Macones 2008 Una aceleración debe iniciar y volver a una línea basal estable. GCP

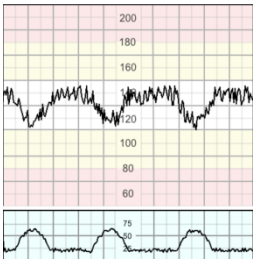
Si se evidencian aceleraciones coincidentes con contracciones uterinas especialmente durante la segunda fase de parto, hay que descartar que se esté registrando la frecuencia cardiaca materna, debido a que FCF fetal desacelera con la contracción y la materna típicamente aumenta. Nurani et al 2012



Acceleration

4- Desaceleraciones: Descenso en la FCF por debajo de la línea basal de más de 15 lpm de amplitud y que dura más de 15 segundos. Se considera que son una respuesta refleja para disminuir el gasto cardíaco cuando el feto es expuesto a un estrés hipóxico o mecánico, para ayudar a mantener el metabolismo aeróbico del miocardio.

- **Desaceleraciones tempranas:** Disminuyen y vuelven a la línea basal de forma gradual (del inicio al nadir ≥30s). Coinciden con las contracciones de forma especular, Macones et al 2008 y conservan la variabilidad dentro de la contracción. Suelen aparecer en la primera fase de parto tardía y segunda fase, y se cree que son secundarias a compresión de la cabeza fetal. No traducen hypoxia/acidosis FIGO 2015

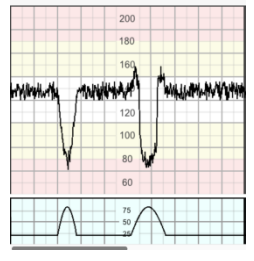


Early Decelerations

- **Desaceleraciones variables:** Tienen forma de "V" y muestran una rápida caída (del inicio al nadir <30s) seguido de una rápida recuperación a la línea basal. Ésta rapidez es debida a compresión umbilical e implica que no permite valorar la variabilidad durante la contracción. Son variables en cuanto a tamaño, forma y en relación con las contracciones uterinas.

  Las desaceleraciones variables constituyen la mayoría de las desaceleraciones durante el trabajo de parto y traducen una respuesta mediada por Baroreceptores al incrementar la presión arterial, como ocurre con la compresión del cordón umbilical.FIGO 2015 También pueden ocurrir (o en asociación con) estimulación periférica de Quimioreceptores. Las desaceleraciones variables se asocian raramente a hipoxia/acidosis, a menos que adquieran una forma de "U" con variabilidad reducida o muy aumentada dentro de la desaceleración (ver desaceleraciones tardías debajo), y/o su duración supera los 3 minutosFIGO 2015, Hamilton et al 2012 (ver desaceleraciones prolongadas debajo).

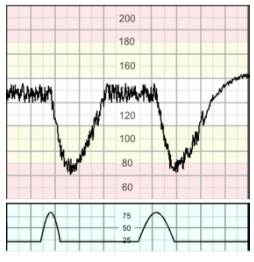
  Se dice que cumplen criterios de "Sixties" si 2 o más de los siguientes se cumplen: disminución de 60lpm o más, llega hasta 60lpm o menos, dura 60 o más segundos. Hamilton et al 2012



Variable Decelerations

- **Desaceleraciones tardías**: Tienen un inicio o recuperación a la línea basal muy gradual y/o disminución o incremento de la variabilidad intra-desaceleración. Ocurre cuando pasan más de 30 segundos entre el principio y el nadir o entre el nadir y la recuperación. Cuando las contracciones están correctamente registradas, las desaceleraciones tardías empiezan más de 20 segundos después del inicio de la contracción, tiene el nadir después del acmé y la vuelta a la línea basal después del final de la contracción. FIGO 2015

  Estas desaceleraciones indican una respuesta a hipoxia fetal mediada por Quimioreceptores. Hamilton et al 2012 En un RCTG sin aceleraciones y con una variabilidad disminuida la definición de desaceleraciones tardías también incluye a aquellas con una amplitud de 10−15 lpm (desaceleraciones leves).



Late Decelerations

Prolonged Deceleration

- **Desaceleraciones prolongadas:** Aquellas que duran más de 3 minutos. Es probable que estén mediadas por Quimioreceptores y por tanto indiquen hipoxia. Las que superan los 5 minutos con una FCF mantenida de menos de 80lpm y variabilidad reducida dentro de la desaceleración están frecuentemente asociados con hipoxia/acidosis fetal aguda y requieren una intervención urgente [FIGO 2015] (ver la "Regla de los 3 minutos").
-

5- **Contracciones:** Son registradas en forma de campana con un incremento gradual y una disminución simétrica. El tocodinamómetro sólo evalúa de forma fiable la frecuencia de las contracciones.[FIGO 2015] La intensidad y duración de las mismas debe ser evaluada mediante palpación manual. Si la frecuencia de las contracciones no puede evaluarse con seguridad con el tocodinamómetro debería realizarse un examen mediante palpación manual durante 10 minutos cada 30 minutos. [GCP]

- **Taquisistolia** supone una frecuencia excesiva de contracciones y se define como la presencia de más de 5 contracciones en 10 minutos, [Peebles et al 1994] en 2 periodos de 10 minutos sucesivos o haciendo la media en un periodo de 30 minutos.
- **Hiperestimulación** es debida a una respuesta exagerada a estimulantes uterinos presentando un aumento en la frecuencia, fuerza y tono de las contracciones, incremento de tono basal entre contracciones y/o contracciones prolongadas en el tiempo de más de 2 minutos. Esto puede ocasionar cambios en la FCF fetal. Por lo tanto, cualquier incremento en la actividad uterina (frecuencia, duración o fuerza) asociado con cambios en el registro fetal deberían considerarse hiperestimulación uterina. Puede también darse raramente en casos sin estimulantes uterinos (para evitar complicaciones, el término "hiperestimulación" se usará indistintamente para referirse a actividad uterina espontánea y por estimulantes).

Estados de actividad fetal [Pillai and James 1990]

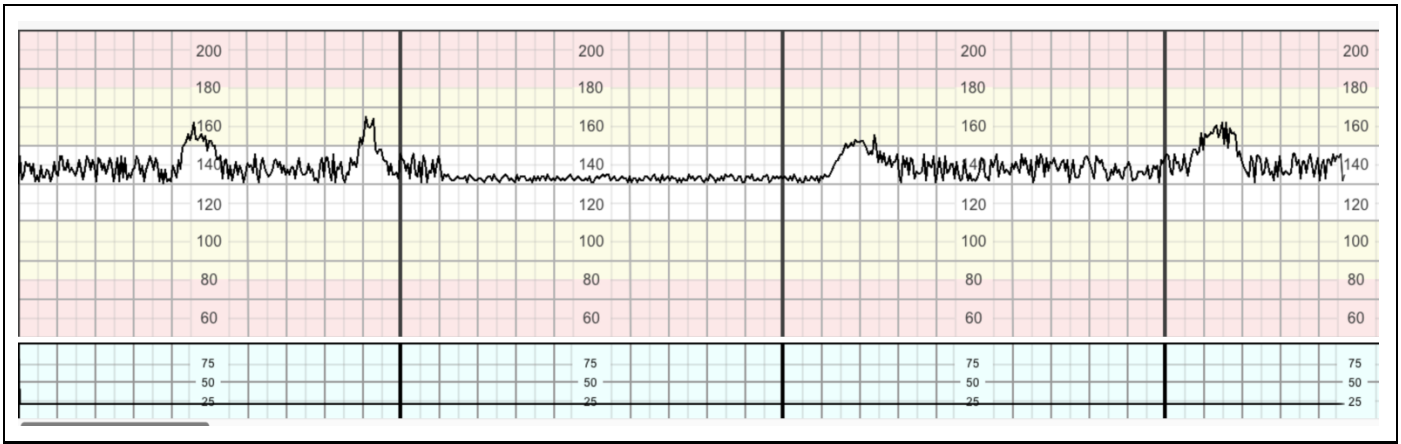
Se refiere a periodos de:

1- **Quiescencia fetal** refleja sueño profundo (sin movimientos oculares): El sueño fetal profundo puede durar hasta 50 minutos y se asocia con una FCFb estable, muy raramente aceleraciones y variabilidad borderline.

