IN THE CORONERS COURT
OF VICTORIA
AT MELBOURNE

Court Reference: 3452/07

FINDING INTO DEATH WITH INQUEST

Form 37 Rule 60(1)
*Section 67 of the **Coroners Act 2008***

Inquest into the Death of SUMMER ELIZABETH ROSE NIEHOFF

Delivered On:	31 January 2012
Delivered At:	Coroners Court of Victoria Level 11, 222 Exhibition Street Melbourne 3000
Hearing Dates:	12 July, 2010
Findings of:	JANE HENDTLASS, CORONER
Representation:	Mr B McTaggart appeared on behalf of Dr Colin Davidson Mr P Halley appeared on behalf of Midwife Gaye Demanuele Ms F Ellis appeared on behalf of Midwife Astrid Tiefholz Mr C Winneke appeared on behalf of Eastern Health
Police Coronial Support Unit (PCSU):	Senior Constable G McFarlane

I, JANE HENDTLASS, Coroner having investigated the death of SUMMER ELIZABETH NIEHOFF

AND having held an inquest in relation to this death on 12 July 2010
at Melbourne

find that the identity of the deceased was SUMMER ELIZABETH ROSE NIEHOFF

born on 31st August, 2007

and the death occurred on 31 August 2007

at Box Hill Hospital, Nelson Road, Box Hill, Victoria 3128

from:

1a. PERINATAL ASPHYXIA.

in the following circumstances:

1. Summer Elizabeth Rose Niehoff was born at Box Hill Hospital at 11.20pm on 30 August 2007. Summer's mother, Brooke Niehoff, was 18 years old when Summer was born. She lived with her parents in Healesville. Ms Niehoff's medical history included depression, cannabis use and smoking as well as two previous pregnancies, which had miscarried. Her general practitioner and obstetrician was Dr Peter Rogers at Healesville Medical Centre.

2. On 16 February 2007, Ms Niehoff had been pregnant for about 10 weeks when she presented to Healesville Medical Centre. Ms Niehoff's pregnancy was generally uneventful and all routine tests and scans were normal. On 24 February, she had an ultrasound scan which confirmed her baby was 11 weeks and four days from conception. On 3 April, Ms Niehoff was concerned about her age and capacity to cope with the baby but she decided to proceed with the pregnancy. On 21 June, blood tests indicated iron deficiency. Her blood group was confirmed to be A Rh(D) negative and there were no abnormal antibodies detected. On 22 August, ultrasound analysis estimated that Ms Niehoff had been pregnant for 37 weeks and three days and the foetal weight to be 3506 grams, which is in the 90th percentile.

3. At about 4.30pm on 29 August 2007, Ms Niehoff's placental membranes ruptured at home. At 5.30pm, she was admitted to Healesville and District Hospital but had not started contractions. At 8.00pm, regular painful contractions commenced spontaneously.

4. Ms Niehoff's labour was long and painful. Dilation of her cervix was slow. Therefore, at 9.10am on 30 August 2007, Dr Rogers initiated oxytocin augmentation of Ms Niehoff's contractions and cardiotocograph (CTG) monitoring of her contractions and the baby's heart rate.

5. Ms Niehoff's pain increased as the frequency and strength of her contractions increased in response to the oxytocin augmentation. However, her cervix dilation remained slow. At 2.15pm on 30 August 2007, Dr Rogers referred her to Box Hill Hospital for epidural anaesthesia and possible surgical delivery.

6. At 2.45pm on 30 August 2007, Ms Niehoff presented at the Box Hill Hospital. She remained anxious, distressed and agitated. The epidural anaesthetic was ineffective in reducing her pain. Her cervix continued to dilate slowly.

7. At 9.30pm on 30 August 2007, the on call general practitioner obstetrician and the obstetric and gynaecology registrar made arrangements to deliver her baby by Caesarean section. However, the midwife advised the doctors that Ms Niehoff could deliver vaginally. Therefore, they reversed their decision to deliver Ms Niehoff's baby surgically and both doctors left Box Hill Hospital.

8. At 10.37pm on 30 August 2007, electronic monitoring of Ms Niehoff's contractions was terminated. At 10.55pm, Ms Niehoff removed the belt holding the CTG in place on her abdomen.

9. At 11.20pm on 30 August 2007, Summer Niehoff was born vaginally. She had no spontaneous respiratory effort and an Apgar score of 1 at one minute, 2 at five minutes. She was intubated and attempts were made to resuscitate her with cardiac massage and adrenaline, bicarbonate, glucose and atropine before death was pronounced.

10. At 12.17am on 31 August 2007, Summer Niehoff died.

11. The forensic pathologist who performed the autopsy formed the opinion that the cause of death was perinatal asphyxia. She commented that the insult causing the inadequate exchange of oxygen and carbon dioxide resulting in a dangerous drop in blood oxygen level accompanied by an increase in carbon dioxide level and accumulation of acid occurred prior to birth. However, the forensic investigations have been unable to determine any particular cause of perinatal asphyxia.

