



Maternal “Oxygen and Fluids Therapy” to Correct Abnormalities in the Cardiotocograph (CTG): Scientific Principles vs Historical (*Mal*) Practices

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Author’s contribution

The sole author designed, analyzed and interpreted and prepared the manuscript.

Article Information

DOI: 10.9734/JAMMR/2020/v32i830460

Editor(s):

(1) Dr. Pietro Scicchitano, Hospital “F. Perinei” Altamura (Ba), Italy.

Reviewers:

(1) Rosete Nogueira, University of Minho, Portugal.

(2) Junaid Rafi, Ipswich Hospital NHS Trust, England.

Complete Peer review History: <http://www.sdiarticle4.com/review-history/57653>

Received 20 March 2020

Accepted 28 May 2020

Published 04 June 2020

Commentary

ABSTRACT

Some Guidelines on Cardiotocograph (CTG) trace continue to recommend the administration of oxygen and fluids to the mother to correct the abnormalities observed on the cardiotocograph. However, the fetus has a separate autonomic nervous system, blood volume, haemoglobin concentration, oxygen saturation and cardiovascular responses as compared to the mother. Therefore, administration of oxygen and fluids to the mother to correct observed “suspicious” CTG traces should be questioned in contemporary obstetric practice. This commentary examines the scientific principles and current scientific evidence on these historical practices, and all practising midwives and obstetricians should urgently review their individual clinical practice, based on the knowledge of anatomy, physiology and biochemistry as well as a critical review of current scientific evidence to prevent avoidable patient harm. Current evidence suggests that administration of oxygen to the mother, who has a normal oxygen saturation does not correct the observed abnormalities on the CTG trace, and it may in fact lead to harm. Similarly, administration of fluids (oral or intravenous) to a woman during labour who is not dehydrated or hypotensive may not only cause maternal dilutional hyponatremia and resultant complications, but also, it may cause neonatal convulsions. Women and babies expect every healthcare provider to practice evidence-based medicine during the intrapartum period, which is based on logic, common sense and robust scientific principles, irrespective of what is erroneously stated by some CTG guidelines.

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Keywords: Cardiotocograph; fetus; fetal hypoxic stress; hypoxic ischaemic encephalopathy.

1. INTRODUCTION

Cardiotocograph (CTG) trace was introduced into clinical practice in 1960s to recognise intrapartum fetal hypoxic stress, so that timely action could be taken to avoid hypoxic ischaemic encephalopathy (HIE) and its long-term sequelae such as cerebral palsy and learning difficulties, and/or perinatal deaths. Unfortunately, CTG trace was introduced into clinical practice without any robust randomised controlled trials, and therefore, it not only resulted in significant inter and intra-observer variability [1,2], it also contributed to confusion with regard to appropriate response to the observed CTG changes. Fetal pathophysiological responses to hypoxic and mechanical stresses were not well understood, and well-meaning midwives and obstetricians were coerced to use the CTG which was introduced into clinical practice without robust scientific evidence to confirm its effectiveness [3]. The lack of deeper knowledge and understanding of fetal pathophysiological responses to intrapartum stress amongst some clinicians who created various “CTG guidelines”, resulted in random grouping different features into different “categories”. This led to the creation of several confusing National and International CTG Guidelines, with different “reassuring” and “non-reassuring” features, and different classification systems (e.g. “Normal, Suspicious, Pathological”; “Normal, Intermediate, Abnormal”; “Category 1, Category 2 and Category 3” or “Normal, Reassuring and Non-Reassuring”).

Due to the lack of an in depth understanding of fetal physiology, several unscientific and illogical historical practices such as giving ice cubes to the mother “to wake the sleeping baby” by causing “shivers”, administration of oral and intravenous fluids to the mother to correct the observed “non-reassuring” features or “suspicious” CTG traces as well as administration of oxygen to the mother to treat ongoing fetal hypoxia, gradually emerged over the last 50 years. Although, the International Consensus CTG Guidelines produced by the International Federation of Gynaecology and Obstetrics (FIGO) in 2015 [4], and the first International Consensus Guidelines on Physiological Interpretation of CTG by 34 experts from 14 countries published in 2018 [5] actively discouraged against the use of maternal oxygen therapy, and the administration of oral and intravenous fluids of the mother to treat CTG

changes, very unfortunately, some national guidelines had continued to advocate maternal fluid therapy to correct the observed CTG changes.

