



Advanced Intermittent Auscultation (AIA) of Fetal Heart Rate in Labour – Launch of a Scientific, Reliable and Forward-Looking Training Module for Birth-Attendants, Combining Simplicity with Sound Bayesian Foundation and Modern Technology

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ABSTRACT

Intrapartum fetal heart rate (FHR) monitoring has very wide clinical application of vital importance. However, there are several different methods of Intermittent auscultation (IA) which continue to suffer from some shortcomings and even inaccuracies resulting in birth asphyxia. Clinical studies alone have not provided the epistemic perfection for IA or cardiotocography (CTG). However, integrating them with the understanding of fetal pathophysiology, practical experience and critical thinking during adverse event investigations provides functional knowledge required for reliable and efficient IA. The “Advanced Intermittent Auscultation (AIA)” regime and training module published in 2022, pragmatically uses the current knowledge-base retaining simplicity of IA while maximising the benefits of widely available affordable modern but simple technology, thus improving efficiency, reliability and accuracy of IA. In addition, AIA opens the possibility judging the FHR baseline variability in future, unfeasible with previous regimes. Many current IA regimes, by mistakenly insisting on actually counting the fetal heart tones, have failed to make progress and remain unsafe, and hence best abandoned. This article describes in detail the foundational concepts of “Advanced Intermittent Auscultation (AIA)”. It demonstrates the superiority of handheld Doppler monitors which should be preferentially used. Importantly, ‘auscultation’ should not mandate ‘actual counting’ by single or multiple-count methods, which is laborious and less accurate. The FHR displayed on the Doppler device has the same accuracy as that on the CTG. Simply observing this display (and modest attention to the tempo of heart sounds) constitutes the most reliable technique of inferring FHR periodic variations. The FHR display should be observed from the latter part of contraction to the beginning of the next contraction (or eventually a full contraction-relaxation cycle). AIA maintains the benefits of the simplicity of IA by avoiding unwarranted, impractical and unproven addition of parameters like FHR cycling or post-deceleration overshoots. The AIA regime is comprehensive, pragmatic, practical, non-laborious (facilitating more holistic care), more accurate / reliable and thus enhances patient safety. Hence, AIA should be adopted

worldwide including by the national professional bodies in UK, Europe, Americas and Australasia.

Keywords: Intermittent auscultation, Electronic fetal monitoring, Fetal heart rate decelerations, Intrapartum fetal monitoring, Intrapartum fetal surveillance, late decelerations, early decelerations

INTRODUCTION

Serious intrapartum fetal hypoxemia although uncommon, leads to devastating outcomes including perinatal mortality or cerebral palsy. Fortunately, in many cases they are eminently preventable even though the birth-attendants have to rely on just the fetal heart rate (FHR) and contraction patterns using cardiotocography (CTG) or intermittent auscultation (IA) as a means of wellbeing assessment. However, in recent years many reputed maternity units across the UK have faced major criticism that IA was not performed, documented or interpreted correctly, and that CTGs were misinterpreted, and some lessons have not been learnt [1]. The brunt of criticism is largely borne by the birth-attendants and managers, but the limitations / misinterpretation of the science and the flaws in guidelines do not receive attention, stymieing the remedial measures. The National Institute for Health and Care Excellence, UK (NICE, 2014, 2019) strongly recommends IA for low-risk labours (which account for up to 45% of all labours) because it has been shown to reduce operative intervention and is generally regarded to be safe [2]. Many other national guidelines also recommend IA in the absence of risk factors [3-6]. However, cases of serious intrapartum asphyxia continue to occur, suggesting that there is scope for an improved regime and consistency or some standardization. Many systematic and scoping reviews have summarised the available clinical studies but none arrive at definitive conclusions to translate into practical improvements [7-10]. Indeed, these systematic reviews have raised many questions but furnished few answers, perpetuating an impression that any new or different recommendations would lack scientific rigor. Most of the current recommendations are derived from fairly old randomised clinical trials (RCTs) from 1980s [7], while the management of labour has changed substantially. On the other hand, in recent years the Bayesian approach (aggregate knowledge, experience and nuanced interpretation of clinical studies) has gained acceptance as the most scientific and rational way of making evidence-based conclusions and recommendations [11-15].

Based on the empirical evidence, the aggregated knowledge and the experience of authors and the grass root birth-attendants, this article describes in detail the foundational reasoning for an "Advanced Intermittent Auscultation (AIA)" regime and training module [16]. Whilst these are amenable to reasoned arguments and debate, the midwives and obstetricians would intuitively recognise the AIA regime as pragmatic, user-friendly and holistic as well as a major step towards enhancing patient safety.

