

IN THE CORONERS COURT
OF VICTORIA
AT MELBOURNE

Court Reference: COR 2007 4502

FINDING INTO DEATH WITHOUT INQUEST

Form 38 Rule 60(2)

Section 67 of the Coroners Act 2008

I, JANE HENDTLASS, Coroner having investigated the death of **TYLER READING-ADAMS**

without holding an inquest:

find that the identity of the deceased was **TYLER READING-ADAMS**

born on 7 November 2007

and the death occurred on 7 November 2007

at Royal Women's Hospital, 20 Flemington Road Parkville 3052

from:

1 (a) INTRAPARTUM HYPOXIA

Pursuant to section 67(2) of the **Coroners Act 2008**, I make findings with respect to **the following circumstances:**

1. Tyler Reading-Adams was 95 minutes old when he died. Tyler's mother was Krystal Reading. She lived with Tyler's father, Paul Adams, and their first child at Unit 2, 31 Thackeray Grove in East Reservoir.
2. Ms Reading was 23 years old. Her medical history included migraine, asthma and cervical dysplasia.
3. On 24 April 2007, Ms Reading attended the antenatal clinic at the Royal Women's Hospital. She was assessed as low risk. Other than smoking, no risk factors were identified.
4. On 11 September 2007, Ms Reading had her 30 week ultrasound. This showed that her baby's right renal pelvis dilation had progressed and required follow up after delivery.

5. On 9, 16, 23 and 30 October 2007, Ms Reading was further reviewed at the Royal Women's Hospital. By 30 October, she was starting to feel heaviness and niggling pains. No problems were identified.
6. At 2.30am on 7 November 2007, Ms Reading's amniotic sac broke spontaneously at home and her contractions began about 10 minutes later. The baby was active and the liquor was clear. Her pregnancy was 40 weeks and six days gestation.
7. At 4.10am on 7 November 2007, Ms Reading presented in a taxi at the Emergency Department at the Royal Women's Hospital. At 4.20am, CTG monitoring commenced. At about 4.30am, she had two strong contractions and the baby became very active, more active than Ms Reading had experienced during the rest of her pregnancy. This period was associated with foetal heart rates of 130 to 150bpm.
8. The CTG in the Emergency Department indicated that the baby's heart rate slowed to about 130bpm at about 5.16am and remained variable until about 5.20am. The baby then became more active with heart rates up to 160bpm.
9. At 5.53am on 7 November 2007, Ms Reading was admitted to the birthing suite at the Royal Women's Hospital. The active stages of her labour were managed by midwives, Swee Lan Yeo and Linda Stegman.
10. The baby's heart rate was monitored intermittently in the birthing suite and the CTG was discontinued.
11. At 6.00am, the baby's heart rate was 120bpm. Ms Reading denies nursing reports that she was uncooperative but she was very distressed because she thought something was wrong. At 6.00am, Ms Reading wanted to push but there were no external signs. She was given nitrous oxide.
12. Ms Stegman and Ms Yeo recorded the foetal heart rates at five minute intervals. At 6.40am the foetal heart rate was 122bpm. At 6.45am it was 92bpm. At 6.50am it was 70bpm. Ms Yeo says this decline in foetal heart rate was not concerning because birth was imminent.
13. At 6.40am, Ms Reading was also assessed by midwife, Abbi Baker. Ms Baker was a Grade Two Midwife with five years experience. She noted the assessments by Ms Stegman and Ms Yeo but recorded a foetal heart rate of 100bpm.

14. Ms Baker also assessed Ms Reading as commencing second stage of her delivery.
15. The medical record indicates that Ms Reading was very distressed and non co-operative with active pushing during the late second stage of labour. However, Ms Reading says she was told to stop pushing because the cord was around the baby's neck. Her recollection is that the midwives released the cord and she was then told she could push again.
16. I am unable to say which version of these events is accurate.
17. At 6.52am on 7 November 2007, Tyler was born vaginally. Therefore the second stage of his delivery lasted 12 minutes.
18. The cord was wrapped tightly around Tyler's neck three times and had a "true knot". Unexpectedly, his Apgar scores were 1 at one and five minutes. An APGAR score of 8, 9 or 10 is required to indicate that a newborn baby is in good health.
19. The obstetric and gynaecology registrar, Dr Jo Vivian-Taylor, commenced resuscitation about three minutes after birth. This included a CPAP mask using room air and increasing oxygen levels. However, Tyler's blood oxygen levels continued to deteriorate.
20. At 5-6 minutes after his birth, the paediatric fellow, Dr Hussain, assessed Tyler with no pulse and intermittent gasps. He intubated Tyler, organised cardiac massage and provided him with further oxygen as well as adrenaline and other medication.
21. However, Tyler's heart rate deteriorated from 100bpm to 80bpm with gasping respirations after ventilation was instituted.
22. At 7.18am, the consultant neonatologist, Dr Sheryle Rogerson, was called to assess Tyler. She recorded that:
 - Admission CTG acceptable
 - CTG normal
 - GBS negative
 - Echocardiogram revealed dilated heart with no function and no flow but occasional flutterings at 80bpm.

