Clinical algorithm for management of fetal heart rate abnormalities during labour

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Abstract

Objective

To construct algorithms with a sequential decision analysis pathway for monitoring of the fetal heart rate and managing fetal heart ratebradycardia, late decelerations and tachycardia during labour.

Population

Low-risk pregnant women in labour with singleton cephalic term pregnancies.

Setting

Institutional births in low- and middle-income countries.

Search strategy

We sought relevant published clinical algorithms, guidelines and randomized trials/reviews by searching the Cochrane Library, PubMed and Google on the terms: “fetal AND heart AND rate AND algorithm AND (labour OR intrapartum)”, up to March 2020.

Case scenarios

The two scenarios included were fetal heart rate bradycardia or late decelerations (potentially related to uterine rupture, placental abruption, cord prolapse, maternal hypotension, uterine hyperstimulation, or unexplained) and fetal heart rate tachycardia (potentially related to maternal hyperthermia,

infection, dehydration, or unexplained). The algorithms provided pathways for definition, assessment, diagnosis, interventions to correct the abnormalities and ongoing monitoring leading to mode of birth, and linking to other algorithms in the series.

Conclusions

The algorithms provide a framework for monitoring and managing fetal heart rate bradycardia, late decelerations and tachycardia during labour. We emphasize the inherent diagnostic inaccuracy of fetal heart rate monitoring, the tendency to over-diagnose fetal compromise, the need to consider fetal heart rate information in the context of other clinical features and the need to engage in informed, shared, family-centred decision-making. We note the need for further research on methods of fetal assessment during labour including clinical fetal arousal testing and the rapid biophysical profile test.

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Keywords

Labour, fetal heart rate, auscultation, Doptone, bradycardia, deceleration, tachycardia, algorithm

Tweetable abstract

Decision analysis algorithms for fetal bradycardia, late decelerations and tachycardia highlight diagnostic limitations.

Introduction

Health care during pregnancy is unique in that two individuals need to be cared for interdependently. Occasionally, the best interests of the mother and baby may be discordant. For example, caesarean section in the interest of the baby for suspected fetal compromise places the mother at increased risk.(1) Clinical decision-making needs to balance the risks for both mother and baby, based on the best available evidence, available resources and the preferences of the mother.

During low-risk labour, the World Health Organization (WHO) recommends intermittent assessment of the fetal heart rate (FHR).(2) The FHR may be assessed by auscultation or with a hand-held doppler device.(3) A normal fetal heart rate is usually defined as a baseline between 110 and 160 beats per minute (bpm), with no decelerations.(4) Abnormal patterns include persistence of bradycardia (<100 bpm), tachycardia (>180 bpm), and recurrent prolonged 'late' decelerations following uterine contractions. 'Non-reassuring' patterns which are neither normal nor clearly abnormal are a common cause for concern as some may resolve spontaneously while others may be an indication of pending fetal compromise. Non-reassuring features include: baseline of 100 to 109 or 161 to 180, variability of less than 5 for 30 to 50 minutes or more than 25 for 15 to 25 minutes, variable decelerations with various duration and frequency. Early, variable and late decelerations are

defined by the shapes and their temporal relation to the uterine contractions. Late decelerations are thought to be related to fetal hypoxia due to reduced uteroplacental blood flow during uterine contractions. Early and variable decelerations are thought to be fetal reflex responses unrelated to hypoxia and their significance is controversial.(5)

Continuous cardiotocography (CTG) in low-risk labours increases caesarean section rates without evidence of clinical improvement for the baby.(6, 7) High-technology methods such as fetal electrocardiographic wave form analysis(8, 9) and fetal pulse oximetry(10) have not yet impacted clinical care, and may not be widely available in the near future. Fetal scalp blood analysis is not widely available and may be associated with the risk of mother to child HIV transmission in untreated mothers.(11) Meconium passage is a poor indicator of fetal wellbeing. It may be precipitated by mechanisms other than fetal compromise, and is related to fetal maturity. It may be caused by a direct effect of smooth muscle stimulants such as prostaglandins or herbal medication on fetal bowel.(12-14) Meconium stained amniotic fluid is covered in another paper in this series.(15) In this article, we present labour algorithms for identifying, diagnosing, managing, and monitoring deviations from normal observations of the fetal heart rate. We emphasize the need to interpret the heart rate findings in the context of a holistic evaluation of clinical features such as the mother's condition, resilience and preferences, uterine contractions, labour progress and signs of cephalopelvic disproportion.