12. Accordingly, I find that Summer Niehoff died from perinatal asphyxia.

13. This Finding will review the circumstances of Summer Niehoff's death with particular emphasis on the history of Ms Niehoff's labour at Healesville and Box Hill Hospitals.

14. It will then comment and make recommendations in relation to:

- Monitoring of the mother's contractions,
- Monitoring of the baby's heart beat,
- Pain control, and
- Use of oxytocin augmentation.

Ms Niehoff's Labour at Healesville and District Hospital

15. At 6.15pm on 26 August 2007, Ms Niehoff presented at Healesville and District Hospital with a three day history of pain and discomfort, worsening at times. She was assessed and sent home with advice to take paracetamol and try to sleep. Dr Rogers was notified.

16. At 5.30pm on 29 August 2007, Ms Niehoff was admitted to Healesville and District Hospital. Her membranes had ruptured but she had not started contractions. At 6.00pm, she had occasional mild contractions. At 8.00pm, regular painful contractions commenced spontaneously and by 9.30pm, Ms Niehoff's uterus was contracting mildly three times every 10 minutes.

17. At 12.15am on 30 August 2007, Ms Niehoff's cervix was 1.5cm dilated. She was already having trouble coping with the pain and using nitrous oxide analgesia so, at 12.30am, Dr Rogers authorised administration of intramuscular pethidine and Maxolon. At 3.00am, midwives administered further pethidine and Maxolon. This relieved the pain and Ms Niehoff was coping better with her contractions. At 5.30am, her cervix was 2cm dilated and a further 100mg pethidine was administered at 5.50am.

18. At 7.55am on 30 August 2007, the nursing staff at Healesville commenced cardiotocograph (CTG) monitoring of Ms Niehoff's contractions and the baby's heart rate. By 8.00am, she was coping well on nitrous oxide and but still only contracting two or three times in 10 minutes. The baby's head was fully engaged and there was minimal foetal heart variability which nursing staff attributed to the pethidine.

19. At 8.30am on 30 August 2007, Dr Rogers examined Ms Niehoff. He assessed her cervix as 3cm dilated and authorised oxytocin augmentation. This infusion of 10U oxytocin in 1L Hartmans solution commenced at 9.10am and was completed at 11.20am.

20. By 10.25am on 30 August 2007, the intensity of Ms Niehoff's contractions had increased. She remained relatively comfortable on nitrous oxide analgesia during the oxytocin augmentation infusion. At 11.00am, the nursing staff at Healesville assessed Ms Niehoff's cervix to be 4cm dilated and the foetal heart seemed fine.

21. However, by 11.25am on 30 August 2007, Ms Niehoff was having constant contractions and she was given a further 100mg pethidine and 10mg Maxolon for her pain and vomiting. At 11.40am, nursing staff notified Dr Rogers.

22. At 12.30pm on 30 August 2007, Dr Rogers assessed Ms Niehoff as still only 4cm dilated and not coping with the pain. Healesville Hospital is not equipped to manage epidural anaesthesia so he referred her to Box Hill Hospital. At 1.00pm, Ms Niehoff was transferred to the Birralee Maternity Service at Box Hill Hospital in an ambulance with mid wife support.

Ms Niehoff's Labour at Box Hill Hospital

23. At 2.15pm on 30 August 2007, Ms Niehoff was admitted to Box Hill Hospital. At 2.45pm, nitrous oxide was commenced for pain relief. At 3.15pm, Midwife Astrid Tiefholz accepted responsibility for Ms Niehoff's care during her labour. At 3.30pm, 1000mls fluid infusion commenced and the CTG was replaced to monitor her contractions and her baby's heart beat.

24. At 3.45pm on 30 August 2007, the Obstetrics and Gynaecology registrar assessed Ms Niehoff's cervix as only 3cm dilated. His plan was to introduce an epidural anaesthetic and then recommence the oxytocin. Her oxytocin infusion would be monitored by midwifery staff according to strength and frequency of contractions. If there was no further progress in two hours after that, Ms Niehoff's medical team planned a caesarean section.

25. Accordingly, at 4.05pm on 30 August 2007, the anaesthetist inserted an epidural line and commenced administration of 200mls of 0.125% bupivacaine and 2mcg/ml fentanyl anaesthetic as an infusion at the rate of 8 ml/hr. He also ordered a 4ml bolus of anaesthetic every half hour if required.

26. At 4.15pm on 30 August 2007, an infusion of 10 units/L oxytocin was recommenced at 12 ml/hr. A urinary catheter was placed and penicillin was also administered because Ms Niehoff's membranes had been ruptured for more than 18 hours. At 4.54pm, Ms Niehoff assessed her pain as 4/10 and she was calmer and more relaxed.