THE EMPIRICAL EVIDENCE FOR IA VERSUS CTG

A Cochrane systematic review [7] analysed 13 RCTs of IA versus CTG. Only two trials were of high methodological quality and the results were dominated by the Dublin trial of 12,964 women [17]. The regime in the Dublin RCT (1981-83) constituted auscultation (counting) of FHR with a Pinard stethoscope for 1 minute after contraction (abnormal if FHR>160 or <100). There was however no specific mention of detection of decelerations in the study protocol. The auscultation was performed every 15 mins in the first stage and every 5 mins in the second

stage of labour purely based on protocol. Moreover, the Dublin hospital practiced a peculiar local version of 'active management of labour'. This was not accepted or followed by most other countries and remained unconventional in the rest of the world even in 1980s. This routine active management, included in the study protocol, involved artificial rupture of membranes (ARM) within 1 hour of admission and early use of oxytocin augmentation. The Dublin RCT excluded 792 cases of meconium liquor upon early ARM (which would not have been discovered in other hospitals or trials). Routine fetal scalp blood sampling (FSBS) was performed if labour exceeded 8 hours. (Twice more common in IA group). Only 1000 babies had umbilical venous pH measured (in the first 2 months of the trial) [17]. If IA was abnormal, CTG was not performed. It would be difficult to argue today that the IA regime of the Dublin trial [17] must be followed rejecting any reasoned modifications such as those proposed in the AIA regime [16]. Importantly, the Cochrane review of 13 RCTs showed no difference in perinatal mortality, cerebral palsy or cord blood acidosis [7]. There was halving of neonatal seizures (significant) with CTG in both high and low-risk cases but no difference in outcome at 12 months. Significant increase (1.3 - 2 times) in the operative delivery rate was associated with the use of CTG [7]. Some epistemic humility is warranted as all of these studies were reported to be at high risk of performance bias, unclear or high risk of detection bias, and unclear risk of reporting bias [7].

There have been a few publications of clinical studies in the recent years but almost all deal with the feasibility of IA, place of Admission CTG or describe practice of a particular regime [18-20]. Furthermore, these studies commonly reiterate the well-known finding that the IA is associated with lower operative delivery rate compared to CTG. None of the studies provide useful evidence for superiority of any one IA regime of over the others and are not even powered to do so. Hence, all meta-analyses or systematic reviews on IA conclude that large scale RCTs comparing different regimes of IA are desirable. Such large RCTs would be difficult, and none seem to be forthcoming. Science and medicine are reason-informed institutions [15]. In situations where high-quality empirical evidence is hard to come by (e.g., in the field of intrapartum fetal monitoring), it would be wrong to have a doctrinaire self-imposed agnosticism of existing knowledge and experience [15]. Even the validity of a 'statistical significance or P value' varies widely depending on the prior probability or plausibility of a hypothesis [12,13]. A Bayesian approach takes account of this by considering the existing aggregate knowledge and experience in that particular field. Hence, a Bayesian approach is highly desirable and scientific rather than predominantly statistical calculations [11-15]. Furthermore, quite a few studies are of poor quality, and many are often misinterpreted and misapplied to current practice. A classic example is a claim that a Pinard stethoscope and Doppler device are equivalent techniques of IA based on doctrinaire application RCTs [21-24] which have been shown to be methodologically poor and inapplicable to current practice [25]. No wonder that the birth attendants have voted with their feet and are almost exclusively using the widely available hand-held Doppler FHR monitors. The AIA module makes a strong case for superiority of Doppler devices over stethoscopes and describes more accurate/reliable ways of using them [16].

WOMEN'S VIEWS

The women's views and choices also need to be considered given that labour is a common natural life event. Some women prefer low-tech solutions that enable mobility, freedom of positioning and autonomy, and wish to avoid excessive medicalization and its potential adverse

consequences. There are different opinions and disagreements about the level of perceived safety and its costs. IA provides a low-tech choice optimizing women centred care with less focus on the CTG machine or a computerized algorithm.

