Intermittent auscultation (surveillance) of fetal heart rate in labour: A progressive evidence-backed approach with aim to improve methodology, convenience, reliability and patient safety.

Shashikant Sholapurkar[1]

[1]Royal United Hospital NHS Trust

May 22, 2020

Abstract

Continued instances of serious birth asphyxia following intermittent auscultation (IA) need not wholly imply inherent limitations. This review uses analytical modelling to establish a safer and improved regime. It demonstrates that the Doppler-device is superior to Pinard stethoscope, with observation of the numerical read-out of fetal heart rate (FHR) from the later part of contraction till the onset of next contraction. Current recommendation of actually counting heart tones for 1 minute has many fallacies. IA should focus on the baseline FHR and late decelerations. Detection of additional FHR changes like accelerations, overshoots or cycling is cumbersome and adds little value.

Introduction

Intermittent auscultation (IA) of fetal heart rate (FHR) is approved for fetal monitoring in low-risk labours in most developed countries.[1-4] In the UK it is expected that up to 50% of women may have IA.[1] However, IA as well as cardiotocography (CTG) are often criticized as 'evidence free zones.' Consequently, a small number of sceptics demand abandonment of CTG itself, [5] not a practical prospect for very good/valid reasons. There are many more detractors of IA (personal communications) who question the few randomised controlled trial (RCTs) showing equivalent outcomes with IA and CTG. The gold standard of evidence in medicine remains RCTs. But, very large studies required for definitive guidance for IA are unlikely to come. As a result, there has been proliferation of several different regimes of IA.[1-4]Instances of serious intrapartum asphyxia continue to occur despite complying with the recommended regimes [6] highlighting the scope and need for improvements. A recent comprehensive systematic review of 26 studies and 11 guidelines concluded that the optimal regime of IA (frequency, duration, method) remains unproven.[7]Similarly, many other systematic analyses have failed to provide practical suggestions for improvement.[6]

Empiricism remains at the heart of science and statistics is said to be its grammar. Interestingly, 'thought experiments' have contributed to many major advances, not just in physics. Critical thinking is now considered at least as important as the statistical tests.[8] This review is not based on anecdotes but evaluates IA regimes and possible improvements by detailed modelling and reasoning, consistent with methods adopted in many consensus guidelines.[1-4] Any evidence when available is supplemented with experience and observational knowledge gained from CTG. The focus is on the actual method of IA only. Other aspects of IA are outside the remit. Some of the discussion may appear very simple, obvious and intuitive, but still needs to be presented for reflection and bringing about practical improvements.

Intermittent Auscultation or Intermittent FHR surveillance?

The question may sound strange. IA is an old term when fetal heart rate (FHR) could only be listened to and counted with stethoscope. Moreover, the very early hand-held Doppler-devices produced only audible tones

but no numerical readout of FHR. But for the last 25 years the Doppler-devices continuously display the instantaneous FHR as beats per minute. Hence, this very basic facility means that it is not a must to actually count the fetal heart tones anymore, even if or just because we continue to use the old term 'auscultation'. Is it really worth changing the terminology of IA to something like 'intermittent FHR surveillance/observation'? Thus, the idea that IA must involve the skill in listening and actually counting sounds[9,10] is out-dated and best discarded. For example, a proposed 'intelligent IA' states, "In conclusion, the recommendation should be to listen for at least a full minute and count the baseline, the steady rate, but listen for accelerations and decelerations." A bit of detailed consideration reveals this foundational recommendation to be full of contradictions (hence void). If one actually counts for one minute, it is not possible to know in advance whether one is starting with a late deceleration or one is going to encounter an acceleration. Moreover, after 'listening' to a deceleration or acceleration, only a part of the one minute (not counted separately) would be the 'steady rate i.e. the baseline'. Then one has not really counted the steady rate separately at all but only the average rate over the full one minute (including the acceleration/deceleration). Extending beyond one minute would require restarting the count from zero again and deciding when to stop counting (when will one be satisfied that one has managed to count the steady the steady rate separately, how?). It is far more accurate, reliable and convenient to simply watch the FHR numerical display on the Doppler-device and observe the FHR figure accelerate or decelerate (approximately how much as well) or remain steady during the entire or part of the duration of auscultation (a minute or flexibly more as much as required).[6] One can decide which part of the observation showed the steady FHR most likely to represent the baseline. In presence of late decelerations or accelerations, the baseline rate is likely to be observed a bit before or during early part of the contraction.[6] Many guidelines (wrongly) persist with the preoccupation of actually counting the fetal heart tones[1,2]; while the WHO guidelines[11]ambiguously mention, "Each auscultation should last at least 1 minute; if the FHR is not always in the normal range (I.e. 110-160bpm), auscultation should be prolonged to at least three contractions." Clearly, the paradox is that one can confirm FHR to be always in the 110-160 range during the auscultation period only by looking at the actual numerical FHR display on the Doppler-device or by a complicated 'multiple count strategy'[4] but not at all by simply counting the fetal heart tones for 1 minute or more.