2- **Sueño activo** (movimientos rápidos oculares): Este es el estado fetal más frecuente y se traduce en el RCTG como presencia de algunas aceleraciones y variabilidad conservada.

3- **Vigilia**: El desvelo active es raro y lo vemos en el RCTG como presencia de múltiples aceleraciones y variabilidad normal. Las aceleraciones pueden llegar a ser tan frecuentes que cueste determinar la FCFb (confluencia de ascensos).

La alternancia de diferentes estados de comportamiento (**cycling**) es un signo de bienestar neurológico y ausencia de hipoxia/acidosis. La transición entre los diferentes estados es más evidente después de las 32-34w de gestación, debido a la maduración del Sistema nervioso.



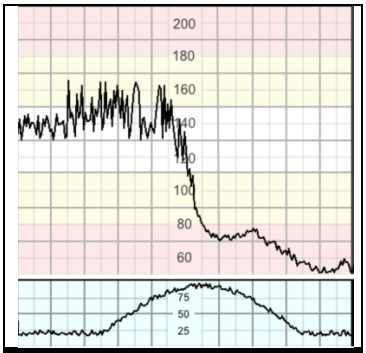
Cycling

Fisiología de la hipoxia durante el trabajo de parto

Durante el trabajo de parto el feto utiliza varios mecanismos adaptativos en respuesta a la hipoxia, y generalmente sigue un patrón similar a la respuesta al ejercicio. La hipoxia intraparto generalmente sigue una de estas 3 opciones:

1. **Hipoxia aguda** **Kamoshita et al. 2010, Leung et al. 2009, Cahil et al. 2013**

- **Se presenta** como una desaceleración aguda que dura más de 5 minutos o más de 3 minutos si se asociada a disminución de la variabilidad dentro de la desaceleración. FIGO 2015



Hipoxia aguda

- **Causas**

  3 Accidentes
  - Prolapso de cordó
  - Desprendimiento de placenta (DPNNI)
  - Rotura uterina

  2 causas yatrogénicas
  - Hipotensión materna (generalmente debida a hipotensión supina o a anestesia epidural)
  - Hiperestimulación uterina (por oxitocina/PGs) o debido a un aumento espontaneo de actividad

- **Caída del pH fetal** a una velocidad de 0.01/min durante la desaceleración Gull et al. 1996
- **El manejo** se hace siguiendo la **Regla de los 3 minutos:**

  0 – 3: Si se objetiva una desaceleración que dura más de 3 minutos y no muestra signos de recuperación se debe solicitar ayuda.

  3 – 6: Se debe intentar diagnosticar la causa
  - Si se diagnostica un accidente el objetivo debe ser finalizar la gestación por la vía más rápida y segura posible (instrumentación o cesárea)
  - Si se diagnostica una causa yatrogénica se deben aplicar medidas inmediatas para corregirlo: evitar la posición de supino, para los estimulantes uterinos, iniciar fluidos endovenosos y administrar tocolíticos.

  6 – 9: En este punto deberían visualizarse los signos de recuperación (restauración de la variabilidad y mejoría de la FCFb). Si no se objetivaran estos signos, la preparación para un parto inmediato debe iniciarse.

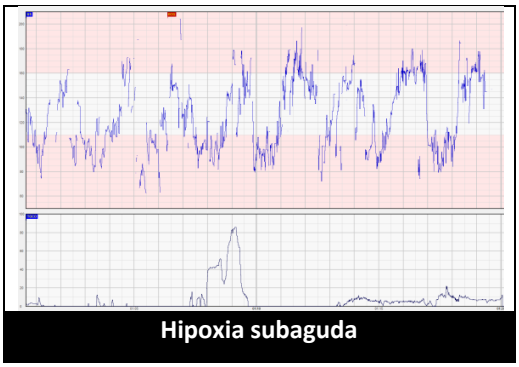
  9 – 12: Si en este momento no se ha recuperado la desaceleración se debe estar iniciando las maniobras para un parto instrumentado o preparando la cesárea, con el objetivo del nacimiento entre el minuto 12 y 15.

Notas importantes:

- La *Regla de los 3 minutos* no debe seguirse si la desaceleración es precedida de reducción de la variabilidad y ausencia de cycling. En este caso se deben realizar maniobras para finalizar de la forma más rápida y segura posible. Williams and Galerneau 2002
- Si previamente a la desaceleración se identifican periodos de *cycling* y la variabilidad es normal antes y durante los 3 primeros minutos de la desaceleración, el 90% se recuperarán antes de 6 minutos y el 95% antes de 9 minutos, siempre que los accidentes agudos hayan sido excluidos.

2. Hipoxia subaguda Albertson et al. 2016

- **Se observa** en aquellos fetos que pasan la mayor parte del tiempo desacelerando.
- Está casi siempre **causado** por hiperestimulación uterina.
- **El pH fetal cae** a una velocidad de 0.01 / 2-3 minutos
- **Manejo**:
    1. Parar / reducir uterotónicos
    2. Evitar la posició en supino
    3. Administar fluidos endovenosos
    4. Administrar tocolíticos si la hiperestimulación persiste a pesar de las medidas previas
    5. Plantear finalizar si la hipoxia persiste a pesar de la tocolisis (parto instrumentado/cesárea)



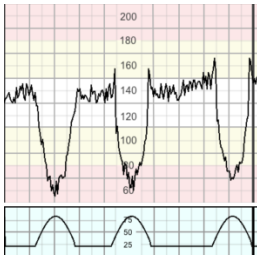
Hipoxia subaguda

En caso de estar en la segunda fase de parto, indicad a la madre que deje de pujar para permitir la recuperación del feto. Si no se observa mejoría en 10 minutos, realizad maniobras activas para finalizar. Si recupera, una vez está estable indicad que reinicie los pujos. Si reapareciera hipoxia subaguda, forzad la finalización por la vía más rápida.

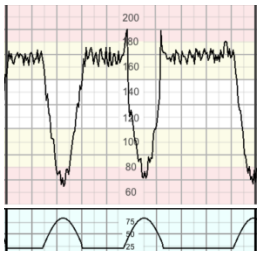
3. Hipoxia progresiva Richardson et al 1996

- Es el tipo de hipoxia más frecuente durante el trabajo de parto.
- Durante este proceso el feto experimenta los mismos cambios que a un adulto le suceden durante el ejercicio.
- Tiende a **presentar los siguientes cambios** en este orden:
    1. Evidencia de estrés hipóxico (desaceleraciones)
    2. Pérdida de aceleraciones y auscencia de *cycling*
    3. Respuesta exagerada al estrés hipóxico (las Desaceleraciones se hacen má anchas y profundas)
    4. Attempted redistribution to perfuse vital organs facilitated by catecholamines (first sign noted is a rise in baseline)
    5. Further redistribution with vasoconstriction affecting the brain (reduced baseline variability)
    6. Terminal heart failure (unstable/ progressive decline in the baseline - “step ladder pattern to death”)

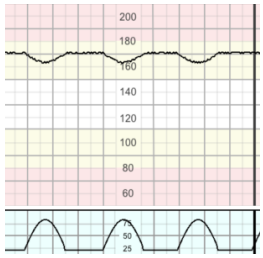
Hipoxia progresiva



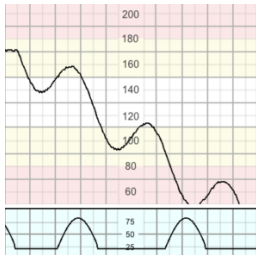
Desaceleraciones



Aumento de la FCFb



Variabilidad reducida



Fracaso cardíaco terminal

Important Notes:

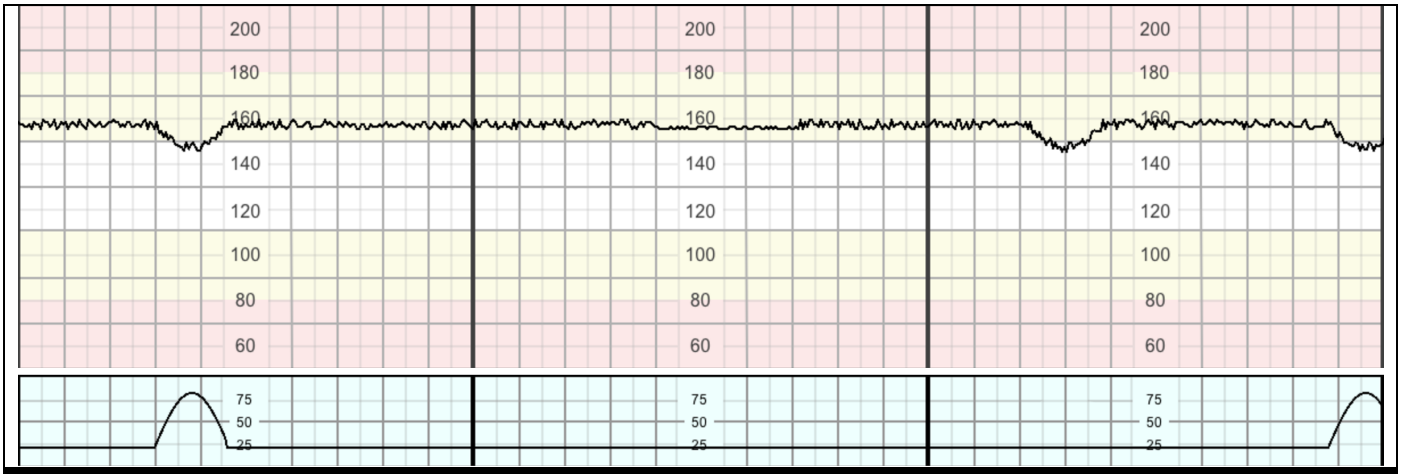
- Stages 1 – 4 represent evidence of stress with maintained fetal **compensation**.
- Stages 5 & 6 represent evidence of stress with fetal **decompensation**.
- Stages 4 & 5 may be reversible although prolonged episodes of hypoxia can lead to fetal organ damage.

- **Management** of gradually progressive hypoxia is by improving fetal conditions with the first signs of redistribution to avoid internal organ damage. (stage 4).

4. Chronic Hypoxia **Pulgar et al 2007**

(This is an antenatal type of hypoxia with implications for intrapartum care)

- **Presents** as a baseline rate at the upper end of normal associated with reduced variability and blunted responses (infrequent accelerations and lack of cycling) and is frequently associated with shallow decelerations.
- This represents a fetus with reduced reserve and increased susceptibility to hypoxic injury during labour.
- Careful consideration should be given when planning interventions potentially increasing the risk of hypoxia, with low threshold for surgical intervention.
- A useful checklist that helps exclude signs of chronic hypoxia is presented below (see table 3).



Hipoxia crónica

Intermittent Auscultation

All women that have existing medical or obstetric conditions should have an obstetric review during pregnancy with a full plan of care formulated for labour and birth. This should include the suitability for different birth settings and the type of fetal monitoring required when in labour. The care plan should be explained to and agreed by the woman.

1 Inclusion Criteria

Continuous electronic fetal monitoring (CEFM) in low risk women is associated with an increased level of intervention without any improvement in outcome. Maude et al 2014 Women who are healthy and have had an uncomplicated pregnancy should be offered and recommended intermittent auscultation to monitor fetal well-being. This should be performed using a Doppler ultrasound or pinard stethoscope. NICE 2014 A woman must be fully informed of the risks and benefits of intermittent auscultation (IA) and CEFM. If during labour, she chooses not to be monitored by the recommended method a full discussion of the potential impact on her and the fetus should be undertaken and the labour ward coordinator and senior obstetrician should be informed. This discussion must be clearly documented in the patient's records.

2 Method

There does not appear to be any good evidence from trials to recommend any particular frequency and duration of IA. Therefore, it is more a 'custom of practice' than 'evidence-based approach'. Walsh 2008 Auscultation is carried out every 15 minutes in the first stage and every 5 minutes in the second stage - a practice adopted from the randomized controlled trials comparing IA and CEFM. On assessing the woman and establishing that she is low risk and is suitable for IA the method is as follows:

- Ask about fetal movements over the preceding 24 hours.
- Perform a full abdominal palpation to determine the lie, presentation and position of the baby.
- At the initial assessment use a pinard stethoscope on the mother's abdomen in line with the fetal scapula to establish the real sounds of the fetal heart (FH). Munro and Jokinen 2012
- On first auscultation listen for at least one full minute in between contractions when the baby is at rest to establish a baseline FH rate. Maude et al 2014
- If in early labour, auscultate during fetal movements or following stimulation of the baby. An acceleration should be noted, and the presence of chronic hypoxia can be excluded. This is more difficult to demonstrate later in labour
- The maternal pulse should be palpated simultaneously while auscultating FH to differentiate between the two, as it is possible to inadvertently pick up maternal heart rate from surrounding vessels. This should be done on the initiation of each auscultation and throughout if a FH abnormality is detected. NCC-WCH 2007
- During the first stage and passive* second stage of labour FH should be auscultated immediately after a contraction for at least 1 minute every 15 minutes.
- During active+ second stage of labour, the FH should be auscultated every 5 minutes. Liston et al 2007
- Count the FH and document as a single number, and not as an average. If using a Doppler do not rely on the range shown on the screen, as there have been instances where the machine has miscalculated the FH rate. NICE 2014, MHRA 2010
- Record acceleration and decelerations, if heard. NICE 2014
- None of the literature suggests that variability can be determined by IA. Munro and Jokinen 2012
- An observed rise in baseline rate, slow recovering decelerations or persistent accelerations (overshoot) after contractions should be confirmed by listening throughout the next 3 contractions to clarify the suspected pattern. Confirmation of an abnormality warrants a move to CEFM and transfer to obstetric-led care (see section criteria for change). FIGO 2015

- Although a CTG machine utilizes the same technology as the handheld Doppler, it should not be used in a low risk labour for intermittent auscultation, as this is inappropriate use of resources. [GCP] The handheld doppler has a narrow beam and is unlikely to easily pick up the maternal sound. It gives a swishing noise when tracked to a blood vessel compared with the electronic heartbeat sounds of the US transducer of a CTG machine, hence the handheld doppler device is preferred.

[*] Passive second stage is defined as the finding of full dilatation of the cervix prior to or in the absence of involuntary expulsive efforts or active maternal effort.
[+] Active second stage is defined as the onset of involuntary expulsive efforts or active maternal effort following confirmation of full dilatation.

3 Documentation

- Initial risk assessment should be documented in the maternal notes on admission in labour.
- The FH should be documented in the notes as a single number counted as beats over one minute.
- Maternal pulse should be documented every hour as a single number.
- Women not in established labour should be encouraged to go home. A clear plan should be established and documented explaining when to return.
- For women in the latent phase of labour with strong regular contractions, showing signs of progress or that have a history of precipitate labour, commence monitoring every 15min and reassess in 2 hours. If still not in labour, reconsider the management plan. It is important to remain alert to possible transitions between different phases of labour and adjust frequency of monitoring accordingly.
- When labour is confirmed a partogram must be started. This will act as a visual prompt to identify any changes from the norm. Blood pressure, pulse, temperature and urine output should also be documented on the partogram.

4 Conversion Criteria for changing from IA to CEFM

During the course of pregnancy or labour the clinical circumstances may change, increasing risk to mother and/or fetus (see table-1). In this situation, the mother should be informed of the rationale for changing the method of auscultation and should also be clearly documented in the notes.