Methods

This work is part of a project commissioned by the World Health Organization, for the management of uneventful and complicated labours, to complement WHO intrapartum care guidelines, and facilitate the development of electronic

evidence-based, decision-support tools by stakeholders, to improve labour outcomes in low-resource settings.(16)

We developed algorithms for two case scenarios, based on findings of a review on fetal heart rate abnormalities, identification of the most common deviations, severity of related complications or clinical outcomes and discussion with the WHO Intrapartum Care Algorithms Working Group. These were as follows: fetal bradycardia or late decelerations (Figure 1); and fetal tachycardia (Figure 2). A detailed description of the methodology used for the development of the algorithms is provided elsewhere.(17)

Search strategy

We searched PubMed and Google for previous relevant algorithms on the terms: “fetal AND heart AND rate AND algorithm AND (labour OR intrapartum)”. We also searched for national/ international/ institutional guidelines, randomized trials and reviews relevant to fetal monitoring in labour. We searched the Cochrane Library on the terms “fetal AND heart AND rate AND (labour OR intrapartum)”; and PubMed using the same search terms in Novermber 2018. We updated the search on 20 March 2020 with a PubMed search on the terms “fetal AND heart AND rate AND (labour OR intrapartum) AND (review OR trial) AND random”. We did not use date or language restrictions.

The literature review was guided by the hierarchy of evidence and prioritised WHO guidelines followed by other international or national guidelines using GRADE methodology. In the absence of guidelines on a case scenario, a combination of existing studies and expert opinion was used to determine key points for consideration in the algorithm. The highest level of evidence found

was used to support the decisions along the management pathway, in the order of up-to-date systematic review (with meta-analyses), up-to-date systematic review (without meta- analyses), any available systematic review, validated decision rules, randomized controlled trials, non-randomized controlled trials, observations studies, and consensus documents. Two reviewers (OTO and MB) screened the title and the abstract, extending manual searching through the reference lists of relevant articles and extracted the recommendations and supporting evidences into an excel file independently. Any inconsistencies were resolved by a third reviewer (GJH).

Population and setting

The algorithms were developed to cover the assessment and management of pregnant women with singleton, term pregnancies considered to be at low risk of developing complications at admission to the birthing facility, with the diagnosis of active labour, regardless of stage of labour, until childbirth. Health facilities in low- and middle-income countries were the priority. However, the algorithms are applicable to any health care setting, and possible adaptations that may be required were acknowledged. The target users for these algorithms are skilled health personnel providing care during childbirth working alone or as part of teams, particularly midwives, non-specialized clinicians (i.e. clinicians without specialist training in obstetrics but who also provide care for women in labour), and specialists.

Algorithm development

Algorithms were developed through an iterative process using standardized guidance, which included evidence hierarchy, expert consensus and peer review.

After collating the evidence, a selection process for inclusion of the evidence in the algorithm took place. Selection was based on relevance of the evidence to the key decision points and severity of the condition targeted by an intervention. The selection also accounted for the strength of evidence and applicability and feasibility in a low- and middle-income countries context. If there were inconsistencies among guidelines, the most up-to-date guidelines and evidence were reviewed and used to inform consultation with experts. A list of inconsistencies was discussed at the WHO Technical Working Group meeting and a consensus reached on evidence for the algorithm.

Draw.io, an open source diagramming software, was used to construct the algorithm in a flowchart format. The online software facilitated remote working by the WHO Technical Working Group. The algorithm was composed of standardised but variable shaped boxes, representing either a clinical state (rounded rectangle), decision point (hexagon), action task (rectangle), or link to a different algorithm (oval). Each box was numbered and joined to other boxes via arrows, to orientate the reader to the direction of flow. The numbers also corresponded to a table of evidence, showing the evidence source for the action and decision points. The algorithms underwent internal peer review by the WHO Intrapartum Care Algorithms Working Group and revisions made where needed.