What FHR abnormalities should IA detect?

It is important to remember that the main asset of IA is its "simplicity" arising from the deliberate intention to detect a limited number of most important FHR abnormalities in low risk cases. This also accounts for its advantage over CTG namely lower medical/operative intervention. Occam's Razor (law of parsimony) is a well-established scientific principle implying that (unnecessary) complexity burdens practitioners of science reducing validity and performance.[12,13] Clinicians facing complex multi-faceted problems need to make optimum use of their attention 'bandwidth' to minimise errors and facilitate appropriate timely decisions. Midwives need to be able to devote more time and attention to broader holistic care to normal women in low risk labours. Hence, the safe practice of IA stemming mainly from the British obstetrics aimed to detect the two most important FHR parameters namely the baseline and late decelerations, as the latter generally have the most significant correlation with fetal hypoxemia/acidemia.[1] This has been the reason for traditional recommendation of FHR auscultation for 1 minute immediately after a uterine contraction.[1-3] The detailed information/accuracy gained from CTG cannot be expected from IA and indeed seems unnecessary at least in low risk cases as a pragmatic compromise.[1-4,6] There is good agreement that IA is not expected to detect baseline FHR variability.[1-4]Descriptions like 'timber, strength and cadence' of fetal heart sounds[7] with Pinard stethoscope (or Doppler-device) have been rightly confined to the history. Significant rhythm irregularities easily heard are obvious exception. Specific detailed explanation about how to detect the two abnormalities by IA guidelines would bestow added confidence and assurance to the nurse-midwives.

Pros and cons of additions like 'Intelligent' IA

Recently, there has been a tendency to demand detection of more and more FHR variations.[9,14] These can be shown to add complexity without even theoretical benefits. One proposed 'intelligent IA' (in addition to flawed recommendation of actual 'counting') lumbers additional unproven burden of actively seeking

FHR accelerations (following fetal movements or vaginal/abdominal examination etc.); and failing that unnecessarily switching over to CTG.[7]But, the absence of FHR accelerations (especially in low risk cases) is not in itself pathological even on CTG and hence doesn't warrant commencing CTG in the first place.[1-4] Thus, one can safely await detection of late decelerations on IA. Hence, accelerations need not be actively sought but noted when present only to differentiate the FHR baseline from them. There is further confused belief that the type of deceleration cannot be ascertained on IA.[9,14]When auscultation is only performed towards the end and after the uterine contraction, the decelerations detected lasting beyond the contractions are of 'late' type by definition.[1,6,15,16] Another recommendation to detect 'post-deceleration overshoots' [14] seems a burdensome distraction, because these are very rare and inconsistent late features of fetal acidemia even on CTG to be clinically useful.[17] A high-quality study of 5388 women showed that out of 57 babies with cord blood arterial pH below 7.10, none showed post-deceleration overshoots during labour.[17] Hence, it would suffice just to detect late decelerations and not get distracted hearing for overshoots. Suggestion to look for quiet and active epochs (cycling) of FHR [14] for reassurance seems equally impractical, unproven and un-actionable. The concept of rise in baseline (within normal range) FHR during labour as an abnormal finding[9] seems to come from uncontrolled unblinded retrospective reviews of known cases of birth asphyxia with its positive predictive value unknown (in the absence of persistent late decelerations). Such creeping additions without good evidence would increase switch over to CTG and medical intervention.