The CTG Guidelines produced by the National Institute of Health and Care Excellence (NICE) in 2014, specifically stated “if there are concerns about the baby’s well-being offer *oral* and intravenous fluids” [6]. This recommendation (Reference 4, Page 458) was not only illogical and scientifically nonsensical, it could also potentially increase the risk of harm to both mothers and babies during labour. In fact, the latest “Early Notification Scheme Report” published in September 2019 by NHS Resolution has recently highlighted maternal hyponatraemia as well as fetal hyponatraemia and convulsions secondary to excessive maternal fluid administration during labour [7]. It is very unfortunate that the NICE Guidelines on CTG interpretation in 2014 continued to recommend “oral and intravenous” fluids to the mother to treat CTG abnormalities when there was scientific evidence in 2009 that suggested that excessive maternal fluid administration increased the risk of maternal hyponatraemia in approximately 26% of women [8].

In the light of recently reported adverse maternal and perinatal outcomes secondary to excessive maternal fluid administration to correct CTG abnormalities in the NHS Resolution “Early Notification Scheme Report”, it is important for midwives and obstetricians to understand the logical and scientific basis for the administration of intravenous and oral fluids or oxygen to the mother to treat the observed abnormalities on the CTG trace.

2. WHAT IS THE SCIENTIFIC RATIONALE OF ADMINISTERING ORAL AND INTRAVENOUS FLUIDS TO THE MOTHER TO CORRECT CTG ABNORMALITIES?

Midwives and obstetricians ought to be aware that physiological changes of pregnancy include approximately a 50% increase in maternal plasma volume, which results in the “physiological” ankle oedema during pregnancy. Therefore, a pregnant woman has excessive water-retention during pregnancy as compared to her non-pregnant state.

In addition, physiological changes in the urinary system results in an approximately 50% increase in the glomerular filtration rate (GFR). It is well-known that the frequency of micturition is increased during pregnancy due to this increased glomerular filtration rate (GFR).

Therefore, it should be of no surprise to any obstetrician or midwife who practices evidence-based medicine, and care for women during labour using scientific principles that the administration of fluids (intravenous or oral) to a woman with an excessive amount of water in her system as a result of pregnancy, is unlikely to be useful. If excessive water is administered to an adult who is not thirsty, it only increases the likelihood of increased micturition as the excess water is eliminated by the kidneys. Similarly, administration of fluids to correct CTG abnormalities, in the absence of maternal dehydration or hypotension, would increase the likelihood of the woman needing to go to the toilet to eliminate the excess of water that has been administered. The suppression of the antidiuretic hormone (ADH) as a result of excessive fluid administration would also reduce the plasma osmolarity and cause electrolyte abnormalities. The latter may result in unavoidable patient harm due to maternal hyponatraemia [7,8], and admission to the neonatal unit due to fetal hyponatraemia [7] and possible increased risk of neonatal convulsions. If excessive fluids are administered "to treat a suspicious CTG" in the presence of an ongoing oxytocin infusion, due to the ADH-like effect of oxytocin, these detrimental effects could be further potentiated.

In the presence of normal maternal blood volume, administering intravenous fluids to the mother in the mistaken belief that it would correct the observed abnormalities on the CTG trace should be considered as an illogical and insane action in contemporary obstetric practice. A fetus has a different circulating volume and fluid balance compared to the mother. One should not be surprised that scientific evidence has shown that administration of even *intravenous* fluids to mothers to correct CTG abnormalities during labour has been shown to be of no benefit [9]. Therefore, it is even more nonsensical that some clinicians continue with the historical unscientific practice of administering "cold" oral fluids to the mother to "wake the sleeping baby". Basic knowledge of physiology would indicate that as the "icy cold" water (or ice cubes, Lucozade, Coca-Cola, Pepsi-Cola or Fanta) would rapidly