23. At 7.40am, gasping ceased. Resuscitation efforts had failed.
24. At 8.30am on 7 November 2007, Tyler Reading-Adams died.
25. Dr Rogerson recorded the following possible diagnoses:
- True Knot in cord
 - Congenital cardiac defect
 - Severe pulmonary hypertension
 - Pulmonary hypoplasia.
26. Dr Rogerson excluded the possibility of pneumothorax. She did not mention the cord around Tyler's neck.
27. In her Medical Practitioner's Deposition, Dr Rogerson expressed the opinion that the cause of death was a true knot on cord and cord around neck leading to asphyxia and cardiac arrest.
28. Further, in her Medical Report on Perinatal Death prepared for the Consultative Council on Obstetric and Paediatric Mortality and Morbidity, Dr Rogerson recorded under Type of Delivery :
- "True knot in cord, cord around neck 3 times"*
29. Further, under the heading of Umbilical Cord, Dr Rogerson recorded:
- "True knot. Cord around neck."*
30. The forensic pathologist who performed the autopsy formed the opinion that the cause of death was complications of intrapartum hypoxia.
31. The umbilical cord was 54 cm long. It contained three patent vessels. There is no mention of a true knot.
32. Histological examination of the placenta found the umbilical cord contained three patent vessels with no evidence of inflammation. There was a small area of recent infarction and evidence of heavy meconium staining. No other specific pathological abnormality was detected.

33. Accordingly, I find that Tyler Reading-Adams died from intrapartum hypoxia.
34. Dr Christine Bessell is the Chief Medical Officer at the Royal Women's Hospital.
35. Dr Bessell says and I agree that the Clinical Practice Guidelines were applied appropriately and there is nothing in the medical records to indicate that a different model of care should have been chosen.
36. However, Dr Bessell has also acknowledged that Tyler probably died because of the true knot in his umbilical cord.
37. I have formed the view that, in the context of no indicative antepartum or intrapartum complications and without evidence of persistent non-reassuring fetal status, Tyler's catastrophic hypoxia occurred during the 12 minutes of the second stage of labour.
38. In the absence of prior diagnosis of a true knot in Tyler's umbilical cord, the midwives performed their duties appropriately.

COMMENTS

Pursuant to section 67(3) of the **Coroners Act 2008**, I make the following comment(s) connected with the death:

1. Professor Jeremy Oats is the Chair of the Consultative Council on Obstetric and Paediatric Mortality and Morbidity (CCOPMM). He also delivers babies at the Royal Women's Hospital.
2. The CCOPMM is established by the *Public Health and Wellbeing Act 2008*.
3. The Victorian Perinatal Data Collection is also established by the *Public Health and Wellbeing Act 2008* under the functions of CCOPMM.
4. These functions include:
 - “(a) *conduct study, research and analysis into the incidence and causes in Victoria of maternal deaths, stillbirths and the deaths of children;*
 - “(b) *conduct study, research and analysis into the incidence and causes of obstetric and paediatric morbidity;*
 - “(c) *conduct a perinatal data collection unit for the purpose of—*

- (i) *collecting, studying, researching and interpreting information on and in relation to births in Victoria;*
- (ii) *identifying and monitoring trends in respect of perinatal health including birth defects and disabilities;*
- (iii) *providing information to the Secretary on the requirements for and the planning of neonatal care units;*
- (iv) *providing information for research into the epidemiology of perinatal health including birth defects and disabilities;*
- (v) *establishing and maintaining a register of birth defects and disabilities;*

Note

Birth defects and disabilities means any birth defect or disability of prenatal origin identified in a foetus or a child.