If CEFM has been commenced due to concerns arising during IA but the CTG is normal after a minimum of 30 minutes, it is deemed suitable to return to IA. [Maude et al 2014] If concerns arise again, CEFM would be recommended until delivery.

If conversion to CEFM is advised but declined, the risks of not continuously monitoring should be explained, and the midwife in charge and obstetric team informed. All discussions must be clearly documented in the notes.

Table 1 – Risk factors indicating conversion from Intermittent Auscultation to Continuous Electronic Fetal Monitoring	
Maternal	**Fetal**
*Pulse over 120 beats/minute on 2 occasions 30 minutes apart	Undiagnosed breech presentation; transverse or oblique lie (review mode of delivery)
*A single reading of diastolic blood pressure ≥ 110 mmHg or systolic blood pressure ≥ 160 mmHg	Free-floating head in a nulliparous woman
*Diastolic blood pressure 90 to 109 mmHg or systolic blood pressure of 140 to 159 mmHg on 2 consecutive readings taken 30 minutes apart	Recurrent Accelerations (immediately following a contraction i.e. overshoot)
Maternal pyrexia (defined as ≥38.0 °C once or ≥37.5 °C on two occasions 1 hour apart)	Fetal heart rate below 110 or above 160 beats/ minute, or if it is perceived as inappropriate for gestational age.
Any vaginal blood loss other than a show	Evidence of a rising baseline on the partogram
The presence of meconium if birth is not imminent NICE 2014	2 x decelerations in fetal heart rate heard on intermittent auscultation after 2 successive contractions
Persistent pain in between contractions	
Epidural analgesia	

* measured between contractions

Continuous Electronic Fetal Monitoring

CEFM could potentially reduce mobility. However, every effort should be made to facilitate the normal physiology of labour by encouraging the woman to adopt upright positions and mobilise. This can be facilitated by the use of wireless telemetry or the encouragement to move within the constraints of being connected to the monitor.

CEFM is a screening tool for hypoxia and does not replace the need for accurate clinical observations on which decisions should be made in conjunction with the CTG. [FIGO 2015]

1 Inclusion criteria

Table 2 – Inclusion criteria for Continuous Electronic Fetal Monitoring	
Maternal indication	**Fetal indication**
Gestation <37 or > 42 weeks	Abnormal Doppler artery velocimetry
Induced labour	Known or suspected IUGR
Administration of oxytocin	Oligohydramnios or polyhydramnios
Ante/Intrapartum haemorrhage	Malpresentation
Maternal illness (e.g. diabetes, cardiac, renal, hyperthyroidism). *	Meconium stained liquor
Pre-eclampsia	Multiple pregnancy (all babies to be monitored)
Previous uterine scar (caesarean section or myomectomy)	Suspected small for gestational age or macrosomia
Contractions > 5:10 or lasting for more than 90 seconds	Reduced fetal movements in the last 24 hours reported by the woman
During / following insertion of an epidural block	Two-vessel cord
Prolonged rupture of membranes > 24 hours unless delivery is imminent.	A rise in baseline, repeated decelerations or slow to recover decelerations, or overshoots
Maternal request	Fetal structural abnormalities diagnosed during the antenatal period and planned for CEFM

* Monitoring as per consultant formulated plan.

The table above is not exhaustive, any condition which is thought to increase the risk of fetal hypoxia mandates CEFM.

2 Interpretation of CTG

- **Step 1:** The clinical setting
  - Current gestational age
  - Antenatal events (e.g. IUGR, PET, medications)
  - Previous CTG traces and their clinical scenario to assess whether they can be used as a baseline for the current monitoring
- **Step 2:** Current clinical situation, and indication for CTG
- **Step 3:** Set the limits acceptable as normal for THIS trace BEFORE starting the assessment
- **Step 4:** Assess the trace:
  - Identified risks
  - Contractions (is the inter-contraction interval more than 90 seconds?)
  - **Baseline Heart rate:**
    - It is the most important feature on a CTG trace.
    - Consider whether the baseline is appropriate for G.A.

- Compare baseline rates on previous CTGs.
- A change in baseline (by >10%) signifies a need for further attention. (In the presence of chronic hypoxia, more subtle changes to the baseline should also be considered significant).

- Variability and Cycling**:**
  - Cycling is a sign of fetal well-being. It signifies normal fetal physiology.
  - In the presence of decelerations and increase in baseline rate, episodes of reduced variability must be managed promptly, and not assumed to be cycling. Reduced variability in this situation is caused by CNS inhibition secondary to hypoxia.
- Accelerations:
  - The presence of accelerations is generally considered to be a reassuring feature.
  - **An acceleration starts from, and returns to the baseline.**
  - It is important to differentiate accelerations from overshoots (rebound increase in heart rate caused by brief accumulation of CO_2 during hypoxic episodes) and shouldering (increase in heart rate preceding and/or following decelerations commonly occurring with cord compressions.
  - **If accelerations are coinciding with contractions, especially in the second stage of labour, exclude maternal heart rate.**
- Decelerations:
  - It is important to realise that although the presence of decelerations does not in itself reflect that the fetus is unwell, it may signal the need to try and alter fetal conditions. Such as:
    - Repeated chemoreceptor decelerations (late, prolonged, or reduced variability within deceleration) signify that the placental stores are being depleted. Frequently, this can be corrected by changing maternal position, or increasing circulating volume by hydration, reducing the stress by reducing/stopping oxytocin. If this does not correct the situation it is important to monitor closely for any rise in baseline rate or reduction of variability.
    - Prolonged decelerations (>5 minutes or >3 minutes with reduced variability) need to be managed according to the 3-minute rule (refer to page 11)
    - An isolated deceleration in non-labouring women is acceptable, however, repeated unprovoked decelerations in non-labouring women are a need for further investigation and assessment.
- **Overall Assessment of Presence of Hypoxia and management plan** (see table below)

Table 3 - Checklist to exclude chronic hypoxia and pre-existing fetal injury [Pereira and Chandraharan 2017]			
1	Baseline fetal heart rate appropriate G.A.	Yes	No
2	Normal variability and cycling	Yes	No
3	Presence of accelerations (not in labour or latent phase of labour)	Yes	No
4	No shallow/ late decelerations	Yes	No
5	Consider the wider clinical picture: meconium, temperature, fetal growth, reduced fetal movements	Yes	No
Overall Impression: Normal / Chronic Hypoxia / Other:			
Management Plan:			

Hypoxia	Features	Management
No Hypoxia	☐ Baseline appropriate for G.A. ☐ Normal variability and cycling ☐ No repetitive decelerations	☐ Consider whether the CTG needs to continue. ☐ If continuing the CTG perform routine hourly review. (see CTG Assessment Tool below)
Evidence of Hypoxia		
Chronic Hypoxia	☐ Higher baseline than expected for G.A. ☐ Reduced variability and/ or absence of cycling ☐ Absence of accelerations ☐ Shallow decelerations ☐ Consider the clinical indicators: reduced fetal movements, thick meconium, bleeding, evidence of chorioamnionitis, postmaturity, IUGR	☐ Avoid further stress ☐ Expedite delivery, if delivery is not imminent
Gradually Evolving Hypoxia	**Compensated** Rise in the baseline (with normal variability and stable baseline) preceded by decelerations and loss of accelerations	☐ Likely to respond to conservative interventions (see below) ☐ Regular review every 30-60 minutes to assess for signs of further hypoxic change, and that the intervention resulted in an improvement. ☐ Other causes such as reduced placental reserve MUST be considered and addressed accordingly.
	Decompensated ☐ Reduced or increased variability ☐ Unstable/ progressive decline in the baseline (step ladder pattern to death)	☐ Needs urgent intervention to reverse the hypoxic insult (remove prostaglandin pessary, stop oxytocin infusion, tocolysis) ☐ Delivery should be expedited, if no signs of improvement are seen
Subacute Hypoxia	☐ More time spent during decelerations than at the baseline ☐ May be associated with saltatory pattern (increased variability)	**First Stage** ☐ Remove prostaglandins/stop oxytocin infusion ☐ If no improvement, needs urgent tocolysis ☐ If still no evidence of improvement within 10-15 minutes, review situation and expedite delivery **Second Stage** ☐ Stop maternal active pushing during contractions until improvement is noted. ☐ If no improvement is noted, consider tocolysis if delivery is not imminent or expedite delivery by operative vaginal delivery
Acute Hypoxia	Prolonged Deceleration (> 3 minutes)	**Preceded by reduced variability and lack of cycling or reduced variability within the first 3 minutes** Immediate delivery by the safest and quickest route **Preceded by normal variability and cycling and normal variability during the first 3 minutes of the deceleration (see 3-minute rule above)** ☐ Exclude the 3 accidents (i.e. cord prolapse, placental abruption, uterine rupture - if an accident is suspected prepare for immediate delivery) ☐ Correct reversible causes ☐ If no improvement by 9 minutes or any of the accidents diagnosed, immediate delivery by the safest and quickest route
Unable to Ascertain fetal wellbeing (Poor signal quality, uncertain baseline, possible recording of the maternal heart rate)		☐ Escalate to senior team ☐ Consider Adjunctive Techniques, if appropriate ☐ Consider the application of FSE to improve signal quality