achieve normal body temperature as soon as it reaches the stomach. After it passes through approximately 4.5 L of intestinal juice and it is absorbed into the maternal plasma, it no longer retains its "coldness". Ice cubes do not circulate in the maternal circulation as "ice cubes" after absorption. Therefore, it is scientifically insane to make an assumption that administration of cold water to the mother would somehow "wake" a sleeping baby, and would help improve the baseline variability observed on the "suspicious" CTG trace. The excessive cold water would have been excreted by the mother due to increased GFR and suppression of ADH, at normal body temperature. If cold water or ice cubes are administered to the mother, even her own urine would not become cold, and therefore, it should be very obvious to all healthcare providers in contemporary obstetric and midwifery practice that definitely the fetus would not "wake up" when cold fluids are administered to the mother. This is because this cold water needs to get absorbed via the maternal gastrointestinal system over time, and then circulate in the maternal plasma prior to reaching the placenta to be transferred across the placenta to reach the fetus.

It is very important to recognise that intravenous fluids should be administered to the mother only in cases of a prolonged deceleration and/or fetal bradycardia secondary to maternal hypotension to restore maternal blood volume [4,5,10]. In addition, they may be part of treatment of maternal sepsis or any other medical condition (e.g. diabetic ketoacidosis), which necessitates the administration of fluids to ensure *maternal wellbeing*. Oral fluids are only indicated in a case of reactive fetal tachycardia secondary to maternal dehydration. However, in this case, one would find increased maternal pulse rate, a dry, coated tongue and a very concentrated urine output in the mother. Fetal heart rate variability reflects the function of the fetal autonomic nervous system of the fetal brain, and therefore, fluids should not be administered with a mistaken belief of "waking the baby" when reduced baseline variability is observed on the CTG trace. Similarly, oral or intravenous fluids should not be administered when recurrent variable or late decelerations are observed on the CTG trace, because even litres and litres of fluids administered to the mother would not correct ongoing umbilical cord compression (i.e. typical or atypical variable decelerations) or existing utero-placental insufficiency (i.e. late decelerations). Placental villi, although they may

appear like trees, do not grow any bigger to transfer more oxygen to the fetus during labour, when fluids are administered to the mother.

Some obstetricians in the past may have thought that the oxygen which was present within the molecule of water (i.e. H₂O) may help correct provide oxygen to the fetus to correct ongoing CTG abnormalities. However, the single atom of oxygen present within the molecule of water is in a bound form and it is useless to provide oxygen to the mother or her fetus. No other healthcare professional in other branches of clinical medicine administers water to deliver oxygen to their patients, if they are concerned about hypoxia. This well-meaning, but totally illogical action by some clinicians in labour wards may have been entirely acceptable in the past when there was a paucity of scientific knowledge. However, it is very important to recognise that scientific knowledge has now advanced, and that patients expect doctors and midwives to ensure that their clinical practice is according to logic and is in line with basic scientific principles. A fetus has an independent, entirely different circulatory system, which is not influenced by a single, bound form of oxygen within a molecule of water, and is not affected by the temperature of ingested fluids by the mother. Administration of oral or intravenous fluids of the mother not only may delay the necessary intervention to correct the underlying cause of observed CTG abnormalities, it may be positively harmful to the mother (dilutional hyponatraemia and hypervolemia which may increase the risk of pulmonary oedema) as well as the fetus (hyponatraemia and neonatal convulsions). Therefore, it should no longer be accepted in contemporary obstetric practice, and clinicians should disregard any illogical CTG Guideline that continues to recommend administration of "oral or intravenous fluids" to the mother to improve "the well-being of the baby" [4].

3. DOES MATERNAL OXYGEN THERAPY TO CORRECT OBSERVED CTG ABNORMALITIES WITHSTAND LOGICAL SCRUTINY?

The normal oxygen saturation of a woman during labour is approximately 98-100%, whereas the fetal oxygen saturation is approximately 60-70%. This is because of the fetus lives in a relatively hypoxic intrauterine environment without any access to atmospheric oxygen, and it has adapted to this hypoxic environment by increasing the haemoglobin level to 180-220 g/L

and having different haemoglobin (HbF) with increased affinity for oxygen.