- (d) *provide to health service providers—*
 - (i) *information on obstetrics and paediatrics;*
 - (ii) *strategies to improve obstetric and paediatric care;*
- (e) *consider, investigate and report on any other matters in respect of obstetric and paediatric mortality and morbidity referred to CCOPMM by the Minister or the Secretary;*
- (f) *liaise with any other Consultative Council (whether or not prescribed) on any matter relevant to the functions of CCOPMM;*
- (g) *publish an annual report on the research and activities of CCOPMM;*
- (h) *perform any other prescribed function;*
- (i) *collect information for the purpose of performing its functions under this subsection.”*

5. Further, the Secretary of the Department of Health must make available to CCOPMM any resources from the Department that are necessary to enable CCOPMM to carry out its functions.
6. All live and still births in Victoria in Victoria must be reported to CCOPMM with data recorded on a standard manual or electronic Birth Report and coded into the Victorian Perinatal Data Collection.
7. Most of these data items comply with the National Perinatal Minimum Data Set and are sent to the National Perinatal Statistics Unit for the production of the annual report on Australia's mothers and babies.
8. Each year the Department of Health reviews the Victorian Perinatal Data Collection on behalf of the CCOPMM.
9. In 2007, the data set included information on every birth in Victoria of at least 20 weeks' gestation or if gestation is unknown, at least 400 grams birth weight.¹
10. These data include over 100 items for each mother and baby. However, there is no specific provision to record any descriptor or other status of the umbilical cord on the data collection form or in the Victorian Perinatal Data Collection.
11. Free text can and is sometimes used to record a description of the umbilical cord under neonatal morbidity or occasional data headings on the data collection form. However, these would not normally be coded into the Victorian Perinatal Data Collection and would lack statistical reliability.
12. Further, The Royal Women's Hospital has continued a specific data field that records the presence of a true knot but this information is not transferred to the Victorian Perinatal Data Collection.
13. Professor Oats says that true knots and the cord being wrapped around the baby's neck are common and in only a few cases are they associated with perinatal asphyxia and/or death and only rarely is there clear evidence these are likely to be causal.

¹ The criteria for reporting a birth to CCOPMM has since changed but this would not influence reporting of babies born in the circumstances that Tyler was born.

14. Not surprisingly in the absence of any capacity to collect aggregated reliable data about the umbilical cord status of babies born in Victoria, Professor Oats says there is very little quality evidence linking adverse perinatal outcomes with the umbilical cord around the babies' neck or with true knots in the umbilical cord.
15. Accordingly, the Executive Medical Advisor at the Royal Women's Hospital, Dr Christine Bessell, has written to me stating:

"We agree that it would be very helpful to ask the Consultative Council on Obstetric and Paediatric Mortality and Morbidity (under which the PDCU operates) to initially assess the availability and reliability of routinely collected data on the incidence of true knots in the umbilical cord, and the feasibility of undertaking research into associated pregnancy factors, which could result in a reduction in adverse pregnancy outcomes."

16. Professor Oats has advised me that, in his opinion, the most feasible way to collect information about umbilical cords would appear to be to request that the three Level 6 Maternity Services in Melbourne² do this as a collaborative project.
17. Each year the Department of Health reviews the Victorian Perinatal Data Collection on behalf of the CCOPMM.
18. On 16 April 2013, the Department of Health sought proposals for revision of the Perinatal Data Collection for births from 1 January 2014.
19. In order to be accepted into the Perinatal Data Collection proposals need to demonstrate clear business justification and be fully costed, meaning funding streams will need to be identified and confirmed. Final acceptance of all proposals is dependent on endorsement by the CCOPMM.
20. International data indicates that Victoria and Australia are not unusual in the lack of information available about the incidence of and mortality and morbidity associated with umbilical cord variations.
21. In 2000, a review of 22012 births in Akershus Central Hospital in Oslo, Norway found 216 or 1% of babies were born with a knotted cord. There was an association between knotted cords

² Royal Women's Hospital, Mercy Hospital for Women and Monash Medical Centre.

and umbilical cord encirclements. There was a 10 times greater likelihood of death for babies with a knotted cord but, if death does not occur, there was no increased risk of obstetrical intervention and Apgar scores were statistically the same as babies without knotted umbilical cords.³

22. In 2001, a review of 69139 births in Soroka University Medical Centre in Israel confirmed the incidence of true knots was 1.2% and there was a four fold increase in antepartum death for these babies. Fetal distress and meconium stained amniotic fluid was twice as high in babies with true knots than in other babies and they were more likely to be delivered surgically.⁴
23. In 2002, a review of 23027 births in Finland also found the incidence of true knots in the umbilical cord was 1.25% with a four fold increase in still birth.⁵
24. True knots are more likely to occur in male foetuses, babies with long cords, babies with cord around the neck or prolapsed cords, monoamniotic twins and polyhydramnios.⁶ In Israel, 1.45% of boys and 1.0% of girls had true umbilical cord knots. Similarly, 1.5% of Jewish babies and 0.7% of Bedouin babies had true umbilical cord knots.
25. In Victoria, 71,444 babies were born in 2011. Applying overseas research, about 890 of these babies could be expected to be born with true knots in their umbilical cords and, of these, eight boys and five girls could be expected to die.
26. These estimates do not take into account differences between Victoria and Israel, Finland and Norway including ethnicity and multiparity. For example, in Israel, 23% of mothers had more than four previous deliveries.
27. Further, in the absence of any statistical data in Victoria about the incidence of umbilical cord complications, no concrete predictions about the influence of umbilical cord complications on the live birth rate for pregnancies with no previously identified concerning factors.