THE FUNDAMENTAL CONCEPT OF THE FETAL HEART RATE AND IMPLICATIONS FOR INTERMITTENT AUSCULTATION

The instinctive, common, and useful parameter of the 'number of heart beats per minute' is simply a convenient shortcut/trade-off to infer how fast or slow (frequency) the pumping action or beating of the heart is. That concept does not actually exist over a minute – which is an accident of how we measure time. What we want to know is the ongoing or concurrent frequency of the fetal heart beating because it is affected by pathophysiological mechanisms, importantly the chemoreflex triggered by hypoxaemia. The speed (frequency) of heartbeat (conceptualised as beats/min) is changing throughout the minute of auscultation especially in a fetus during labour (unlike in resting adults in whom it is generally 'relatively' stable). The Doppler device advantageously calculates the concurrent FHR at any given moment by measuring the time interval between successive ventricular contractions (similar to the ECG calculating HR by measuring RR-intervals). The varying heartbeat instantaneously appears on the Doppler device display screen conceptualised as 'beats/min'. Furthermore, the Doppler device is highly accurate in calculating the beating frequency of the heart. The same Doppler technique is used to measure and plot the FHR on a CTG. All methods of actual counting the heart tones (single-count or the laborious multiple-count) are much less accurate and simply a rough or average approximation. Moreover, they are fallacious when there have been periodic changes like accelerations or decelerations during the minute of auscultation (Figures 1 and 2).

Illustrative Fetal Heart Rate (FHR) Trace with Deceleration

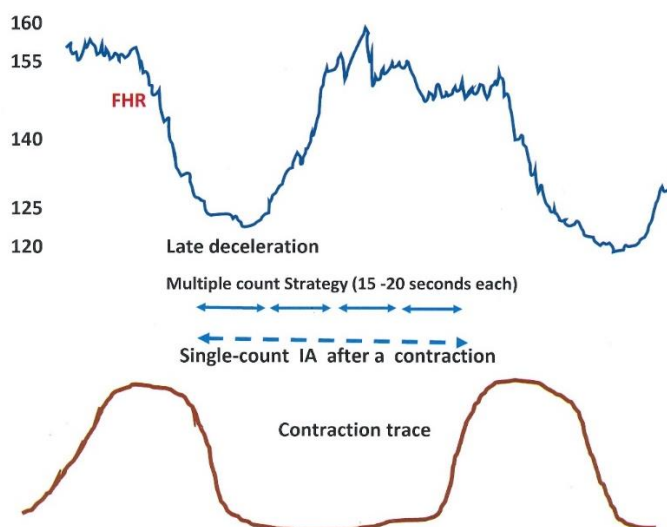


Figure 1: Schematic illustration of IA of FHR with late deceleration: Care is required not to mistake the recovering late deceleration as an acceleration. Actually, counting the fetal heart tones over 1 minute with a Pinard stethoscope or Doppler-device [2,26] will give a figure of about 140 bpm, not representative of the true baseline as well as the late deceleration. Even the cumbersome 'multiple-count strategy' is less accurate than simply observing the numerical

FHR display on the Doppler-device because the deceleration / acceleration is likely to spread across the two consecutive counting epochs of 15 or 20 seconds.

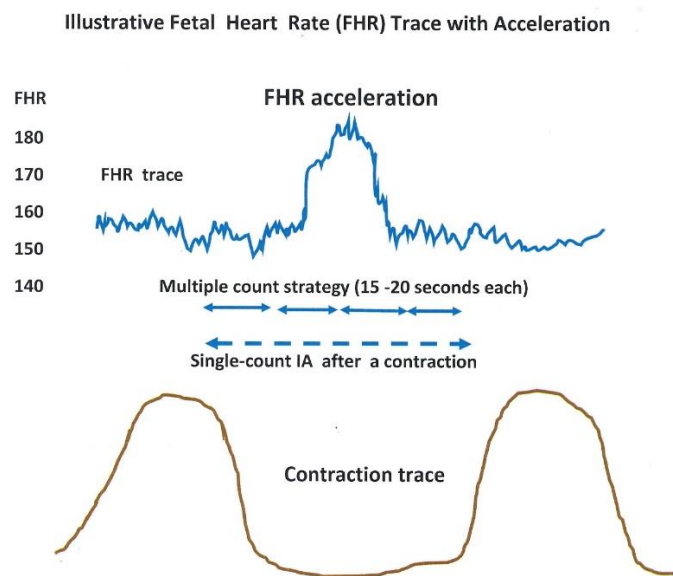


Figure2: Schematic illustration of IA of FHR with acceleration: An acceleration can be inferred when a rise of FHR of 15 bpm or more is observed on Doppler-device display, preceded by a normal FHR baseline and return to it after the acceleration. This is difficult to detect precisely while counting fetal heart beats over a minute. The total count spuriously gives an abnormally high figure (170 bpm) instead of a true baseline of 155 bpm.