27. At the end of his shift, the Obstetrics and Gynaecology registrar tried to contact the incoming Obstetrics and Gynaecology consultant, Dr Jason Clark, without success so he handed Ms Niehoff's medical care over to the general practitioner obstetrician on call, Dr Colin Davidson.

28. At 5.07pm on 30 August 2007, Ms Tiefholz continued the plan established by the Obstetrics and Gynaecology registrar. She administered the first bolus of epidural anaesthetic and increased the oxytocin infusion rate to 24 ml/hr. At 5.27pm, she administered a second bolus of anaesthetic and increased the oxytocin infusion rate to 36 ml/hr. By 7.15pm, Ms Niehoff was having two contractions every 10 minutes.

29. At 7.15pm, Ms Niehoff's uterus was still contracting every two minutes and her baby's heart rate had increased to 160 beats per minute. Ms Tiefholz conducted a vaginal examination which indicated that her cervix was 7cm dilated. Despite the indicators of possible uterine hyperstimulation, she increased the oxytocin infusion rate to 48 ml/hr and, at 7.45pm, to 60ml/hr.

30. From 7.48pm to 8.20pm, Ms Niehoff was particularly restless and the CTG recording of the baby's heart beat was unclear. However, Ms Tiefholz recorded that foetal heart rate had declined to 140 beats per minute, the variability of the foetal heart function was a bit low and the baby's head was well down in the pelvis but unable to be seen vaginally. She assessed Ms Niehoff as in transition to the second stage of labour. At 8.20pm, Ms Tiefholz notified Dr Davidson.

31. In his statement, Dr Davidson noted that the foetal heart rate baseline dropped at 8.50pm and there were some short variable decelerations. There was also a period of reduced variability which returned to normal over the next 15 minutes. He attributed these to Ms Niehoff pushing inappropriately when not fully dilated.

32. By 9.00pm on 30 August 2007, the infusion of oxytocin remained at 60 ml/hr and Ms Niehoff's contractions remained two to three minutes apart. At 9.18pm, vaginal examination showed Ms Niehoff's cervix remained 7-8cm dilated. Despite a further bolus dose of epidural anaesthetic at

9.22pm, Ms Niehoff remained agitated and exhausted with extreme pain. At 9.45pm, Ms Tiefholz administered more nitrous oxide with no obvious effect on Ms Niehoff's pain. At 9.51pm, she administered a further bolus of anaesthetic.

33. Overlapping with Ms Tiefholz's attempts to manage Ms Niehoff's pain and agitation, Dr Davidson assessed Ms Niehoff's progress at 9.30pm on 30 August 2007. He also recorded that she remained extremely agitated and stressed so that she was unable to cooperate with her management team. At 9.40pm, he assessed her cervix as only dilated to 9cm but the baby was in a satisfactory position and the CTG tracing was "re-assuring". Ms Niehoff asked Dr Davidson to deliver her baby using a Caesarean section.

34. At 9.50pm on 30 August 2007, Dr Davidson discussed Ms Niehoff's management with Dr Clark on the telephone. They agreed to proceed with a Caesarean section. Dr Clark went to the hospital and prepared for surgery. He did not see Ms Niehoff. At 10.05pm, Dr Davidson obtained formal consent to deliver Ms Niehoff's baby by Caesarean section and she was also prepared for surgery.

35. At 10.05pm on 30 August 2007, Ms Tiefholz completed her shift and handed over management of Ms Niehoff's labour to Midwife Gaye Demanuele. In her handover to Ms Demanuele, Ms Tiefholz confirmed that Ms Niehoff was still highly agitated and that her distress had increased in response to oxytocin augmentation. Ms Tiefholz also confirmed that the epidural block had become ineffective despite top up doses but the CTG showed no signs of foetal distress although some period of reduced variability could be attributed to the effects of the epidural analgesia.

36. Ms Demanuele says she did not review the full CTG recording during the time she cared for Ms Niehoff. In her statement, Ms Demanuele also says that external monitoring of the foetal heart rate in the second stage of labour is unreliable. She asked Ms Tiefholz whether there had been any attempt to reposition the epidural catheter to achive greater pain relief and she was told this would occur in theatre.

37. Then, at 10.15pm on 30 August 2007, Ms Niehoff told Ms Demanuele that she could feel her baby's head in her pelvis and through her vagina and she was occasionally feeling the sensation to push. Ms Demanuele performed an internal examination to confirm that Ms Niehoff's cervix was fully dilated and the baby's head was 3cm distal to the internal ischial spines and in an occipito-anterior position. Ms Demanuele then spoke to Dr Clark and said she thought Ms Niehoff would be able to deliver vaginally.