³ T. Sornes, Umbilical cord knots, *Acta Obstetrica et Gynaecologica Scandinavica* 79(2000) 157-9.

⁴ R HersHKovitz, T Silberstein, E Sheiner, I Shoham-Vardi, G Holcberg, M Katz & M Mazor, Risk factors associated with true knots of the umbilical cord, *Europ. J Obstet & Gynec and Reproduct Bio.* 98 (2001) 36-9.

⁵ U Airas & S Heinonen, Clinical significance of true umbilical knots: A population based analysis, *Amer. J Perinatol* 19(2002) 127-132.

⁶ T. Sornes, Umbilical cord knots, *Acta Obstetrica et Gynaecologica Scandinavica* 79 (2000) 157-9; R HersHKovitz, T Silberstein, E Sheiner, I Shoham-Vardi, G Holcberg, M Katz & M Mazor, Risk factors associated with true knots of the umbilical cord, *Europ. J Obstet & Gynec and Reproduct Biol.* 98 (2001) 36-9; U Airas & S Heinonen, Clinical significance of true umbilical knots: A population based analysis, *Amer. J Perinatol* 19 (2002) 127-132.

28. On 16 April 2013, the Department of Health published proposed changes to the reporting criteria for all births to CCOPMM to come into effect on 1 January 2014. Most of these changes have been proposed by the Department of Health. However, they can only be implemented with consent of CCOPMM.
29. The proposed changes in the data collected about Victorian babies still do not include any requirement to record any descriptor or other status of the umbilical cord.
30. Further, on 24 April 2013, CCOPMM published the annual review of Business Rules for data coded into the Victorian Perinatal Data Collection.
31. The changes in Business Rules for data coded into the Victorian Perinatal Data Collection have been designed to encourage electronic reporting of live and still births using the Department of Health portals already used by most health services for other reporting purposes.
32. The planned changes in data collection from 1 January 2014 mean that now is an appropriate time to introduce a new field which will provide long term information about umbilical cord status as well as abnormalities and complications in Victorian babies.
33. Therefore, I recommend that the Department of Health recommend revision of the Victorian and Australian Perinatal Data Collections for births from 1 January 2014 to include information about the status of the umbilical cord including whether or not it is round the neck or has a true knot and providing for free text to clarify any other abnormalities.

Recommendation 1

34. In the meantime, I recommend that CCOPMM, of its own initiative, arrange for the three Level 6 Maternity Services in Victoria at the Royal Women's Hospital, Mercy Hospital for Women and Monash Medical Centre, commence use of their current reporting procedures to include information about the status of the umbilical cord including whether it is round the neck and/or has a true knot and to clarify any other abnormalities. **Recommendation 2**
35. I also recommend that the Secretary of the Department of Health provide CCOPMM with the funding required to implement these changes in the Victorian Perinatal Data Collection for births from 1 January 2014. **Recommendation 3**
39. In 2009, Ferguson and Dodson stated:

“Surprisingly while the umbilical cord must effectively function in an environment where mechanical forces abound, it is one tissue that has largely been ignored by bioengineers and physical scientists.”⁷

42. The reasons for this lack of apparent interest in umbilical cords include:

- Lack of understanding of the mechanism which determines the outcome for babies with a true knot in their umbilical cord and, to a lesser extent, and cords around the babies’ neck;
- Technical difficulty in accurately identifying the true knot before the baby enters second stage of delivery; and
- Clinicians’ concern about their appropriate clinical response to a known true knot in the umbilical cord of a foetus and/or the cord around the baby’s neck.

43. However, recent research has shown that that factors associated with venous occlusion in knotted umbilical cords are also those that are physically less likely to protect the cord from occlusion. Therefore, the mechanism of the increased risk of death associated with true knots is probably venous obstruction causing hypoxia.

44. For example, in 2005, Tuxen *et al* showed that the risk of cord vascular occlusion in artificially knotted umbilical cords was associated with low cord thickness⁸, low cord hydration index, low venous flow capacity prior to knotting and low foetal birth weight.⁹

45. Further, technical developments in ultrasonography indicate that, with the right equipment, it is possible to diagnose of true knot during routine ante-natal scans.