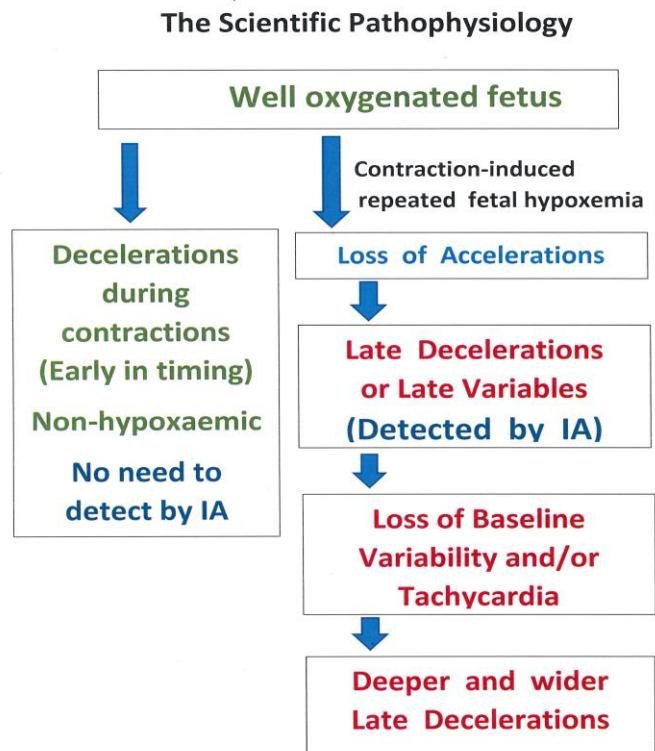


Figure 3: The most scientific pathophysiological model for detection of abnormal FHR patterns in the “Advanced Intermittent Auscultation” (AIA).

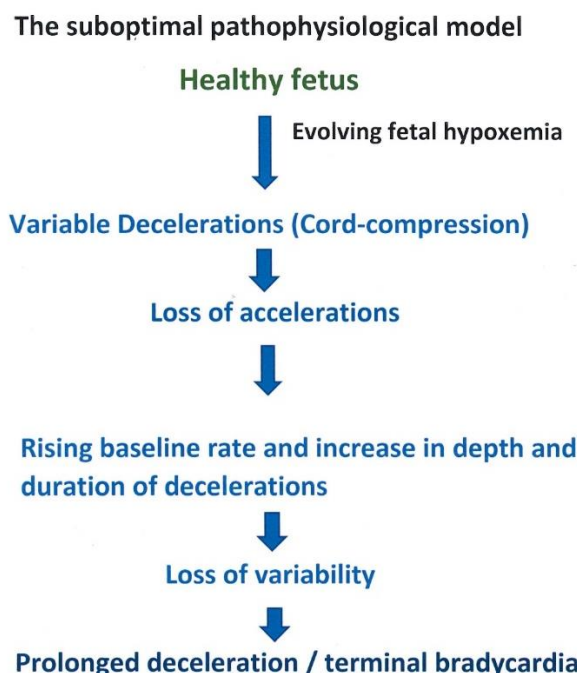


Figure 4: Erroneous pathophysiological model currently forwarded by some IA regimes [27]. Note that contrary to the belief above, variable decelerations i.e., cord-compression are not a common cause of fetal hypoxemia [31]. Instead, All IA regimes quite rightly aim to detect late decelerations or variables with late components only.

MUST FETAL HEART TONES BE ACTUALLY COUNTED? THE SCIENTIFIC EVIDENCE

Prior to 1990s, when 'Doppler FHR display units' were not available, there was no option but to actually count the fetal heart sounds with the help of a Pinard or common clinical stethoscope. However, the NICE (2014, 2019) and the 'intelligent IA' method (approved by the Royal College of Obstetricians and Gynaecologists, RCOG) continue to recommend that the heart tones must be counted even when using the modern hand-held Doppler devices [2,26,27]. In the UK, midwives who almost exclusively use hand-held Doppler monitors are currently mandated to actually count the fetal heart sounds ignoring the instantaneous and contemporaneous FHR digital display [2]. This may be because of strict adherence to the methodology of the 40-year-old Dublin RCT [17] when Doppler units were not available. The intelligent IA method mandates, "Count the fetal heart tones for at least a full minute and count the baseline, the steady rate, but listen for accelerations and decelerations" [26]. However, in the presence of periodic variations only a part of the one minute would be the 'steady rate i.e., the baseline'. Notably, then one hasn't really counted the steady rate (the baseline) separately at all but only the non-relevant average rate over the full minute (including any acceleration/ deceleration). This is clearly fallacious, unsatisfactory and contrary to basic numerical intelligence.