38. Dr Clark discussed the changed situation with Dr Davidson before he agreed to abandon plans for surgical delivery and left the hospital. Dr Davidson examined Ms Niehoff and agreed that she was progressing towards a vaginal birth. He was reassured by the CTG trace of the foetal heart rate at 10.30pm and, at that stage, he also anticipated a vaginal delivery.

39. Dr Davidson and Dr Clark both say that they were unable to accurately monitor Ms Niehoff's uterine contractions on the CTG due to her extreme agitation and restlessness. However, she responded positively to reassurance from Ms Demanuele and the baby's vertex continued to advance slowly.

40. At 10.37pm, Ms Niehoff pulled off the belt that enabled electronic monitoring of her contractions. Ms Demanuele continued to monitor Ms Niehoff's contractions manually. She says they were explosive contractions but there was no indication of hyperstimulation at that stage.

41. At 10.40pm on 30 August 2007, Dr Davidson left the hospital. He says Dr Clark assumed responsibility for the Ms Niehoff's management. Dr Clark had already gone home.

42. At 10.50pm on 30 August 2007, Ms Niehoff also removed the Doppler ultrasound monitor of the baby's heart beat. After this, Ms Demanuele continued to auscultate the foetal heart rate intermittently by holding the foetal heart rate sensor in place on her abdomen. She did not record these measurements in the hospital record. However, she noted retrospectively that the baseline remained 120 to 130 beats per minute, with brief variable decelerations to 90 beats per minute of 10 seconds duration with good recovery. At 11.15pm, Ms Demanuele last documented an assessment of the foetal heart rate. In evidence, Ms Demanuele said it was perhaps a minute or two between when she last heard the baby's heart rate was okay and when Summer was born.

43. At 11.20pm on 30 August 2007, Summer Niehoff was born vaginally at Box Hill Hospital. She had no spontaneous respiratory effort and an Apgar score of 1 at one minute and 2 at five minutes. A slow pulse was detected but this had ceased when she was placed in the resuscitation cot. Summer was intubated and resuscitated with adrenaline and further cardiac massage before death was pronounced.

44. At 12.17am on 31 August 2007, resuscitation attempts ceased and Summer Niehoff died.

Comments and Recommendations:

Pursuant to section 67(3) and section 72(2) of the **Coroners Act 2008**, I make the following comments and recommendations connected with the death:

1. Summer Niehoff was the child of a young and anxious mother who had lost two previous pregnancies and was scared about the delivery process. Ms Niehoff's cervix dilated very slowly after painful contractions commenced spontaneously at Healesville and Community Hospital.

2. Cardiotocograph (CTG) monitoring of Ms Niehoff's contractions and the baby's heart rate commenced at 7.55am on 30 August 2007. Oxytocin augmentation was established at 9.15am after 13 hours of painful but inconsistent contractions.

3. Ms Niehoff's labour remained slow and she was transferred to Box Hill Hospital for epidural anaesthesia because this procedure was not available at Healesville. Her labour was managed by Midwife Astrid Tiefholz and the Gynecology and Obstetrics registrar.

4. At 3.45pm on 30 August 2007, the plan was to establish an epidural anaesthetic and perform a Caesarean section if there was no improvement in two hours. At 4.05pm, the epidural anaesthetic was established. At 5.07pm, 5.27pm, 9.22pm and 9.51pm, further boluses of anaesthetic were added to the infusion.

4. Further, at 4.15pm on 30 August 2007, oxytocin augmentation was re-established. The rate of infusion of of 10 units/L increased sequentially from 12 ml/hr to 60ml/hr at 7.45pm.

5. At about 9.30pm on 30 August 2007, there was no significant improvement in the rate of dilation of Ms Niehoff's cervix or her tolerance of pain. Dr Colin Davidson and Dr Jason Clark agreed that Ms Niehoff's baby should be delivered surgically. At 10.05pm, Ms Tiefholz handed over management of Ms Niehoff's labour to another midwife, Gaye Demanuele.

6. However, at 10.15pm on 30 August 2007, Ms Demanuele examined Ms Niehoff and advised Dr Clark that Ms Niehoff's cervix was fully dilated and she thought a vaginal birth was possible. Dr Davidson also examined Ms Niehoff and agreed to abandon the plan for a Caesarean section. Accordingly, responsibility for managing of Ms Niehoff's vaginal delivery reverted to Ms Demanuele. Dr Davidson and Dr Clark left the hospital

7. At 10.37pm on 30 August 2007, electronic monitoring of Ms Niehoff's contractions was terminated. At 10.55pm, Ms Niehoff also removed the belt holding the CTG in place so that there was also no CTG record of the Ms Niehoff's contractions or the foetal heart beat for the last 45 minutes of labour. During this period, Ms Demanuele manually monitored Ms Niehoff's contractions and her baby's heart rate. She also delivered Summer vaginally with the assistance of a second midwife.