Trace Display Doppler Monitors

Recently, more advanced handheld Doppler FHR monitors provide numerical readouts as well as 'FHR trace display'. The intermittently recorded FHR traces could be replayed during labour and downloaded onto computers for archiving. It would be tempting to assume that the 'FHR trace display' must be a definitive advantage. However, the main advantage of IA is its simplicity and practicality in midwife-led units, home births and rural settings. Moreover, trace recording and archiving is likely to exponentially increase (rather than decrease) the medical litigation as happened with CTG. It appears that the trace-display Doppler-device is an unsatisfactory half-way house between IA and CTG.[18]

Detecting FHR baseline and late decelerations with IA

(dispensing preoccupation with actual 'counting' for 1 minute)

Notably, there isn't detailed guidance on detecting the baseline FHR and decelerations reliably on auscultation over 1 minute or more, which is quite different from assessing it on CTG. This is demonstrated in very simple schematic illustrations (Figures 1-3), although intuitive, need to be presented for reflection. Guidelines [1,2] loosely recommend "counting fetal heart-beats for 1 minute and documenting it as a single figure as the baseline FHR." Some authors have claimed that midwives mistakenly write a very wide (or entire) range of FHR observed as the baseline e.g. 130-146.[10] But, this is not at all the experience in UK and seems underestimation of midwives' ability. British midwives have been documenting a narrow range of FHR baseline (e.g. 120 -125/min) with comments as accelerating to 140 /min.[6] Paradoxically, replacing observation of numerical display by an actual count over 1 minute (which may have no relation to the baseline, see figures 2 and 3) is a flawed unwise retrogressive step.[1,2,9,10] Any challenge to this retrogressive advice is further countered by an argument that there is no evidence to recommend Doppler-device instead of Pinard stethoscope, a mistaken simplistic interpretation in systematic reviews and guidelines.[1,2,7] It is far more reliable and accurate to carefully observe the temporal FHR numerical readouts on the Doppler-device and then select an approximate single figure representing the average baseline.[6,18] FHR baseline in reality is not a single figure but could be written as such.

Place for Figures 1, 2, 3

A deceleration can only be imprecisely/subjectively suspected on 'Pinard auscultation'; unless one is estimating FHR using 'multiple count strategy'. This involves counting heart beats separately for every 10-15 seconds segments during the period of auscultation which is a sound recommendation by the American College of Nurse-midwives (ACNM).[4] This 'multiple count strategy' is certainly possible (was author's practice) but difficult; hence rarely practiced if at all. However, this cumbersome practice becomes completely

unnecessary where Doppler-devices are easily available which are designed to display temporal variations in FHR. A review article in 2015 highlighted that even with a Doppler-device, special care needs to be taken in detecting late FHR decelerations because the trough of the deceleration may have already passed and the recovering FHR (often in the normal range) immediately after the contraction have been misinterpreted as 'accelerations' leading to procrastination until the decelerations become severe.[6,18] This may be the likely cause of presumed unexplained birth asphyxia after an apparently normal IA documentation.[6] Following these findings, the Royal College of Obstetricians and Gynaecologists (RCOG) and Royal college of Midwives (RCM) are implementing a practice change to commence auscultation towards the end of the contractions (unpublished RCOG and RCM document). Unfortunately, this has been implemented with an erroneous advice that auscultation for 30 seconds after the contraction would suffice with total 1 minute of counting (unpublished document); obviously because of preoccupation with 'counting' fetal heart tones. However, extending auscultation to onset of next contraction would be safer, because in the presence of late decelerations or accelerations, the accurate baseline is best ascertained by observing the FHR display on the Doppler-device just before or at the onset next contraction.[6] Additional safeguard would be to confirm acceleration only when preceded and followed by a normal baseline. The Doppler-device easily allows extension of the auscultation period very flexibly beyond 1 minute which seems crucial in confirming periodic FHR changes (figures 1-3). In contrast, the act of counting heart beats with Pinard stethoscope reaches its natural but arbitrary end at 1 minute and could unwarily preclude further flexible extension. Thus, the Doppler-device FHR display has a major advantage over 'Pinard' in discerning both the meaningful FHR baseline and periodic changes most importantly the late decelerations.