Another common mistaken reason for insisting on actual count of fetal heart sounds in the UK [2,26,27] seems a major misconception regarding the accuracy of the FHR figure (beats/min) displayed on the Doppler device. A highly confused obstetric consultant from a teaching university hospital in London, with no practical experience in IA, recently commented in a peer review report, "I was taught not to rely on the number on the screen as the accuracy of this cannot be guaranteed. I discussed this with a group of about twenty midwives this week, and

none relied on the screen number alone as all had concerns about the accuracy of this". We are aware that the midwives would be wary of disagreeing. Such confident ignorance by an obstetrician has a deleterious influence on midwifery colleagues and patient care which is highly lamentable. The clinical hand-held monitors use the Doppler technology of the same accuracy as that for the CTG machines. Exactly the same FHR read-outs on the Doppler display screen are plotted on the CTG paper - which is the accepted common gold-standard accurate continuous record of FHR. Most importantly, a clinical trial published in a leading American Journal concluded, "The accuracy of the heartbeat monitor was excellent compared with cardiotocography, with mean difference of -0.3 bpm only and 95th centile difference between -1.6 (CI -2.0 to 1.3) and $+1.0$ (CI $0.7-1.4$) bpm, with intraclass coefficient 0.99. The FHR was detected on all occasions" [28]. It would be impossible to confirm an exact match but these results are compatible with a precise match. This should reassure maternity regulatory organizations in the UK not to mandate the grass root midwives to perform a laborious and meaningless count currently based on a serious misconception. Very rarely there can be difficulty in picking up FHR which is precisely same for both the hand-held Doppler device and the CTG. Midwives are well versed in dealing with these difficulties appropriately.

Subsequent to a recent publication that challenged the single count over a minute and debated multiple-count method [25], the Oxford based 'intelligent IA' team modified their recommendations to suggest that a multiple-count method counting heart sounds in separate 15 seconds epochs (and estimating FHR as beats/min) for 1 minute should be undertaken [27]. This was indeed the first author's practice in late 1980s but only because the hand-held Doppler monitors were not available. With the advent of Doppler monitors the highly laborious and relatively inaccurate multiple-count technique is now very much redundant. Moreover, it would be near superhuman to do this every 5 minute in the second stage of labour whilst providing effective care and support to the woman. Indeed, the Oxford experience showed that 50% of birth-attendants found the 'multiple-count method' very difficult [27]. It is not surprising that the 'multiple-count method' has not been practiced in the UK in the last 2 years or before that. Quite rationally, in the rest of Europe, Australia and New Zealand, the fetal heart sounds are not actually counted while using the Doppler monitor, only the displayed FHR is observed (personal communication with professor of Midwifery Ellen Blix, Oslo Metropolitan University and senior Australian midwives). Now is the appropriate time for the NICE, RCOG and the Royal College of Midwives (RCM) to acknowledge and adopt the AIA guideline [16] which is further explained in this paper.

WHAT REGIMES ARE CURRENTLY TAUGHT OR PRACTICED?

In the United Kingdom, NICE guidelines [2] mandate actual counting of FH sounds for one minute after a contraction which should be documented as a single figure (presumably baseline FHR). The mandated frequency is every 15 minutes in first stage and every 5 mins in second stage of labour. The 'Intelligent IA' adopted by the RCOG and RCM also insists on actual counting, erroneously asserting that IA is in fact 'a skill in counting' [26,27]. In Australia, the Royal Australian and New Zealand College of Obstetricians and Gynaecologists [4] has made consensus-based recommendations: IA must be performed with a technique that can accurately measure the fetal heart rate in the individual woman. In practice, there does not appear to be any consistent method taught/followed. Each auscultation episode should commence toward the end of a contraction and be continued for at least 30-60 seconds; every 15-30 minutes in

the active phase of the first stage and with each contraction or every five minutes in the active second stage of labour.