Please Note:

- If fetal well-being cannot be determined, timely advice and management needs to be sought.
- **Be aware that if the CTG parameters of baseline fetal heart rate and baseline variability are normal, the risk of fetal acidosis is low.** NICE 2014, FIGO 2015
- Even if the CTG trace is classified as pathological, if the baseline fetal heart rate is stable, and the variability is reassuring, according to both NICE and FIGO guidelines, no intervention is required other than careful observation.
- In many trusts, it would still be advisable to classify the CTG trace according to the trust agreed national guideline (FIGO / NICE). If the trace is classified as suspicious or pathological while no evidence of hypoxia is noted, this has to be clearly documented in the notes justifying the management plan.

Table 4 - CTG Assessment Tool						
Baseline	bpm	**Variability**	bpm	**Accelerations**		**Decelerations**
Rise in Baseline (≥ 10%)				**Yes**		**No**
Inter-contraction interval > 90 sec				**Yes**		**No**
Maintained Cycling				**Yes**		**No**
Abnormal Variability (<5 or >25)				**Yes**		**No**
Features of Hypoxia				**Yes**		**No**
Type						
Central Organs well oxygenated				**Yes**		**No**
Other risk factors noted						
Recommended Management						

3 Actions in situation of suspected fetal hypoxia

Identify reversible causes as alleviating them can lead to subsequent recovery of adequate fetal oxygenation and the return to a normal trace.
When CTG changes develop, it is important to address underlying causes before hypoxia occurs. The midwife caring for the woman should escalate to a senior midwife/obstetric team for review without delay.

3.1 Excessive uterine activity (most frequent cause)

- Could be detected by palpating the uterine fundus assessing the frequency, strength and duration of contractions and the tone in between.
- It can usually be reversed by
  - Reducing or stopping oxytocin infusion
  - Removing administered prostaglandins
  - Starting acute tocolysis with beta-adrenergic agonists (terbutaline) or nitro-glycerine
  - During the second stage of labour, maternal pushing efforts can also contribute to fetal hypoxia/acidosis and the mother can be asked to stop pushing until the situation has improved. FIGO 2015 If this does not improve the trace, delivery should be expedited.

Important note:
Due to the longer half-life of prostaglandins, hyperstimulation usually requires the removal of the pessary and administration of tocolytics at the same time, especially when dealing with acute hypoxia.

3.2 Aorto-caval compression can occur in supine position. Turning the mother to lateral or upright positions may relieve compression.

3.3 Transient cord compression (variable decelerations) can sometimes be relieved by changing maternal position

3.4 Sudden maternal hypotension most frequently occurs after spinal or epidural administration. This is reversible by rapid fluid administration ± I.V. ephedrine bolus (by the anaesthetic team).

3.5 ACTION WITH NO SUPPORTING EVIDENCE

- Oxygen administration to the mother in a well oxygenated mother, this does not alleviate fetal hypoxia and may actually be more harmful. Fawole and Hofmeyr 2012
- I.V. fluids in normotensive, well hydrated women. Although, some may consider IV fluids to improve the placental flow, administration of IV fluids in chronic hypoxia and chorioamnionitis may provide a false sense of reassurance without improving perinatal outcomes. ***Good clinical judgement is required to diagnose the underlying cause of the changes on the CTG, to judge the reversibility of the conditions with which it is associated, and to determine the timing of delivery. The objective is to avoid prolonged fetal hypoxia / acidosis, as well as unnecessary obstetric interventions. Additional methods such as fetal scalp stimulation and STAN monitoring may be used to evaluate fetal oxygenation.***

4 Quality, Documentation and Storage

4.1 Documentation

- It is the responsibility of every clinician using the CTG machine to perform the following initial checks prior to commencing the trace:
  - Correct Date and Time
  - Correct scale in use
  - Paper specific for the machine in use, with correct orientation
- Every trace should start by clearly documenting
  - The name, DOB, and hospital number of the patient
  - Machine Number
  - Indication for CEFM
  - Maternal observations
- Ongoing documentation of
  - Maternal heart rate every hour
    - Simultaneous maternal heart rate monitoring should be considered in:
      - Fetal heart block
      - Fetal heart rate similar to maternal heart rate
      - Maternal tachycardia
      - During 2nd stage of labour
      - Trace shows accelerations coinciding with contractions/ expulsive efforts
  - Maternal BP and temperature is to be measured every 4 hours unless more frequent observations are indicated clinically
  - Relevant intrapartum events for example
    - Vaginal examination
    - Siting of an epidural
    - Review of CTG

4.2 Quality

- External FHR monitoring is the recommended initial method, provided that a recording of acceptable quality is obtained i.e. that the basic CTG features can be identified. If the trace is of poor quality early recourse to FSE is advised if no contraindications exist. Such instances include increased maternal BMI and poor recording during second stage (thus avoiding monitoring maternal heart rate).
- Monitoring of Twins:
  - CEFM should preferably be performed with dual channel monitors.
  - Clearly identify which trace is allocated to which twin on the CTG and in the notes.

- Consider offsetting twin 2 by 20 beats in order to clearly identify each twin separately.
- External monitoring of both twins is acceptable for as long as distinct traces of good quality are obtained.
- There should be a low threshold for internal monitoring of the presenting twin in the absence of contraindications as it is often superior in quality especially in the second stage.

4.3 Storage

CTG must be stored for 25 years. Given that thermal paper deteriorates and is only legible for about 10 years, storage should ideally be in electronic form.

Adjunctive Techniques to Assess Fetal Wellbeing

Be aware that if the CTG parameters of baseline fetal heart rate and baseline variability are stable, the risk of fetal acidosis is low. [NICE 2014, FIGO 2015]

It is important to attempt to understand the physiological events behind changes in fetal heart rate pattern (see above). This can provide reassurance of fetal status without the need to perform further testing. However, in situations where changes cannot be explained, it is important to seek senior advice and plan further testing accordingly.