8. Summer was non-responsive at birth and died about one hour later despite attempted resuscitation.

9. Summer died from perinatal asphyxia. Perinatal asphyxia is caused by low levels of oxygen in the baby's brain prior to its delivery.

10. In the later stages of labour when the baby is entering the birth canal, it is normal for the oxygen supply to the baby to become restricted during the mother's contractions. However, in circumstances involving uterine hyperstimulation, the mother's contractions occur too frequently to allow proper relaxation of the uterus between contractions. This is important because the baby needs 60-90 seconds between each contraction to restore adequate foetal oxygenation. If the time between contractions is too short to allow the oxygen level in the baby's blood to be restored, the baby's brain can be damaged.

11. One cause of peri-natal asphyxia is uterine hyperstimulation, which is defined as either:

- five or more contractions in ten minutes over a 30 minute period,
- contractions lasting more than two minutes in duration, or
- contractions of normal duration occurring within 60 seconds of each other. [1]

[1] Uterine Hyperstimulation: Fetal Management Guideline, Clinical Protocols and Guidelines, Southern Health, Version 2.1 August 2009.

12. Uterine hyperstimulation can occur when extra oxytocin is administered to increase the frequency of uterine contractions and associated rate of dilation of the cervix to allow birth. Accordingly, protocols for oxytocin augmentation require the mother's treating team to closely monitor her contractions and the baby's heart rate during oxytocin augmented labour.

13. Therefore, it is routine for the mother's treating team to monitor the frequency and strength of her contractions and her baby's heart beat during oxytocin augmented labour. This can be achieved by manual palpation of the mother's abdomen to assess contractions and periodic monitoring of the baby's heart rate using a hand held Doppler foetal heart rate monitor.

14. Alternatively, the clinicians managing the labour can use CTG equipment secured to the mother's abdomen to continually monitor her contractions and the baby's heart rate. The output from the CTG is recorded on a trace which can be analysed by treating staff and reviewed in retrospect.

15. Dr Malcolm Barnett gave evidence at the Inquest. He had been Director of Obstetrics and Gynaecology at Box Hill Hospital, Director of Women's and Children's Services at Box Hill Hospital and Director of Women's and Children's Services for Eastern Health for about 2½ years and was not in the position when Summer was born.

16. Dr Barnett explained that Eastern Health undertook an extensive review of Summer's death and two other perinatal deaths that occurred at about the same time. He has reviewed the medical record and authorised independent reviews by a consultant obstetrician at Monash Medical Centre, Professor Euan Wallace, and by Dr Neil Roy who is a resuscitation specialist.

17. Professor Wallace, Dr Roy and the Director of Nursing and Midwifery at Box Hill Hospital, Associate Professor Denise Patterson, are all members of the Leadership Group of the Maternal and Newborn Clinical Network. The Victorian Department of Health established the Maternal and Newborn Clinical Network in August 2007 following a statewide forum for people interested in perinatal care.

18. In commenting on Ms Niehoff's labour and the circumstances of Summer's death, I have relied on these expert reviews as well as the evidence presented to the Court.

Monitoring of the mother's contractions

19. The tocograph component of the CTG monitors the mother's contractions by measuring the pressure in her abdomen so that peaks in the trace recording indicate the frequency of contractions and the size of these peaks indicate the intensity of the contractions. This means that the tocograph may be inaccurate in the way it depicts a patient's contractions if it is wrongly placed on the abdomen and/or the mother is active and moving around. In the absence of a well adjusted and sensitive CTG, contractions are routinely assessed by palpation of the abdomen.

20. At 4.15pm on 30 August 2007, augmentation of Ms Niehoff's contractions with an oxytocin infusion recommenced at Box Hill Hospital. At 4.20pm, Ms Tiefholz interpreted the tocograph to show Ms Niehoff's contractions were about two to three minutes apart. Although Ms Niehoff's pain levels

were fluctuating, there is no evidence that this assessment was checked against manual palpation. However, in the absence of on-going oxytocin augmentation, there is no reason to suspect Ms Niehoff was already experiencing uterine hyperstimulation.

21. By 7.15pm on 30 August 2007, there was reason to suspect that uterine hyperstimulation could be occurring:

- At 7.15pm, Ms Niehoff's uterus was contracting every two minutes and her baby's heart rate had increased to 160 beats per minute.
- The oxytocin infusion rate had increased from 35ml/hour at 5.27pm to 60ml/hour at 7.45pm.
- From 7.48pm to 8.20pm, Ms Niehoff was particularly restless and Dr Barnett was unable to say whether his inability to read the tocograph was caused by hyperstimulation or because Ms Niehoff's movements were preventing detection of changes in pressure in the abdomen.
- Dr Clark says that, at times around 10.50pm, retrospective analysis of the CTG suggests the possibility of uterine hyperstimulation.
- Eastern Health reviews of their monitoring requirements and interpretation of CTGs have raised concerns about the possibility of uterine hyperstimulation and whether the CTGs were interpreted correctly.