46. For example, in Spain, investigators have used the 29 week ultrasound identification of a transection of the umbilical cord surrounded by one of its loops to diagnose a true knot of the umbilical cord. They have then studied the effect of changes in the tension in a foetus’ umbilical cord on blood flow using four-dimensional ultrasonography.¹⁰

⁷ VL Ferguson & RB Dodson, Bioengineering aspects of the umbilical cord, *Europ. J. Obstet. & Gynaec. and Reproductive Biol.*, 144 (2009) 108-13.

⁸ Mostly low quantities of Wharton’s jelly.

⁹ AJ Tuxen, M Permezel, SP Walker & HM Georgiou, Factors affecting Venous Perfusion during Experimental Cord Knotting, *Placenta*, 26 (2005) 753-7.

¹⁰ CLR y Cajal & RO Martinez, Four-dimensional ultrasonography of a true knot of the umbilical cord, *Amer. J. Obstet. & Gynsec.* 195(2006) 896-8.

47. The Israeli researchers also recommended careful sonographic and Doppler examinations of the umbilical cords of foetuses in these at risk groups. With advancing ultrasound technology and reducing costs, barriers to use of this type of technology can be expected to decline in the next few years.

48. The remaining issue for improving the survivability of babies born with a true knot in their umbilical cord and cords around the babies' neck remains clinicians' response to knowledge that a foetus has an umbilical cord complication. The Finns say little can be done to reduce the risk of foetal deaths associated with true knots during pregnancy:

*"monitored vaginal delivery appears to be a safe option for fetuses with true knots."*¹¹

49. However, it seems to me that clinicians will become more interested in finding ways to minimise the risk to babies with true knots in their umbilical cords and cords around the babies' neck when they are able to identify these complications during pregnancy and become aware of the risk factors that influence the outcome.

50. Therefore, I recommend that the Department of Health monitor the data produced by the new collection of information about umbilical cords to inform it about the priority to give to procurement of new radiology equipment which can identify true knots and cords around the foetus' neck so that clinical responses can be informed by the knowledge of potential cord vascular occlusion. **Recommendation 4**

51. Further, I recommend that CCOPMM and the Royal Australian and New Zealand College of Obstetricians and Gynaecologists publish the statistical information that becomes available from the Victorian Perinatal Data Collection as a way of encouraging obstetricians and midwives to consider how they can minimise the risks associated with true knots, cords around the neck and other umbilical cord complications in otherwise uncomplicated births. **Recommendation 5**

¹¹ U Airas & S Heinonen, Clinical significance of true umbilical knots: A population-based analysis, Amer.J. Perinatol. 19(2002) 127-132.

RECOMMENDATIONS

Pursuant to section 72(2) of the **Coroners Act 2008**, I make the following recommendation(s) connected with the death:

I recommend that:

1. The Department of Health recommend revision of the Victorian and Australian Perinatal Data Collections for births from 1 January 2014 to include information about the status of the umbilical cord including whether it is round the neck or has a true knot and providing for free text to clarify any other abnormalities
2. The Consultative Council on Obstetric and Paediatric Mortality and Morbidity, of its own initiative, arrange for the three Level 6 Maternity Services in Victoria to commence use of their current reporting procedures to include information about the status of the umbilical cord including whether it is round the neck and/or has a true knot and to clarify any other abnormalities.
3. The Secretary of the Department of Health provide the Consultative Council on Obstetric and Paediatric Mortality and Morbidity with the funding required to implement these changes in the Victorian Perinatal Data Collections for births from 1 January 2014.
4. The Department of Health monitor the data produced by the new data collection to inform it about the priority it should give to procuring new radiology equipment which can identify true knots and cord around the foetus' neck so that clinical responses can be informed by the knowledge of potential cord vascular occlusion.
5. The Consultative Council on Obstetric and Paediatric Mortality and Morbidity and the Royal Australian and New Zealand College of Obstetricians and Gynaecologists publish the statistical information that becomes available from the Victorian Perinatal Data Collection as a way of encouraging obstetricians and midwives to consider how they can minimise the risks associated with true knots and other umbilical cord complications in otherwise non-concerning births.

I direct publication of this Finding on the Coroners Court website.

I direct that a copy of this finding be provided to the following:

Ms Krystal Reading, Next of Kin

Minister of Health

Secretary for Department of Health

Chair of Consultative Council on Obstetric and Paediatric Mortality and Morbidity

The Royal Australian and New Zealand College of Obstetricians and Gynaecologists

Signature:



DR JANE HENDTLASS

Coroner

Date: **9 May 2013**