From a physiological perspective, it should be very obvious to any practising obstetrician and midwife that administration of oxygen to treat abnormalities on the CTG trace is illogical. This is because the maternal oxygen saturation is approximately 98-100%, whereas the normal fetal oxygen saturation is approximately 60 to 70%. Therefore, unless the maternal oxygen saturation falls to a very low level (e.g. in cases of severe bronchial asthma with evidence of reduced maternal oxygen saturation, amniotic fluid embolism, maternal cardiovascular collapse or during pre-oxygenation prior to the administration of a general anaesthetic), administration of oxygen to the mother would not increase fetal oxygen saturation during labour.

Current recognised international consensus guidelines on CTG interpretation no longer recommend the use of maternal oxygen therapy to treat CTG abnormalities [4,5]. In fact, Cochrane Systematic Review on Maternal Oxygen Therapy to treat fetal heart rate abnormalities has concluded that not only there was no evidence that this intervention would help improve perinatal outcomes, abnormal cord blood pH values (less than 7.2) were recorded significantly more frequently in the oxygenation group than the control group (RR 3.51, 95% CI 1.34 to 9.19) [11]. This finding should not be surprising to any obstetrician or midwife who understands human physiology because excessive oxygen administration to the mother (i.e. hyperbaric oxygen) may lead to vasospasm of the spiral arterioles supplying the placental bed, leading to increased risk of hypoxia and acidosis in the fetus. Moreover, excessive oxygen may also lead to the production of oxygen-free radicals which may increase the risk of fetal neurological injury. Therefore, in contemporary obstetric practice, maternal oxygen therapy during labour should only be reserved correct maternal hypoxia, and it should not be used to treat fetal heart rate abnormalities observed on the CTG trace [12].

A recent commentary has highlighted the potential patient harm as a result of continued use of some illogical, and "non-evidence-based" guidelines on CTG interpretation [13]. Therefore, practising midwives and obstetricians should urgently review their individual clinical practice, based on their *own* knowledge of anatomy, physiology and biochemistry as well as a critical

review of current scientific evidence to prevent avoidable patient harm (Fig. 1). If there is a poor maternal or fetal outcome secondary to the administration of oxygen and/or oral or intravenous fluids to treat fetal heart rate abnormalities observed on the CTG trace, it can no longer be morally, ethically, scientifically and medico-legally justifiable in contemporary obstetric practice. With advances of scientific knowledge and emerging scientific evidence, illogical and harmful historical obstetric practices should be relegated to the dustbin of “personal opinion-based” medicine, where they rightly belong, to safeguard patient care.

4. WHAT ABOUT INTRAVENOUS FLUIDS FOR AN “UNCOMPLICATED” FETAL TACHYCARDIA?

Due to the lack of understanding of fetal pathophysiology, some obstetricians involved in producing CTG Guidelines coined the term “uncomplicated fetal tachycardia” and recommended oral and/or intravenous fluids to treat this condition. Tachycardia increases the workload of the myocardium, increases the oxygen consumption, reduces the myocardial blood supply due to prolonged compression of

the perforating coronary arteries, predisposing the myocardium to anaerobic metabolism. Therefore, both adults and fetuses will not increase their heart rate without an underlying reason to so, because, prolonged periods of tachycardia would lead to the depletion of myocardial energy stores (glycogen) resulting in a negative cardiac energy balance. Presence of tachycardia in the absence of deceleration should not be termed “uncomplicated” fetal tachycardia in contemporary obstetric practice. In the absence of maternal dehydration, the most likely underlying cause is an ongoing (subclinical) chorioamnionitis. Recently, it has been shown that a rise in the baseline FHR without preceding decelerations is a hallmark of chorioamnionitis, which is a fetal disease and not a maternal disease. Therefore, a vast majority of women during labour (approximately 85%) would not show any evidence of maternal tachycardia or maternal pyrexia [14]. Intravenous fluids administered to the mother to treat “uncomplicated fetal tachycardia” as recommended by some CTG Guidelines is likely to delay delivery and provide a false sense of reassurance. Moreover, it may worsen perinatal outcomes because maternal water does not treat the ongoing bacterial infection in the fetus.