22. However, I am unable to say whether or not Ms Niehoff was experiencing uterine hyperstimulation after 7.15pm on 30 August 2007 because:

- Dr Clark, Dr Davidson and Dr Barnett all say that Ms Niehoff's uterine contractions were unable to be monitored accurately on the CTG due to her extreme agitation and restlessness. Dr Davidson told the Court they relied on the midwives' assessments of the strength and frequency of the contractions in making their decisions.
- Ms Demanuele did not manually assess Ms Niehoff's contractions while the CTG was in place.
- At 10.37pm on 30 August 2007, electronic monitoring of Ms Niehoff's contractions was terminated. There is no record of the frequency or severity of Ms Niehoff's contractions after this time but Ms Demanuele confirmed she monitored Ms Niehoff's contractions by palpating her abdomen. She says they were explosive contractions and there was no indication of hyperstimulation at that stage.

23. Therefore, I am unable to say whether or when the perinatal asphyxia diagnosed in Ms Niehoff's baby after birth was caused by hyperstimulation of Ms Niehoff's uterus.

24. However, to the extent that hyperstimulation may have caused perinatal asphyxia in Ms Niehoff's baby, the information available to Ms Niehoff's management team when they needed it to decide whether or not to change her oxytocin dose and whether or not to deliver her baby by Caesarean section was inadequate and may have contributed to Summer's death.

25. The Maternal and Newborn Clinical Network Guideline for oxytocin augmentation in labour states *inter alia*:

> *"**3.4 Observations post commencement of oxytocin (Syntocinon®)***
> - *Continuous cardiotocograph (CTG) is indicated with commencement of oxytocin (Syntocinon®) infusion*
> - *Uterine contractions should be assessed carefully for a 10 minute period at 30 minute intervals. Contraction frequency and duration should be reconciled with uterine activity recorded on the CTG*
> - *Strength of contraction is a subjective assessment requiring manual palpation (by midwife or doctor) correlated with how the woman perceives her contractions*
> - *Support and pain relief options should be offered to women accordingly.."* [2]

26. Under these Guidelines, Ms Niehoff's contractions would have been assessed manually at least every 30 minutes even when the CTG was in place and these observations would have been correlated with the tocograph and with Ms Niehoff's clinical presentation.

27. I accept that the The Maternal and Newborn Clinical Network Guideline for oxytocin augmentation in labour would have improved monitoring of Ms Niehoff's contractions and may have prevented Summer's death.

Monitoring of the baby's heart beat

28. Foetal tachycardia, loss of variability of contraction pressure and late stage foetal heart decelerations may be indicators of compromised foetal oxygen supply. These changes are measured mechanically by the ultrasound heart monitor component of the CTG and are recorded on the same CTG record as the trace of the mother's contractions. Therefore, when it is working properly, the cardiograph provides evidence of foetal cardiac distress associated with hyperstimulation or for other reasons.

29. Ms Niehoff's baby's heartbeat was monitored using a CTG until 10.05pm on 30 August 2007, when Ms Tiefholz went off duty. At 7.48pm, she had determined that Ms Niehoff was transitioning into the second stage of labour and she contacted Dr Davidson at 8.20pm.

30. Further, Ms Demanuele used a hand held Doppler foetal heart rate monitor to auscultate the foetal heart rate at 10.50pm, 10.55pm, 11.05pm 11.10pm and 11.15pm on 30 August 2007. In her retrospective report, Ms Demanuele remembered that the baseline remained 120 to 130 beats per minute with variable decelerations to 90 beats per minute of 10 seconds duration and good recovery. Ms Demanuele said it was perhaps a minute or two between when she last heard the baby's heart rate was okay and when Summer was born.

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[2] Maternity & Newborn Clinical Network, Oxytocin (Syntocinon®) Induction and Augmentation of Labour Clinical Practice Guideline (CPG).

31. The CTG record of Ms Niehoff's labour has been reviewed by several Eastern Health medical practitioners and by Professor Wallace. On one level, they agree that there was no evidence of foetal distress:

- Dr Clark and Dr Barnett agree that there was no evidence of complications when they retrospectively reviewed Ms Niehoff's CTG record until around 10.50pm.
- Dr Barnett also completed the Discharge Summary on 31 August 2007, indicating "non-pathological CTG".
- Dr Davidson also says that the CTG had no features of concern until 10.30pm.
- Professor Wallace is of the view that CTG surveillance at Box Hill was generally consistent with good practice.