1 Fetal Scalp Stimulation

- **Supporting Evidence**

  There are many observational studies supporting the use of fetal scalp stimulation (FSS) compared to fetal blood sampling. However, the evidence grading for the trials behind the use of FSS is predominantly moderate to low. [Skupski et al 2002]

- **Limitation**

  There is no consensus on the clinical situation for FSS to be used. [FIGO 2015]

- **Method**

  FSS involves stimulating the fetal scalp by rubbing it with the examiner's fingers. Other techniques involve using forceps to clasp the fetal skin, or alternatively using vibroacoustic stimulation applied to the mother's abdomen. However, these are not locally available. [Elimian 1997] Digital scalp stimulation is the most widely used as it is the easiest to perform, least invasive, and appears to have a similar predictive value for fetal hypoxia/acidosis to the other alternatives. [FIGO 2015]

- **Interpretation**

  If an acceleration is noted at FSS the likelihood of fetal hypoxia is <2.5%, while in the absence of an acceleration, the likelihood of fetal hypoxia is > 38%. [Skupski et al 2002] The risk of hypoxia is increased if the lack of acceleration is associated with reduced variability. [Elimian 1997] The information should be considered in the context of the entire clinical picture. [FIGO 2015, NICE 2014]

2 Combined Continuous Fetal monitoring with ST-Analysis (STAN)

- **Supportive evidence**

  There have been six meta-analyses assessing the effectiveness of STAN in ascertainment of fetal wellbeing. Five of these have shown that although STAN reduces the need for fetal scalp blood sampling and operative vaginal delivery, there was no improvement in number of births by caesarean section, babies with low APGAR scores at 5 minutes, severe fetal metabolic acidosis, or the number of babies with neonatal encephalopathy. [Adalina et al 2015] The sixth meta-analysis claimed to have found a mistake within the other five, and after correcting for this, it showed reduction of rates of metabolic acidosis. [Olofsson et al 2014] The latest meta-analysis which included the largest US randomised trial on STAN [Blix et al, 2016] has reported 36% statistically significant reduction in neonatal metabolic acidosis and 8% reduction in operative vaginal birth. Therefore, in the opinion of the authors, STAN remains the only additional test of fetal wellbeing with robust scientific evidence. [Bhide et al, 2016, Chandraharan E, 2018.]

- **Principles**
  - When the CTG is normal, ST events should be ignored as in this setting they do not indicate fetal hypoxia/acidosis. They occur in about 50% of well oxygenated fetuses. The generation of ST events on a normal CTG may be secondary to fetal catecholamine-mediated cardiac glycogenolysis or changes in the vector of the ECG complexes during fetal movements.
  - A few cases have been described in which CTG traces have gradually changed to show signs of hypoxia, without the appearance of ST events. [Westerhuis et al 2007] However, these cases illustrated the erroneous use of STAN in preterminal CTG Traces and in fetal infection (i.e. not suitable for STAN monitoring). For this reason, any abnormal CTG lasting more than 60 minutes, or less if the CTG

pattern deteriorates rapidly, requires assessment by a senior obstetrician whether or not ST events occur. [FIGO 2015]

- With a CTG showing persistently reduced variability or a pattern indicating a severe or acute hypoxic event, intervention is always required irrespective of ST data. [Amer-Wahlin et al 2007]
- Everybody using STAN must have undergone adequate training and assessment.
- In the presence of sepsis, the analysis becomes unreliable. The fetal brain may get injured by pathways other than hypoxia and is even more susceptible to injury by hypoxia which may not be reflected by ST events. This needs to be taken into account if initiating STAN on uncomplicated fetal tachycardia.

Prerequisites

- A CTG with a stable baseline, normal variability and accelerations is required at the start of monitoring for a confident evaluation of ST data. [FIGO 2015] However, even in an abnormal CTG Trace, if the baseline fetal heart rate remains stable and the variability is reassuring (i.e. good central organ oxygenation), STAN can be commenced [Preti et al, 2013.]
- The ST technology has not been extensively evaluated for gestational ages below 36 weeks. Repetitive Biphasic ST Events may be noted due to the immaturity of fetal myocardium.
- No existing contraindications to the application of FSE
- TENS has to be discontinued as it interferes with the acquisition of the ECG signal

Contraindications

- It should not be initiated in active second stage, spontaneous pushing or in a precipitate labour.
- Pre-terminal trace or acute hypoxia
- Suspected chorioamnionitis – whilst STAN may be used to identify hypoxia, clinicians should be aware of the alternative (i.e. inflammatory) pathway of brain damage. Therefore, the management decisions should be based on the progress of labour, parity, presence of meconium and observed CTG features, irrespective of the absence of STAN Events
- Active genital Herpes infection
- Women seropositive to hepatitis B, C, D, E, or to HIV
- Suspected fetal blood disorders
- Uncertainty about the presenting part
- When artificial rupture of membranes is inappropriate
- Structural or functional cardiac abnormality in the fetus preventing reliable monitoring
- If immediate delivery is required for any other indication

Method

It is a combined assessment of the standard fetal heart rate trace with an automated analysis of the fetal electrocardiogram. This is obtained by placing a spiral electrode on the fetal scalp. The machine initially analyses the ST segments (required 20 'x's) to obtain a baseline shape of the ECG complex, which usually takes the first 4 minutes. Subsequently, it compares the complex every 30 beats for changes indicating the presence of possible ischaemia. With every successful comparison made, an 'x' is indicated at the bottom of the trace.

Interpretation

Trace interpretation needs to take into account the CTG pattern classification and the degree of ST changes. The system's automatic warnings of ST events occur when it detects changes in ECG morphology when compared with the previous state. (table 5). A Flow Chart to aid management when using STAN for fetal monitoring is provided in the Appendix. [Townsend and Chandraharan 2015]

Signal Quality Check

- The effectiveness of STAN depends on the quality and continuity of the signal obtained by the scalp electrode. If the fetal ECG signal is lost for 4 minutes or longer (i.e. no crosses underneath the CTG for 4 minutes), or if less than 10 successful checks are completed within 10 minutes, then the ECG signal can no longer be compared to the baseline ECG. An alarm will sound if this has occurred. In such situations, it is recommended that if the CTG has remained normal in the period of loss then monitoring can be continued. If there is suspicion of fetal hypoxia based on the interpretation of the

CTG during the gap, STAN should not be considered reliable.

- Recording the maternal ECG
  The scalp electrode may pick up the maternal ECG if it is applied to the cervix or if there is no fetal heartbeat. For this reason, the ECG complex is displayed on the screen and should be reviewed every time monitoring is commenced and whenever there is suspicion that a trace is maternal and not fetal. A maternal ECG will appear different – the P wave will usually appear blunted or absent as it is not transmitted so far from the maternal heart to be picked up by the fetal electrode, and the QRS complex is wider. It will coincide with the maternal pulse.
- Fetal heart rate >170 bpm
  As the fetal heart rate increases, so does the possibility that the repolarising activity of the ventricle (the T wave) will occur simultaneously with the P wave of the next atrial contraction. As a result, the morphology of the T wave may theoretically be altered in such a way as to either mask significant changes or to trigger STAN events of no other significance. Therefore, caution should be exercised in the presence of fetal tachycardia secondary to chorioamnionitis. STAN monitoring is not recommended in the presence of cardiac arrhythmias.

Table 5 - Classification of CTG

	Baseline Rate	Variability and Reactivity	Decelerations
Normal CTG	□ 110 – 150 bpm	□ Accelerations □ Variability 5 - 25	□ Early uniform decelerations □ Uncomplicated variable decelerations with duration < 60s and loss of < 60 beats from Base rate
Intermediary CTG	□ 100 – 110 bpm □ 150 – 170 bpm □ Decelerations < 100 bpm for ≤ 3 minutes	□ > 25 bpm (Saltatory pattern) □ < 5 bpm > 40 min with absence of accelerations	□ Uncomplicated variable decelerations with duration of < 60s and loss of > 60 beats
	The combination of several intermediary factors results in an abnormal CTG		
Abnormal	□ 150 – 170 bpm and reduced variability □ > 170 bpm □ prolonged deceleration < 100 bpm for > 3 minutes	□ < 5 bpm for > 60 minutes □ sinusoidal pattern	□ Complicated variable deceleration with a duration of > 60s □ Repeated late uniform decelerations
Pre-terminal	Total lack of variability (<2bpm) and reactivity with or without decelerations		

ST Analysis

ST Event	Normal CTG	Intermediary	Abnormal	Pre-terminal
Episodic T-QRS rise	□ Expectant management □ Continued Observation	> 0.15	> 0.10	Immediate delivery
Baseline T-QRS rise		> 0.10	> 0.05	
Biphasic ST		3 biphasic log messages	2 biphasic log messages	

The above guideline was based on FIGO CTG Guidelines of 1987 as ST-Analyser was validated using these guidelines. Based on the experience and perinatal outcomes of the maternity units which have implemented STAN after training staff on fetal physiology, the Editorial Board recommends the use of the STAN guideline in combination of deeper understanding of fetal physiology.