We validated the decision pathways by identifying available evidence sources (systematic reviews, meta-analysis, clinical practice guidelines, or relevant single studies) and selecting the highest level of evidence. We extracted recommendations and supporting evidence that apply to each case scenario: what observations would warrant a clinical suspicion of the case scenario; what observations define or are characteristics of the case scenario; what differential diagnoses the observations could indicate; what treatment/intervention options exist to slow the progression orcorrect the deviation back to normal; what

observations or assessments are needed to monitor clinical progression of the scenario; and women's views and preferences. Where no guideline existed, we used an evidence hierarchical approach.

Results

Search results

The flow chart of the literature searches is shown in Figure S1.

We identified six guidelines or guidance documents. WHO Managing complications in pregnancy and childbirth (MCPC),(18) WHO pregnancy, childbirth, postpartum, and newborn care (PCPNC),(19) UK National Institute for Clinical Excellence (NICE),(20) Institute for Clinical Systems Improvement (ICSI),(21) National Clinical Guideline for Intrapartum Fetal Heart Rate Monitoring: Ireland(22) and WHO recommendations: intrapartum care for a positive childbirth experience.(2)

The guidelines were incorporated into the algorithms as indicated in Table S1.

The Cochrane Library search yielded 55 Cochrane reviews and 727 trials. We screened the 55 review titles and abstracts and selected 13 for consideration of inclusion.(6, 8, 10, 23-32) We identified 25 trials not included in the above reviews, and selected nine for potential inclusion.(33-41) The PubMed searches identified twelve relevant non-Cochrane systematic reviews and trials.(42-53)

We identified three previously published algorithms: California Maternal Quality Care Collaborative (CMQCC),(54) based on the paper of Clark et al 2013;(55)and FHR tracing and notification guidelines and Kaiser Permanente Vallejo Medical Center suggested algorithm for the management of variant

intrapartum fetal heart rate tracings (≥32 weeks estimated gestational age) chart.(56)

Fetal bradycardia or late decelerations (Figure 1 and table S2)

We combined fetal bradycardia with late FHR decelerations because the initial approach to these two abnormalities was similar in the algorithm.

Condition

Fetal bradycardia was defined as fetal heart rate <100bpm lasting for 3 minutes or more.

Late decelerations were defined as a gradual slowing of the FHR with onset more than 20 seconds after the onset of uterine contractions; the onset, nadir and return follow after the onset, peak and return of uterine contractions; and U-shaped in morphology. NICE defined a non-reassuring FHR pattern as one with late decelerations occurring in over 50% of contractions for less than 30 minutes and an abnormal FHR pattern as late decelerations lasting for 30 minutes or more.(20)

These condition may be picked up either by intermittent auscultation or continuous electronic fetal monitoring where appropriate.

Assessment and treatment

Fetal bradycardia or recurrent late decelerations occurring in over 50% of contractions should trigger a rapid comprehensive maternal and labour assessment to differentiate reversible from irreversible and unknown causes and guide the decision on further management and mode of delivery and its urgency if necessary.

Initial management includes repositioning the woman on her left side and stopping any oxytocic agent. Maternal hypotension and uterine hyperstimulation are potentially correctable causes of fetal bradycardia/ late decelerations in which intravenous rehydration and acute tocolytics usually suffice respectively and the clinicians should observe gradual recovery of the FHR pattern.

A quick maternal survey will usually reveal the obvious irreversible causes of uterine rupture, placental abruption and cord prolapse which require prompt maternal resuscitation and delivery.(47) Abnormal uterine contour, loss of presenting part and fetal parts palpable in the abdomen, particularly in women with previous uterine scar, are suggestive of uterine rupture while persistent tender uterus with or without vaginal bleeding could indicate placental abruption. Vaginal examination could identify umbilical cord prolapse and assess the labour progress to decide the best mode of delivery within the clinical context.

For persistent prolonged bradycardia despite conservative management, the loss of FHR variability prior to or during the bradycardia should prompt the preparation of an operative delivery because these FHR patterns are associated with fetal decompensation and significant acidemia.(48-50) A longer period of observation could be allowed if FHR variability is retained and the heart rate recovers gradually. The time limit to observe the response to conservative management is ill-defined and the attending clinicians should also take into consideration the local logistics to arrange a speedy delivery. Observation for 9 minutes may be adopted since 95% will recover by 9 minutes.(50, 51) A good practice is to involve relevant personnel and begin preparation early even before the decision for delivery. More research is

needed on the clinical observation that persistent severe bradycardia <80bpm with ultrasound showing twitching of fetal heart muscle rather than contraction which is associated with a negligible chance of survival.