Most IA guidelines and scoping reviews state that the Doppler device and Pinard stethoscope as equally reliable and one does not offer any benefit over the other [2-6, 8,9,26]. This seems to contradict the practical knowledge and experience of the midwives. Furthermore, it is often mistakenly stated that IA cannot determine the type or shape of decelerations [3, 27]. This is untrue because IA detects decelerations after contractions, hence these are by definition 'late' decelerations as opposed to the decelerations during contractions (early) which IA does not aim to detect as they are because of non-hypoxemic reflexes like head-compression (figures 3 and 4) [29]. Mr Austin Ugwumadu (St Georges Hospital, London) and his colleagues have been for many years prominently engaged in a 'flat-earther-style' denial of early or head-compression decelerations. Instead, they are promoting a 'pathological' (i.e., false) science that all FHR decelerations are due to fetal hypoxemia [29]. A young midwife recently commented on a labour ward round, "There are recurrent decelerations during contractions on CTG in this patient, but they are all benign and are due to the rapid descent of the fetal head". When questioned why she thinks the rapid descent of head should cause benign nonhypoxemic decelerations, she felt embarrassed because she was falsely indoctrinated during her training that benign head-compression decelerations simply do not occur. But she knew and judged better, just like most other birth-attendants [30]. Secondly, FHR decelerations do not have an inherent real shape. The shape generated on a recording-strip is determined by the horizontal and vertical scale of the CTG paper especially the recording speed. For example, the same 'rapid' decelerations on a British/Australian CTG would look 'gradual' on an American CTG. The many inconsistencies and sheer contradictions about the relationship of shape of decelerations (on CTG) to presumptive aetiology as well as pathophysiology make 'shape' a flawed, highly confusing and invalid concept [31]. Hence, the proposed updated NICE (2022) guidelines fortunately do not include any 'shape criteria' in the definitions of FHR decelerations. It has been said, "A set of beliefs (framework) that includes a contradiction can be deployed to deduce anything and is perfectly useless" [15]. Intelligence is a very diverged entity and generally divided into nine different types (Howard Gardener) [32]. AIA attends to the basics of the relevant type namely the 'logical-mathematical' intelligence (i.e., number/reasoning compliant) unlike some others (Figures 1 to 4).

LAUNCH OF "ADVANCED INTERMITTENT AUSCULTATION (AIA)" MODULE

Given the inconsistency of practice and the drawbacks of current IA regimes, a user-friendly and more accurate / reliable regime of IA with a training module has been launched incorporating the advantages created by the Doppler monitors [16]. The characteristics of the AIA are:

1. It is simple and less effort-intensive thus facilitating more holistic midwifery care,
2. It focusses on a limited number of crucial FHR parameters,
3. It encourages advantageous and preferred usage of Doppler monitors,
4. It provides practical new skills to judge the FHR baseline variability,
5. It enhances the accuracy and reliability and thus patient safety.

ADVANTAGES OF THE DOPPLER DEVICE FOR AIA

This may be preaching to the converted because the birth-attendants are already very familiar with the following advantages of hand-held Doppler monitors with a digital FHR display. They

are user-friendly and labour-saving, and provide an accurate and instantaneous concurrent FHR reading. They inform (display) the temporal variation in FHR. One can also better hear these FHR variations when not distracted by the laborious task of actual counting. The true FHR baseline can be more reliably ascertained. Furthermore, where necessary, the auscultation duration can be flexibly extended to as long as required and the auscultation can be easily repeated (non-tiring). Elimination of the need to perform manual count spares midwives' attention-bandwidth facilitating better information-processing of the FHR variations, decision-making and the provision of other aspects of intrapartum care. It is also often reassuring and anxiety-reducing for mothers to hear the fetal heart sounds when normal. Extension of the skill set to rule out an abnormally low baseline variability is feasible with AIA using Doppler monitors as discussed later (studies are currently underway in UK and Australia).

WHAT FHR PARAMETERS TO DETECT ON AIA?

The AIA aims to detect the FHR baseline and late decelerations. In addition, it may be possible to rule out abnormally low baseline variability at the outset and then every 30 minutes or so (seen as a relatively fixed FHR rate on the digital display of a Doppler monitor). Accelerations should not be ignored but simply noted when present as they provide added reassurance. However, time and effort need not be spent to actively seek accelerations. This is because the absence of accelerations alone does not need any action as it is not considered abnormal or suspicious even on CTG. All national guidelines [2-6] state that the absence of accelerations and/or presence of early decelerations is unlikely to be associated with fetal compromise when occurring in isolation [2-6].

The detailed guidance on how to detect the various FHR parameters can be found in the AIA training module [16]. AIA, in common with all other IA regimes, does not aim to detect out of the blue prolonged bradycardias. Non-recovering isolated prolonged bradycardia would be incredibly rare in low-risk labours and could be missed by auscultation even every 15 minutes. However, the British Guideline-makers (NICE, RCOG, RCM) could/should approve AIA selecting an auscultation frequency of every 15 minutes in the first stage and every 5 minutes in the second stage of labour, if that remains the consensus in UK. However, the practicality, burden and necessity of such frequent IA assessments need to be deliberated.

HAZARDS OF ADDING ADDITIONAL UNPROVEN FHR PARAMETERS

The main virtue of IA is its simplicity which is responsible for its lower operative delivery rate at the same time maintaining safety during low-risk labours. Hence, AIA maintains that any extra FHR parameters should not be added without substantial evidence and justification. The Law of Parsimony or Occam's razor is a well proven / accepted principle (though not an absolute rule) that if something can be achieved equally well with fewer presumptions and considerations, then that approach is right and more appropriate compared to the other more complex or multifaceted approaches [33]. Unwarranted complexity can engender cognitive overload and information-misinterpretation. This can already be seen happening in the case of CTG as discussed next.