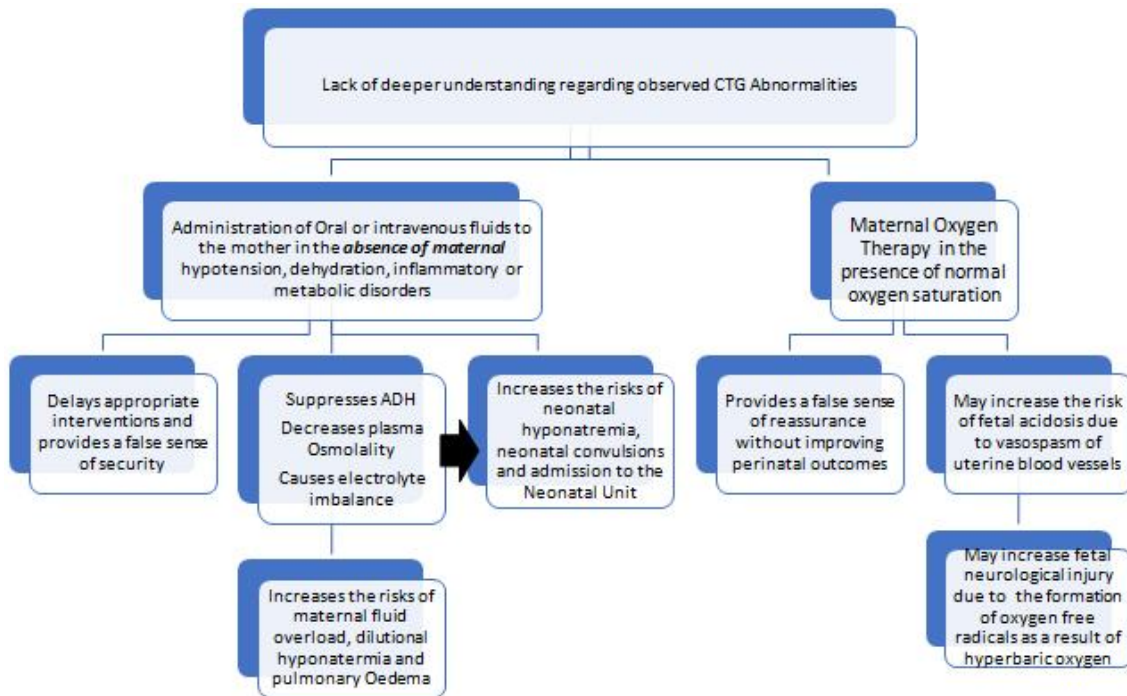


Fig. 1. Potential detrimental effects of maternal fluid and oxygen therapy to treat fetal heart rate abnormalities on the CTG trace

Instead of using terminologies such as “suspicious CTGs” and “uncomplicated tachycardias”, clinicians should scrutinise the CTG trace for abnormal features such as absence of fetal heart rate cycling to diagnose subclinical chorioamnionitis [14]. Similarly, developing a deeper understanding of fetal pathophysiology and classifying the CTG traces based on the ‘Types of Intrapartum Hypoxia’ [15] instead of randomly grouping features to classify CTG traces into “Normal”, “Suspicious”, “Pathological”, will help obviate the need for maternal administration of water and oxygen to treat CTG abnormalities.

5. CONCLUSION

Practising, frontline clinicians owe a duty of care to their patients to disregard any CTG guideline that recommends “oral or intravenous fluids” to treat abnormalities on the CTG trace, as this recommendation is contrary to the knowledge of maternal physiological changes in pregnancy and scientific evidence. In the light of the recent “Each Baby Counts” Report published by the Royal College of Obstetricians and Gynaecologists’ (RCOG) in March 2020, which concluded that in 72% of cases of perinatal deaths and severe brain damage (out of 986 babies), a different care may have resulted in different outcomes [16]. There is an urgent need to question historical, unscientific and scientifically nonsensical practices. Ignorance of scientific principles and contemporary scientific evidence whilst managing women and babies during labour should no longer be condoned or excused, in the light of recent reports [7,16] highlighting avoidable patient harm. Women and babies expect every healthcare provider to practice evidence-based medicine during the intrapartum period, which is based on logic, common sense and robust scientific principles, irrespective of what is erroneously stated by some CTG guidelines. Reduced variability due to the depression of fetal central nervous system due to an ongoing hypoxia, chorioamnionitis or the fetal deep sleep cycle cannot be reversed by oral or intravenous fluids administered to the mother, irrespective of how cold the fluid is. Equally, administration of oxygen to the mother, who has a normal oxygen saturation does not correct the observed abnormalities on the CTG trace, and it may in fact lead to harm.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Author has declared that no competing interests exist.