For late decelerations that are persistent despite initial resuscitative measures and are not due to underlying irreversible causes, the published criteria for significant features of decelerations do not have robust evidence. Normal FHR variability usually indicates low risk of fetal hypoxia.(50) Progressive loss of FHR variability or worsening late decelerations (deeper and wider decelerations) increases the chance of fetal acidemia and requires further intervention.(51) Where late deccelerations are frequent and persistent beyond 30 minutes, further interventions are recommended to confirm fetal wellbeing.(20) Although the diagnostic accuracy of fetal scalp or acoustic stimulation needs further evaluation, this non-invasive initial approach could be used to assess the fetal response, otherwise scalp blood pH/ lactate level could be measured and guide further management. Where these are not possible or findings of the assessment are abnormal, delivery isndicated

Fetal tachycardia (Figure 2 and table S3)

Condition

Fetal tachycardia was defined as heart rate > 160bpm. The condition could be picked up either by intermittent auscultation or continuous electronic fetal monitoring where appropriate.

Assessment and treatment

Initial quick maternal and labour evaluation should gather essential information to facilitate subsequent management. The assessment should begin with the overall analysis of the FHR pattern. Even in the absence of maternal signs of infection, chorioamnionitis should be suspected in cases with persistent or insidious fetal tachycardia, together with late decelerations, meconium liquor, loss of variability or lack of cycling.(50, 52) Expedited delivery is needed and cover with antibiotics.

A detailed history taking, physical examination and measurement of vital signs of blood pressure, pulse and temperature would help to differentiate the other causes of fetal tachycardia which include dehydration, maternal pyrexia or drug-induced. Fluid resuscitation should be started in women with signs of dehydration. If the laboring woman has fever, antipyretics and physical cooling can bring down the temperature and antibiotics may be considered.

The FHR pattern should be reviewed 30 minutes after conservative management. If FHR pattern/ liquor status is suggestive of chorioamnionitis, delivery should be expedited with antibiotic cover. Persistent fetal tachycardia with other non-reassuring or abnormal features requires further evaluation. The non-invasive and easy application of fetal scalp stimulation or acoustic stimulation could be used to assess fetal response. In the context of suspected fetal infection, fetal scalp pH/ lactate could be normal and fetal neurological injury could be caused by a non-hypoxic pathway or lowering the threshold of hypoxia induced neuronal injury.(50, 53) Therefore, clinicians should exercise caution and only select cases having low risk of chorioamnionitis for conservative management.

Discussion

Main findings

We have focused on fetal assessment during labour in low risk women in a low-resource setting. We have identified the common abnormalities which can be detected clinically using intermittent auscultation and constructed algorithms to guide management though clinical assessment to identify possible causes, interventions to correct the heart rate abnormalities, reassessment and criteria for operative intervention. Fetal tachycardia and bradycardia or late decelerations are frequently associated with neonatal morbidity and mortality. Prompt and comprehensive evaluation using these clinical algorithms could assist the less experienced birth attendant in low-resource setting to expedite the delivery of fetuses with high likelihood of being hypoxic while avoiding unnecessary operative delivery in cases where fetal acidemia/ hypoxia is unlikely.

Strengths

The strengths of our paper are that the clinical algorithms are derived from comprehensive systematic review based on the best available evidence. We used robust, systematic methodology which was standardized by WHO across this series of algorithms. We have indicated points in our algorithm which link to other relevant algorithms in the series for management of underlying causes of abnormal FHR. We have also highlighted points at which care needs to be escalated for a medical review to manage more complex situations.