Doppler-device versus Pinard stethoscope: Evidence from RCTs

In addition to the practically perceived accuracy, the hand-held Doppler-device has additional advantages of ease, simplicity and reassurance to the mother of hearing the fetal heart sounds. Why do then guidelines [1-4,11] maintain that that the Doppler-device or Pinard are equally preferable? Indeed, a systematic scoping review of many aspects of IA was unhelpful for practice improvement but highlighted only one conclusion namely "there was no evidence to recommend Doppler-device instead of Pinard".[7] But is this sole conclusion valid? Is the evidence judiciously interpreted and then appropriately applied? Does statistics often leads scientists to deny differences that are clear to see or experience?[8,19]

There are four RCTs of "Doppler vs Pinard" including 8436 women, all from African countries.[7,20-23] In three studies the facility of CTG was not available/used at all.[20-22] In contrast, CTG is the recommended recourse after abnormal IA in developed countries to optimise perinatal outcome.[1-4] Only one study [23] from a teaching university hospital had CTG facility available (for a separate group); but it appears that the Doppler and Pinard groups did not have CTG after detection of abnormalities on IA. The perinatal outcome was much worse in the Pinard than in the Doppler group (neonatal convulsions 6 vs 0, hypoxic encephalopathy 7 vs 1, perinatal mortality 5 vs 2), but the differences were not statistically significant due to small patient numbers (312 and 310) in the two groups.[23] Most importantly all four study protocols only required detection of FHR baseline in the abnormal range (<120 or >160 beats/minute); but the detection of late decelerations was not required/advised.[20-23] This was indeed the standard recommendation by the World Health Organisation (WHO) when these RCTs were performed.[24] This recommendation has only recently been upgraded by the WHO [11] to include decelerations thus making these RCTs [20-23] outmoded. The main perceptible advantage of Doppler-device is the improved detection of FHR decelerations. Thus, for reasons above it can be concluded that the results from these African RCTs[7,20-23] cannot be extrapolated to the obstetric practice in developed countries.

Doppler-device versus Pinard stethoscope: A Bayesian approach

Even if one insists on following the statistical proof from RCTs above, a Bayesian approach is preferred by many clinicians and statisticians.[19] Well-held persuasive prior beliefs/knowledge will move little in the light of weak or equivocal new evidence. Bayes' theorem [19] states,

The initial odds for a hypothesis x The likelihood ratio (from new evidence) = The final odds for the

hypothesis

If the initial odds for preferring a Doppler-device are quite high, multiplying by the likelihood ratio of "1" from (invalid) evidence of equivalence would not change those high initial odds at all.

Future developments

It could be argued that to reliably detect FHR baseline and decelerations, it may be better to perform IA after two or three successive contractions which would take about 10 minutes. The IA frequency can then be safely decreased to every 30 minutes or so during the first stage of labour.[25] There is an option of performing IA from before and through the contraction until the beginning of the next contraction (a full cycle). But, then the midwives need to be empowered to ignore the FHR decelerations (if auscultated) which are concordant with contractions recovering by the end the contraction; as these non-hypoxemic decelerations are currently quite rightly ignored with the most guidelines of IA anyway.[1-3,6,25]

Recommendations and conclusions

The case selection criteria for IA and actions on abnormal IA have been well described in most guidelines.[1-4] However, the advice on the method of IA has potential to be improved to avoid serious mistakes.[6,25] IA should now be regarded as 'intermittent FHR surveillance' and best not necessitate actual counting.