A prominent British study of 19,460 babies analysed perinatal outcomes in 1998, introduced team based CTG training in 2000 and reanalysed outcomes in 2003 [34]. Infants born with 5-minute Apgar scores of < 6 decreased from 8.7 to 4.5 per 1,000 births ($P < 0.001$) and those with all grades of hypoxemic ischemic encephalopathy (HIE) decreased from 2.7 to 1.3 per

1,000 births ($P = 0.032$) [34]. This seems a fairly unique example of a large, good quality empirical study showing excellent clinical outcomes with CTG as well as sustained improvement with training. The British CTG interpretation system at that time comprised of purely timing-based pattern-recognition of FHR decelerations namely early (majority), late and variable (minority) [29,31,34]. The UK adopted a contradictory pattern-recognition consisting of majority variable decelerations in 2007 [2,31]. Since then, despite over a decade of increasing training, resources and practice-improvements, the incidence of HIE (all grades) is currently many times worse compared to 1998 – 2003 [29]. Some obstetricians demand to introduce more complex CTG interpretation algorithms arguing that CTG currently does not detect brain damage due to stroke and infection (a tenuous link). Primary vascular stroke in fetus is virtually unknown, almost all cases of intraventricular haemorrhage with or without intracerebral extension, arise due to severe prolonged hypoxia – which the CTG is aimed to detect. For many decades, birth attendants have taken into account concurrent background risk factors to determine the significance of any CTG abnormalities and the urgency of intervention. New complicated CTG algorithms incorporating several varying degrees of fetal and maternal risk factors are being proposed but their results are unknown and need to be proven. These may need some form of computerized decision making which remains vexed. Furthermore, these algorithms may substantially swell the ‘false positives’ leading to further dissatisfaction, and paradoxically increase the need and extent of subjective decision making.

A few recent IA regimes propose detection of additional FHR parameters like ‘post-deceleration overshoots’ and ‘fetal cycling’ [26,27,35]. The advisability of such increments must be considered in the context of the discussion in the preceding paragraph. The concept of ‘post-deceleration overshoots’ comes from repeated prolonged cord-occlusion studies in laboratory animals, which cannot necessarily be applied to human fetus or labour [29,30]. On the other hand, rigorous clinical studies in human labour have shown ‘post-deceleration overshoots’ to be of no predictive value [36, 37]. Fetal cycling (alternate sleep and awake cycles) is not a useful or integral part of the current CTG interpretation frameworks and hence must not be added to IA regimes. Prolonged reduced variability on CTG is abnormal, but an ‘absence of a sleep or resting phase’ has no significance on a CTG. Hence, detection of cycling is not a must and indeed would be unnecessary burden.

UNCOMPLICATED FHR BASELINE RISE BY 20BPM

Another very recent recommendation by NICE has been to consider a progressive rise in FHR baseline by about 20 bpm (but still in the normal range) without any other FHR abnormalities during labour to be ‘abnormal’, hence IA will need to be escalated to CTG [38]. Although the evidence for this is not quoted [38], it is now adopted as a part of AIA at least in the UK. It seems reasonable to consider that a ‘degree of rise in baseline’ could be more relevant than a general cut-off of 160/min. The experience (practicality and usefulness) of adopting this criterion as a ‘suspicious’ in 1st stage and ‘pathological’ in 2nd stage on CTG will become clear in the next few years. Controlled clinical studies would be valuable to determine the positive and negative predictive value for detection of hypoxic adverse fetal outcomes of the rise of FHR baseline by 20 bpm on CTG (within the normal range without pathological decelerations or low baseline variability) especially in the second stage. A concern to be watched on CTG is the possibility of weariness, distraction and fatigue from increased false-alarms. On the other hand, the aspiration to keep caesarean rate below 30% doesn’t exist anymore. The usefulness of ‘20 bpm’ criterion in low-risk labours undergoing IA is not known. However, we acknowledge that

this criterion will become a required practice for CTG in the UK and consequently for IA; and hence is incorporated in the AIA in the UK for the time being while awaiting further experience. When suspected, the rise of baseline by 20 bpm should be confirmed by more frequent auscultation over 15 minutes during AIA. The downside is that more women will be escalated to CTG. The FHR baseline is known to commonly rise and/or fall temporarily for periods of time during labour (e.g., sleep-wake-activity cycles). Hopefully, some cases may be reverted back to IA if the baseline settles. The recommendation regarding 20bpm rise in FHR baseline seems to have come from retrospective investigations by the RCOG's 'Each baby counts' initiative and the Health Service Investigation Branch (HSIB) into the cases of severe birth asphyxia in UK. Such post-hoc analyses (unblinded uncontrolled retrospective methodology) of adverse events can contribute important learning lessons, but caution is required to distinguish noise from true signal [39]. The practical experience in next few years will shed some light on this aspect.