REFERENCES

1. Ayres-de-Campos D, Artero D, Costa-Santos C, Bernardes J. Knowledge of adverse neonatal outcome alters clinicians’ interpretation of the intrapartum cardiotocograph. *BJOG. An Int J Obstet Gynaecol.* 2011;118:978–84.
2. Gyllencreutz E, Hulthén Varli I, Lindqvist PG, Holzmann M. Reliability in cardiotocography interpretation – impact of extended on-site education in addition to web-based learning: An observational study. *Acta Obstet Gynecol Scand.* 2017;96:496–502.
3. Chandrahara E. Handbook of CTG interpretation. Cambridge: Cambridge University Press; 2017.
4. Ayres-de-Campos D, Spong CY, Chandrahara E, FIGO Intrapartum Fetal Monitoring Expert Consensus Panel. FIGO consensus guidelines on intrapartum fetal monitoring: Cardiotocography. *Int J Gynaecol Obstet.* 2015;131(1):13-24.
5. Available:<https://physiological-ctg.com/guideline.html>
6. National Institute of Clinical Excellence. Intrapartum care: Care of healthy women and their babies during labour. NICE Clinical Guideline. 2014;458.
7. Available:<https://resolution.nhs.uk/wp-content/uploads/2019/09/NHS-Resolution-Early-Notification-report.pdf>
8. Moen V, Brudin L, Rundgren M, Irestedt L. Hyponatraemia complicating labour are or unrecognised? A prospective observational study. *BJOG.* 2009;116:552-56.
9. Simpson KR, James DC. Efficacy of intrauterine resuscitation techniques in improving fetal oxygen status during labor. *Obstet Gynecol.* 2005;105(6):1362–8.
10. Pinas A, Chandrahara E. Continuous cardiotocography during labour: Analysis, classification and management. *Best Pract Res Clin Obstet Gynaecol.* 2016;30:33-47.
11. Fawole B, Hofmeyr GJ. Maternal oxygen administration for fetal distress. *Cochrane*

- Database of Systematic Reviews. 2012;12. Art. No.: CD000136. DOI: 10.1002/14651858.CD000136.pub2
12. Chandrahara E, Arulkumaran S. Prevention of birth asphyxia: Responding appropriately to cardiotocograph (CTG) traces. *Best Pract Res Clin Obstet Gynaecol.* 2007;21(4):609-24.
 13. Chandrahara E. Intrapartum care: An urgent need to question historical practices and 'non-evidence'-based, illogical foetal monitoring guidelines to avoid patient harm. *J Patient Saf Risk Manag.* 2019;24:210–7.
 14. Galli L, Dall'Asta A, Whelehan V, Archer A, Chandrahara E. Intrapartum cardiotocography patterns observed in suspected clinical and subclinical chorioamnionitis in term fetuses. *J Obstet Gynaecol Res.* 2019;45(12):2343-2350. DOI: 10.1111/jog.14133
 15. Yatham SS, Whelehan V, Archer A, Chandrahara E. Types of intrapartum hypoxia on the cardiotocograph (CTG): Do they have any relationship with the type of brain injury in the MRI scan in term babies? *J Obstet Gynaecol.* 2019;1-6. [Published Online Ahead of Print, 2019 Oct 15] DOI: 10.1080/01443615.2019.1652576 Available: <https://www.rcog.org.uk/globalassets/documents/guidelines/research--audit/each-baby-counts/each-baby-counts-2019-progress-report.pdf>

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Peer-review history:

The peer review history for this paper can be accessed here:
<http://www.sdiarticle4.com/review-history/57653>