1. When only Pinard stethoscope is available for IA (e.g. in resource-poor countries), the 'multiple-count' strategy[4] is more accurate to detect FHR changes. If this is impractical then a single count monitoring could be practiced. With unavailability of CTG and much higher burden / importance of maternal, neonatal and infant care, intrapartum fetal monitoring (IA) has a different/lower priority in in many resource-poor settings.

2. Actually counting the fetal heart tones with a Doppler-device[1,9,10] seems an unnecessary, unsafe and retrograde step.[6] Guidelines should now recommend preferential use of Doppler-device (when available) for IA, starting auscultation i.e. observation of numerical FHR display in the later part of the contraction and continuing up to the onset of next contraction rather than just 1 minute. The baseline FHR and decelerations can be best inferred from the instantaneous FHR read-outs on the Doppler-device rather than actually counting the fetal heart tones. The maternal pulse should be briefly felt to differentiate from FHR.

3. Specific guidance would be valuable regarding judgement of FHR baseline (approximate single figure) especially when accelerations and decelerations noted on Doppler display as described in this article. The pitfall of missing a recovering late deceleration during the early phase of auscultation[6] needs to be highlighted in the British and other guidelines to enhance patient safety.

4. Simple time-line analysis reveals that it is practically near-impossible to perform IA every 15 minutes in first stage without fail. But, failure to do so can be considered negligent practice. About 5-10 minutes would be required every time for IA and some more for documentation and reflection. Guidelines should stipulate IA every 15-30 minutes during first stage and every 5-10 minutes in second stage.[2,25]

5. It could only be briefly mentioned that the findings of IA need to be interpreted in the context of clinical picture as IA is being practiced mostly in low risk clinical picture. Any persistent abnormalities on IA despite conservative measures need escalation to CTG monitoring.

Acknowledgements: The author is grateful to the midwives in his institute and other hospitals who have always showed keen interest and willingness to share their wisdom and experience in intermittent auscultation and CTG.

Declaration of interest: The author has no conflict of interest or funding to declare. The article is based on author's hands-on experience of IA for 8 years, followed by supervisory role for IA (Pinard / Doppler) and CTG experience for 25 years.

Contribution to Authorship: The author conceived the review, performed the literature search and wrote the contents.

Funding Statement: No funding was received for this manuscript.

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Legend to figures

Figure 1 (Illustration 1)

Without accelerations or decelerations, Doppler read-outs or 'FHR counted over 1 minute' will give reliable estimate of the baseline FHR. But, the effort of actually counting heart beats over 1 minute could compromise the special attention required to detect any decelerations recovering just after the contractions. Simply observing the numerical read-outs on a Doppler-device allows more attention to any temporal changes of FHR as well as very flexible extension of auscultation duration.

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Figure 2 (Illustration 2)

Schematic illustration of IA of FHR with late deceleration: Care is required not to mistake the recovering late deceleration for an acceleration.[6] Hence it is safer to start auscultation in the later part of contraction. Actually counting fetal heart tones over 1 minute with a Pinard stethoscope or Doppler-device[1,2] will give a figure of about 140 bpm not representative of the true baseline, with a significant risk of missing detection of the late deceleration and inability to easily and flexibly extend the auscultation duration.

Figure 3 (Illustration 3)

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/subjectively while counting fetal heart beats over a minute with Pinard stethoscope. The total count over 1 minute spuriously gives an abnormally high figure (170 bpm) instead of a true baseline of 155 bpm. Even the cumbersome 'multiple count strategy'[4] is less accurate than simply observing the numerical FHR display on the Doppler-device.

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