ASSESSING BASELINE VARIABILITY

Traditionally, the IA is not meant to pick up abnormal or low baseline variability. Some IA regimes [26,27] claim to detect 'baseline variability' in their goals, but it is not seen to be materialized. It is sometimes misconstrued that counting FHR in epochs of every 5 seconds could detect baseline variability. A quick calculation on the back of an envelope shows that this is not possible by counting. Suppose the baseline changes by 8 - 10 beats/60 sec (normal variability). The difference in the beat count over 5 seconds will be $8 \div 12$, which is less than 1 beat difference in 5 seconds. Moreover, the baseline may change in both directions thus cancelling out the difference in the count. Thus, no amount of actual counting of heart-tones, even in consecutive short, time-epochs, can give dependable or truthful measure of baseline variability. However, for the first time with the advent of digital displays of instantaneous FHR on Doppler-devices, it is possible to make a fair judgement about the FHR baseline variability. The birth-attendants can see the FHR number varying on the screen-display and could assess if it has varied by 5 beats or more excluding the periodic changes (accelerations or decelerations). Not having to actually count or perform complicated mental arithmetic of multiple-count method is important if birth-attendants seek to develop and practice this additional skill. Simple studies of interpretation of video-recordings of FHR number display on CTG or Doppler device are very feasible in this regard. Currently, guessing / suspecting low baseline variability could be adopted as an informal, if not mandatory, aspect of AIA. In low-risk pregnancies and labour, it would be extremely rare for the fetus to have low baseline variability especially if the mother has been experiencing adequate fetal movements before labour. One of the major advantages of the 'Advanced IA' is that it can facilitate suspicion of persistent low baseline variability prompting switch over to CTG. Many units practice an 'admission CTG' as a local preference, which could become unnecessary with 'AIA'.

IA WHEN DOPPLER MONITORS ARE NOT AVAILABLE

Fortunately, the Doppler monitors have become cheap and are widely available even in resource poor settings. In the rare situation of lack of Doppler monitors, a Pinard stethoscope or the bell end of a common clinical stethoscope should be used to listen and count fetal heart tones. When the experience of 'multiple-count method' is lacking, a single count method could be practiced as a compromise. It gives a rough estimation of the FHR baseline and any decelerations could be subjectively "heard" or assessed. However, the role of fetal monitoring in these situations seems limited because of constraints on timely transfer, access to modern

maternity units, lack of safe operative delivery and the low specificity of intrapartum fetal monitoring itself.

CONCLUSIONS

The Advanced Intermittent Auscultation (AIA) regime and training module [16] is designed for midwives, obstetricians and their Professional bodies to enhance the ability to deliver safe effective care to mothers and babies. The AIA adopts a broad evidence-based approach - assimilating clinical studies, published literature, and a critical analysis of birth-attendants' knowledge and experience. It maximises the potential of hand-held Doppler monitors by simply observing the digital FHR display to improve the detection of crucial FHR variations. It opens the innovative possibility of the detection of baseline variability in future. It preserves the simplicity and benefits of IA without the burden of unproven additions while improving its accuracy and safety. In the UK, the Each Baby Counts (EBC) 2020 Final Progress Report states that the rates of stillbirths, neonatal deaths and brain injuries suffered during childbirth at term during the last four years of the programme have remained 'stubbornly static' [40]. This is despite the multitude of initiatives and interventions by National Health Service (NHS) organisations including the EBC. The goal and commitment by the NHS to halve the perinatal mortality by 2025 compared to 2010 remains quite elusive. The recent intrapartum fetal monitoring guidelines by NICE (2022) now categorise FHR decelerations purely based on time-relationship to contractions which corrects the previous false pattern-recognition of the FHR decelerations [31,38]. Similarly, the NICE and RCM should adopt the more scientific and safer regime of AIA [16], essential to bring about the desired improvement in perinatal outcomes which will of course take a few years to materialize.

'AIA' is comprehensive regime for worldwide intrapartum care including the UK, Europe, Australia, New Zealand, Canada and Americas. AIA should be approved and adopted by national professional bodies and guideline-makers.

Declaration of interest

The authors have no conflict of interest to declare. Some of the contents of the article are individual opinions only of one or both authors; and may not necessarily reflect current teaching or practice. **The first peer-reviewed version of this article was published in June 2022 which is accessible on ResearchGate [41].**

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