Limitations

Limitations include the presence of some inconsistencies amongst the international guidelines (see Table S1), with no clear evidence to guide

assessment of recommendation reliability, as well as lack of evidence for prioritizing interventions. Where possible, we based ourrecommendations on level of evidence, and where evidence was lacking we used the more commonly used recommendations among guidelines or relied on expert consensus of the WHO Intrapartum Care Algorithms Working Group, which may introduce personal bias. For example, the definition of fetal bradycardia was different among various guidelines and we used 100 bpm as the cut-off for our algorithm as it was mostly commonly used among the international guidelines.(18-21) Oxygen supplementation was suggested by MCPC but its evidence for benefit in the presence of an abnormal FHR pattern was not strong and therefore it was not included in the algorithm.(18)

To make the algorithms reasonably concise for clinical usefulness and pragmatic we did not include all possible eventualities. The evidence used was geared towards a low-resource hospital setting, and may not be applicable to other clinical settings such as home births. The algorithm is also based on evidence from low-risk pregnancies, and may not be applicable to all high-risk situations.

Interpretation

Current methods to assess fetal wellbeing are inherently inaccurate. They are based on a combination of fetal activity, fetal heart rate patterns, and fetal responsiveness to stimuli (plus in some settings direct measurement of fetal scalp blood pH or lactate). As with any inaccurate screening or diagnostic test, the possibility exists that inappropriate intervention in false positive tests will result in more harm from the test than benefit. The ubiquity and increasing popularity of electronic monitoring globally may further exacerbate this

phenomenon in particular in low-resource setting where skillful birth attendants are not available for the correct interpretation of FHR patterns, in the fear of fetal hypoxaemia or acidaemia during labour which is a major cause of stillbirth and fetal neurological damage. In developing these algorithms, we have attempted to use the best available evidence to strike a balance between detecting most cases of true fetal compromise while avoiding excessive unnecessary intervention.

The only other similar algorithm we identified was based primarily on cardiotocographic findings.(55) The CMQCC algorithm (5, 55) is limited to category II cardiotocograph pattern in labour, and is not included in our algorithm as there is little information on evidence for the guidance. A letter to the editor criticizes the algorithm as not being evidence-based, and applicable to 80% of women who develop this pattern during labour. The FHR tracing and notification guidelines algorithm (56) focuses on the time limit within which the attending doctor or midwife should be informed of the various categories of FHR abnormality. This aspect is not dealt with in our algorithms. The Kaiser Permanente Vallejo Medical Center suggested algorithm for the management of variant intrapartum FHR tracings (≥32 weeks estimated gestational age) chart (13)is intended to assist the provider in the management of variant intrapartum FHR tracings. The algorithm has several similarities to our algorithm but is more detailed with respect to cardiotocographic findings, and recommends oxygen therapy which we do not.

Algorithms by their nature cannot take into account the complexity of clinical conditions. The algorithms may provide general guidance on a logical sequence of decision-making, but in all cases evaluation of the whole clinical setting, including family preferences, should take precedence. The algorithms

may also need adaptation according to local resource availability. We have emphasized the lack of robust evidence to support several aspects of the algorithms.

Conclusions

These algorithms may be helpful guide the process of clinical decision-making in the management of FHR abnormalities during labour, taking into account the caveats mentioned above, and the need to engage in informed, shared, family-centred decision-making. The most important research priority is to seek strategies to assess fetal wellbeing with greater accuracy than is currently possible. This could include research to strengthen the limited evidence on the use of simple clinical fetal arousal testing to augment assessment based on FHR characteristics alone;digital fetal scalp stimulation testing(57); and confirmation of promising results with the rapid biophysical profile test.(43)

Authors' contributions

OTO and MB conceived the methodology for the development of intrapartum care algorithms for management of labour. OTO, MB and GJHperformed the screening of search outputs, identified eligible studies, and extracted data. GJH performed the data analysis and developed the algorithms with inputs from KF and the WHO Intrapartum Care Algorithms Working Group. GJH wrote the first draft of the paper. KWC substantially revised the paper. All authors contributed to revising the final version and approved the manuscript for publication.

Disclosure of interest

GJH is author of some of the evidence evaluated for inclusion in the algorithms. Evaluation of the evidence was by consensus of the WHO Intrapartum Care Algorithms Working Group. The authors have no other conflict of interest to declare. Completed disclosure of interests forms are available to view online as supporting information.

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Figures

Figure 1. Algorithm A. Fetal heart rate bradycardia or late decelerations.

Figure 2. Algorithm B. Fetal heart rate tachycardia.

Supplementary materials

Figure S1. Search results flowchart

Table S1 Summary of Evidence Table

Table S2. Annotation table for fetal bradycardia or late decelerations

Table S3. Annotation table for fetal tachycardia

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