- Presentation
  If a STAN electrode is applied to a fetus in the breech presentation, the ECG recording will be inverted. This can give the impression of a negative ST segment and false biphasic events may be recorded.

There is a 'breech mode' function which can be used to invert the ECG. This was evaluated in an observational study, Stein et al 2006 which found no increase in adverse neonatal outcomes when compared to using STAN in the vertex presentation.

Practice Points when using STAN for fetal Monitoring

1. Always consider the 'Wider Clinical Picture' (Meconium, Oxytocin, Temperature, Haemorrhage, Hyperstimulation, Rate of Progress or the presence of uterine Scar – MOTHERS) whilst using STAN without solely relying on 'Black Boxes' (ST Events).
2. Even in the presence of significant STAN Events in the first or second stage of labour, first take action to improve fetal oxygenation (i.e. stopping oxytocin, changing maternal position and/or administration of terbutaline or stopping active maternal pushing). If the CTG improves and central organs are well oxygenated with no evidence of a subacute or saltatory pattern, it is appropriate to continue labour, based on the observed clinical picture.
3. Conversely, even in the absence of significant ST Events, in the presence of an unstable baseline heart rate, reduced baseline variability with preceding decelerations and an increase in the baseline fetal heart rate or saltatory pattern or absence of cycling or saltatory pattern, urgent action has to be taken to improve fetal oxygenation, irrespective of the presence of STAN Events. If fetal condition cannot be improved, urgent delivery should be accomplished, and one should not await STAN Events.
4. In clinical or subclinical chorioamnionitis or in the presence of thick meconium stained amniotic fluid, the pathway for fetal neurological damage may be non-hypoxic and therefore, management should depend on the clinical situation, including the rate of progress and the requirement for oxytocin augmentation, irrespective of the absence of STAN Events. STAN is a test of fetal hypoxia and not of inflammatory neurological and myocardial damage.
5. STAN should not be commenced in cases of chronic hypoxia as the fetus had most likely exhausted all the glycogen reserves in the myocardium and therefore, may not be able to generate any ST Events.

3 Fetal Scalp Blood Sampling

The Cochrane systematic review in 2013 has demonstrated that there is no available evidence of a correlation between fetal scalp pH and improvement in long term outcomes. In addition, the review has also demonstrated that contrary to the erroneous belief in the past, current evidence suggests that FBS may increase the number of caesarean sections and operative vaginal births. Further review of evidence has shown rare, but, potentially serious fetal complications. Therefore, as current scientific evidence does not support the use of FBS in clinical practice as its benefits no longer outweigh its risks, the authors of this guideline do not support the use of FBS as an adjunctive technique for the assessment of fetal well-being.

Special circumstances

Other factors that are present during labour such as prolonged rupture of membranes, defined as spontaneous rupture of membranes for greater than 24 hours, chorioamnionitis, anhydramnious, meconium-stained liquor, maternal infection or pyrexia, and the speed of evolution of hypoxia are likely to modify the responses of the fetus as well as affect the perinatal outcome. Sacco et al 2015

1 Meconium

Meconium stained liquor (MSL) can be present in a normal post term fetus without an indication that the baby has experienced hypoxia. In a preterm fetus, <34/40, the presence of meconium signifies that there is likely infection, such as listeria, ureaplasma or rotavirus. Blot et al. 1983 Clear liquor has antibacterial properties, however in the presence of meconium these properties are restricted. Unsworth and Vause 2010 With thick meconium, E coli has the ability to grow rapidly, whereas Group B Streptococcus proliferates even in clear liquor. Eidelman et al. 2002 Fetal tachycardia (≥160 bpm), in the presence of MSL has a Relative Risk of 51 for the development of chorioamnionitis, in comparison to clear liquor. Blot et al. 1983

MSL is associated with complications in the newborn. The most severe complication is meconium aspiration syndrome (MAS). Unsworth and Vause 2010 Aspiration of meconium can occur in-utero with fetal gasping, or after birth, with the first breaths of life. Mundhra and Agarwal 2013

There is still no effective and safe treatment or prophylactic measure for MAS once the meconium has passed below the vocal cords into the lungs. Chandraharan and McDonnell 2015

Evidence shows that when the placental oxygen supply is interrupted, the fetus attempts to breathe. Should these attempts fail to provide an alternative oxygen supply, and if hypoxia continues, the respiratory centre becomes unable to continue initiating breathing and the breathing stops, usually within 2 to 3 minutes. MOET 2014

In view of this, extra vigilance should be taken to observe for signs of hypoxia in the presence of meconium. A lower threshold for expediting delivery should be considered when there is meconium and signs of hypoxia as a CTG cannot predict if a fetus will gasp or when this would happen.

If a fetus has passed meconium, the mother should be informed that there is a risk of meconium already being present in the lungs. Most meconium will be expelled from the fetal lungs as the baby passes down the birth canal but in 1-3% of live births, the baby will develop MAS. Impey et al. 2008

2 Oxytocin and Hyperstimulation

Care should be taken when using prostaglandins or oxytocin to augment or stimulate labour. One of the iatrogenic causes of prolonged decelerations includes prolonged or frequent uterine contractions secondary to oxytocin. If this cause is identified, immediate action should be taken to improve utero-placental oxygenation by stopping oxytocin and changing maternal position to reduce the stress the baby is experiencing. FIGO 2015 Consideration should also be given to starting acute tocolysis using a beta-adrenergic agonist such as terbutaline. NICE 2014

CEFM is necessary with oxytocin augmentation. If the fetal heart rate is normal, oxytocin should be titrated to achieve contractions at a rate of 4:10. It should be reduced if contractions occur more frequently than 5:10. If evidence/suspicion of fetal decompensation occur, oxytocin infusion should be stopped and an urgent assessment of the fetal condition should be undertaken and documented by an obstetrician. Arulkumaran et al. 2004 In the event of acute hypoxia, oxytocin should be stopped, and the 3-minute rule initiated. A full assessment of the fetal condition must be undertaken and documented by an obstetrician BEFORE oxytocin is recommenced.

3 Pyrexia

Heat transmission during pregnancy results in fetal temperature being 0.3-0.5°C higher than maternal temperature. The umbilical circulation transfers 85% of the heat produced by the fetus to the maternal circulation. The remaining 15% is dissipated through the fetal skin to the amnion and is then transferred through the uterine wall to the maternal abdomen. Lieberman et al. 2000 If there is pyrexia, the metabolic demands of the fetal tissues are increased and so the risk of hypoxia is elevated. Holt et al. 1994 This should be considered especially when using oxytocin, and a prolonged labour should be avoided. The combination of maternal pyrexia with cord acidosis [indicative of fetal acidosis] greatly increases the risk of neonatal encephalopathy. Evidence suggests that acidosis and pyrexia represent two separate causal pathways of neonatal encephalopathy leading to a cumulative effect. Impey et al. 2008

There is no clear evidence to suggest when a fetus should be delivered if there is maternal or fetal infection. In view of the lack of clear evidence/guidance on a safely acceptable time frame for delivery, a clear discussion with the mother should be undertaken with agreed management plan and time frame documented from this. Measures, such as paracetamol, IV fluids and IV antibiotics, should be used to treat any pyrexia and infection. Evidence shows that an intrapartum maternal dose of 1500mg of cefuroxime IV produces effective fetal concentrations for prophylaxis, but not treatment. Holte et al. 2004

Intrapartum fever, even when unlikely to be caused by infection, is associated with a fourfold increase in the risk of unexplained, early-onset seizures in term infants. Holt 1994

4 Antepartum Haemorrhage

Major placental abruption is one of the 3 major intrapartum accidents and may present as a single and sudden drop in the baseline rate (acute hypoxia). In this case, delivery must be expedited as it is most likely to be the evidence of a placental abruption and is irreversible. FIGO 2015 It is also important to note that the use of tocolytics in APH may aggravate placental separation causing worsening fetal hypoxia.