32. However, in the alternative:

- From 7.48pm to 8.20pm, Ms Niehoff was particularly restless and Dr Barnett said the CTG recording of the baby's heartbeat was unclear.
- At 8.15pm, Ms Tiefholz recorded that foetal heart rate had declined to 140 beats per minute, the variability of the foetal heart function was a bit low.
- Dr Davidson noted that the foetal heart rate baseline dropped again at 8.50pm and there were some short variable decelerations. There was also a period of reduced variability, which returned to normal over the next 15 minutes. He attributed these to Ms Niehoff pushing inappropriately when not fully dilated.
- Professor Wallace found there was evidence of inadequate intrapartum foetal surveillance in the last 40 minutes or second stage of labour.
- Dr Barnett also acknowledges that intrapartum foetal surveillance was not adequate during the last part of labour. He says this is clear from the poor quality of the CTG trace.
- Eastern Health have reviewed their foetal surveillance and interpretation of CTGs. Concerns were also raised about whether the CTGs were interpreted correctly.

33. Problems may arise with the recording by the ultrasound heart monitor component of the CTG graph particularly if the foetus is in a posterior position and/or the mother is very physically active. If the ultrasound is in an unfavourable position, the maternal heart beat may also interfere with assessment of the foetal heart sounds. Further, Ms Demanuele stated that external monitoring of the foetal heart rate in the second stage of labour is unreliable.

34. Therefore, I am also unable to say whether or not the perinatal asphyxia that we know occurred during Ms Niehoff's labour was associated with changes in the heart function of Ms Niehoff's baby after 7.40pm because of factors we know influence foetal heart monitoring adequacy and reliability: Ms Niehoff was transitioning into second stage of labour, she was very active and, after the CTG was removed, the records of ausculation are intermittent and retrospective.

36. Despite this equipment limitation, Dr Barnett told the Court that Eastern Health policy was for the ECG monitor to remain in place when oxytocin augmentation was occurring and the alternative to

having the belt *in situ* would be to continue hand held monitoring of the foetal heart rate with a Doppler foetal heart rate monitor.

36. To the extent that perinatal asphyxia in Ms Niehoff's baby may have been associated with changes in her foetal heart function after 7.40pm on 30August 2007, the information provided to Ms Niehoff's management team when they needed it to decide whether or not to change her oxytocin dose and whether or not to deliver her baby by Caesarean section was inadequate and unreliable and may have contributed to Summer's death.

37. It is also significant that the doctors who had to decide whether or not to proceed with planned surgical delivery relied heavily on communication with the midwives about their assessments of Ms Niehoff's contractions and her baby's heart function during a period when she was intolerant of pain, anxious and moving about and the monitoring equipment was unreliable.

38. As a result of this inadequacy, Eastern Health have reviewed their policies and new training models for medical and midwifery staff have been established. As relevant, these changes include the following:

- Medical and midwifery staff must complete one of the foetal surveillance education programmes that are available. These are either the RANZCOG programme or a K2 package.
- Foetal surveillance education has been centralised through their foetal monitoring and assessment centre.
- Their current "Hyperstimulation in Labour" guidelines require continuous CTG, discontinue IV oxytocin, rapid infusion of IV fluid.
- Eastern Health have also reviewed and developed their Education Programme relating to the Management of Labour to include but not limited to the use of oxytocin augmentation and the use of scalp lactates and the use of foetal scalp electrodes. This was incorporated into their orientation programmes as of the beginning of 2008.

39. Counsel for Ms Demanuele also submits that all clinical staff should be given regular training in interpretation of the CTG. Further, the CTG should be reported every 30 minutes during labour and checked by a second midwife.

40. I accept that the new Eastern Health new training models for medical and midwifery staff would have improved monitoring of Ms Niehoff's baby's heart function and may have prevented Summer's death.

41. I also accept that better recording of manual assessments of foetal heart function would have improved the reliability of information provided to Ms Niehoff's management team when they were making decisions about whether or not to continue to deliver her baby by Caesarean section. However, I am unable to say whether, by the time the CTG was removed, surgery was an option or Summer's death was preventable.

Pain Relief

42. Medical management of Ms Niehoff's labour was strongly influenced by her agitation and by intolerance of the pain generated by her frequent severe uterine contractions induced by oxytocin augmentation. Pethidine, nitrous oxide and epidural administration of increasing doses of anaesthetic did not provide adequate ongoing pain relief.

43. Dr Barnett acknowledged that Ms Niehoff's pain relief was not adequate. Further, he said that, in retrospect, it appeared that inadequate pain relief meant that it was very difficult to maintain continuous foetal monitoring in the last three quarters of an hour of labour.

44. Improved pain relief could have changed the outcome for Summer because Ms Niehoff would have tolerated the CTG better and would have been less anxious during her second stage of labour. Further, she would have been less active so the recording may have been more reliable.

45. However, nearly all the medical staff who reviewed Summer's death and/or gave evidence in the Inquest relied on CTG recordings taken when Ms Niehoff was actively intolerant of her pain to agree that there was no evidence of foetal distress during her labour. Given the acknowledged inadequate monitoring of foetal heart rate, it is difficult to understand how they could reach this or any other professional opinion about the baby's cardiac function *in utero*.

46. Following review of the Eastern Health augmented labour policies, their "Epidural in Labour" guidelines contra-indicate use of epidural anaesthetic if the woman is unable to cooperate with the anaesthetist. Through her Counsel, Ms Demanuele also submits that mothers who do not obtain sufficient pain relief from epidural anaesthetic should be reviewed by an anaesthetist to consider re-siting of the epidural access.

47. I accept that better pain relief would have improved monitoring of Ms Niehoff's contractions and her baby's heart function and may have prevented Summer's death.

Oxytocin augmentation

48. Oxytocin augmentation was used during Ms Niehoff's labour to stimulate dilation of her cervix. At Eastern Health, oxytocin infusion is administered by the midwife attending the patient at a rate determined by the protocol in the Maternity Handbook 2008 and is adjusted taking in the consideration of the patient's response.

49. Professor Wallace expressed the view that oxytocin augmentation of labour at Healesville should have commenced earlier when it was clear that progress was not good. However, at least until 10.30pm on 31 August 2007, increasing doses of oxytocin were associated with greater pain and distress for Ms Niehoff without the expected rapid ripening of the cervix. In turn, the pain and distress caused on-going problems with CTG monitoring of her contractions and the baby's heart rate which may have masked evidence of uterine hyperstimulation. Therefore, in the absence of adequate pain

relief, it seems unlikely that commencing oxytocin augmentation earlier in labour would have improved the outcome for Summer.

50. A Victorian Department of Health Maternal and Newborn Clinical Network Guideline states *inter alia*:

> *"**Limitations to Oxytocin Use***
> *2.1 Contraindications*
> *Never proceed to IOL in women with the following:*
> .....
> - *Any other contraindication to labour or vaginal birth*
> - *Spontaneous labour*
> - *Abnormal cardiotocograph (CTG) or known fetal compromise .."*[3]

51. Under these Guidelines, oxytocin augmentation was contraindicated because Ms Niehoff commenced labour spontaneously at Healesville Hospital.

52. Further, there is no evidence that Ms Niehoff's management team made any effort to reduce the rate of oxytocin infusion when her pain and anxiety made it difficult or impossible to adequately monitor her contractions or the baby's heart function or when plans were made for surgical delivery.

53. On the contrary, at 7.15pm on 30 August 2007, Ms Tiefholz increased the oxytocin infusion rate to 48 ml/hr and, at 7.45pm, to 60ml/hr even though Ms Niehoff's uterus was contracting every two minutes and her baby's heart rate had increased to 160 beats per minute. Of course, Ms Niehoff bacame even more distressed and the reliability of the CTG was further compromised.

54. Eastern Health have reviewed their "Oxytocin Infusion Guidelines" to advise that oxytocin is ceased or decreased when evidence of hyperstimulation occurs i.e. more than five contractions in 10 minutes or contractions lasting longer than 90 seconds. The effectiveness of this practice will rely on succssessful implementation of their monitoring training and guidelines.

55. Further, in contrast to Professor Wallace's comments, Eastern Health now require informed consent by the woman before oxytocin augmentation begins. The need for informed consent is not controversial. However, it seems unlikely that Ms Niehoff would have consented to continuing oxytocin augmentation if she had been properly appraised of its painful consequences. If her labour had continued slowly with adequate pain relief, the planned Caesarean delivery would have probably proceeded at 10.30pm and Summer may have survived.

56. Therefore, I remain unconvinced that the current Eastern Health "Oxytocin Infusion Guidelines" would have changed the outcome for Summer Niehoff.

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[3] Maternity & Newborn Clinical Network, Oxytocin (Syntocinon®) Induction and Augmentation of Labour Clinical Practice Guideline (CPG).

Recommendations

I recommend that:

1. The Royal Australian and New Zealand College for Obstetrics and Gynaecology review the procedural and policy changes implemented by Eastern Health with a view to extending their application to other birthing units.

2. Eastern Health and the Royal Australian and New Zealand College for Obstetrics and Gynaecology consider the importance of adequate pain relief during oxytocin augmentation with a view to changing their policies to require regular review by an anaesthetist to ensure maximum effectiveness is achieved.

3. Eastern Health require midwives and obstetricians to reassess their continuing use of oxytocin augmentation in circumstances where they have not achieved adequate pain relief and this interferes with adequate CTG monitoring of the mother's contractions and/or the baby's heart function.

4. Eastern Health require midwives and obstetricians to record their manual assessments of patients' contractions and foetal heart rates so that they can communicate the patients' condition when decisions are being made about surgical delivery.

Signature:

DR JANE HENDTLASS
CORONER

31 January 2012

Coroners Court of Victoria