5 Epidural

This can cause a sudden drop in maternal blood pressure which causes redistribution of maternal blood away from the placenta resulting in inadequate placental perfusion. It will present as a single and sudden drop in the baseline rate (acute hypoxia). In this instance, it is reversible and should be corrected by changing the maternal position and IV fluids ± I.V. ephedrine (to be administered by the anaesthetic team). Greenwell et al. 2012 This vasodilation can also cause an increase in maternal temperature as a result of altered thermoregulation. RCOG 2015

6 Scar rupture

If a woman has had a previous lower segment caesarean section and begins to labour, the risk of uterine scar rupture is between 0.07% Nahum and Isaac 2016 – 0.5% RCOG 2015 and must be considered. This is the third major intrapartum accident and may present as a single and sudden drop in the baseline rate (acute hypoxia). In this case, delivery must be expedited as it is irreversible. FIGO 2015

7 Subclinical Chorioamnionitis

Research has shown that only 8-12% of women with histologically confirmed chorioamnionitis would demonstrate tachycardia and pyrexia during labour. Therefore, any increase in the baseline fetal heart rate without preceding decelerations should arouse the suspicion of an ongoing subclinical chorioamnionitis. Other clinical parameters, such as presence of meconium, rate of progress of labour, history of prolonged rupture of membranes or prolonged labour and absence of cycling should be considered whilst making management decisions.

8 Preterm Afors and Chandraharan 2011

There is paucity of evidence/ guidelines on the use of CTG in Preterm babies. This has resulted in some authors advising against continuous monitoring in extreme prematurity (24 – 28 weeks). The key factors affecting FHR characteristics in the preterm fetus are immaturity of the central and peripheral nervous systems, reduced placental reserve, immature adrenal gland and myocardium, and reduced amount of Wharton's jelly in the umbilical cord.

CTG findings include:

- Immaturity of the autonomic nervous system will result in a higher baseline heart rate and reduced variability.
- Immaturity of the somatic nervous system may result in less accelerations being less frequent and of smaller amplitude (10bpm) and for a shorter duration (10sec). This is especially more evident at gestations before 30 weeks.
- Fetal heart rate decelerations in the absence of uterine contractions often occur in the normal preterm fetus between 20 and 30 weeks' gestation. Variable decelerations have been shown to occur in 70–75% of intrapartum preterm fetuses, in comparison to 30-50% of term fetuses.
- Immaturity of the central nervous system results in a less developed cycling pattern, this is especially more evident in extreme prematurity.

9 Effect of medication on the CTG

It is important to consider the effect of any medication administered to the mother during labour and anticipate the changes it may cause on the CTG trace. This is even more important when medications are given for the purpose of improving fetal conditions. In such cases, we would need to consider what to look for as signs of improvement, what may occur if our intervention did not work or if the situation is worsening, how soon to expect changes and how long should they last for.

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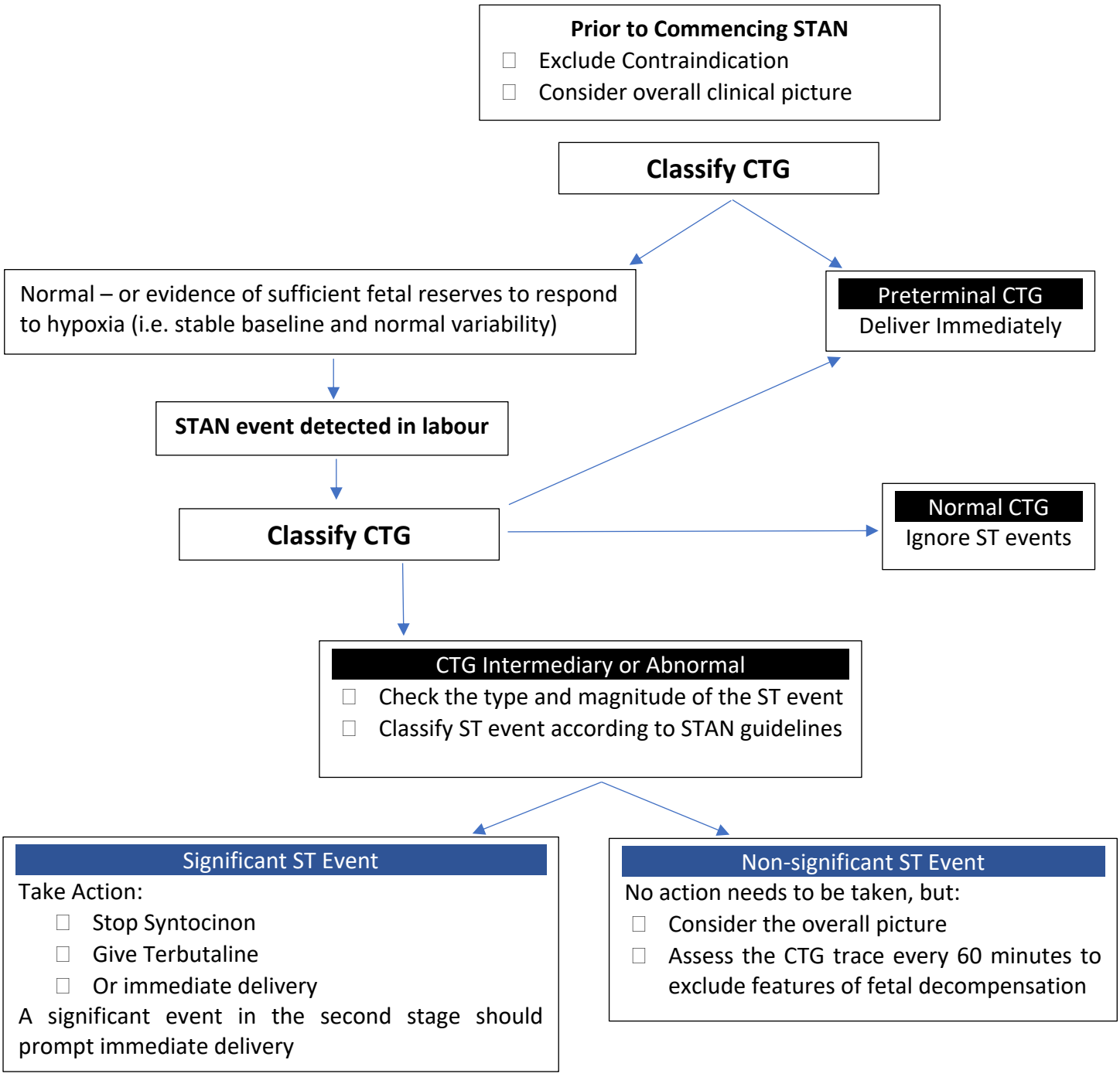
Appendix


Prior to Commencing STAN
Exclude Contraindication
Consider overall clinical picture
Classify CTG
Normal – or evidence of sufficient fetal reserves to respond to hypoxia (i.e. stable baseline and normal variability)
Preterminal CTG
Deliver Immediately
STAN event detected in labour
Classify CTG
Normal CTG
Ignore ST events
CTG Intermediary or Abnormal
Check the type and magnitude of the ST event
Classify ST event according to STAN guidelines
Significant ST Event
Take Action:
Stop Syntocinon
Give Terbutaline
Or immediate delivery
A significant event in the second stage should prompt immediate delivery
Non-significant ST Event
No action needs to be taken, but:
Consider the overall picture
Assess the CTG trace every 60 minutes to exclude features of fetal decompensation