Perinatal and Maternal Mortality Review Committee

He matenga ohorere, he wairua uiui, wairua mutungakore

Health Quality & Safety Commission New Zealand
Kupu Taurangi Hauora o Aotearoa

Executive Summary
of the
Ninth Annual Report of the Perinatal and Maternal Mortality Review Committee
Reporting mortality 2013

(Full report available online at
http://www.hqsc.govt.nz/our-programmes/mrc/pmmrc/publications-and-resources/publication/2123/)

Executive Summary and Recommendations

Terms of Reference and Mortality Definitions PMMRC

- The Perinatal and Maternal Mortality Review Committee (PMMRC) is responsible for reviewing maternal deaths and all deaths of infants born from 20 weeks gestation (or weighing at least 400g if gestation is unknown) to 28 completed days after birth.
- A maternal death is the death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the duration and site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management. It does not include accidental or incidental causes of death of a pregnant woman.
- Maternities are all live births and all fetal deaths at 20 weeks or beyond or weighing at least 400g if gestation was unknown. The maternal mortality ratio is calculated per 100,000 maternities.
- Fetal death is the death of a fetus at 20 weeks gestation or beyond (≥20 weeks) or weighing at least 400g if gestation is unknown. Fetal death includes stillbirth and termination of pregnancy.
- Neonatal death is the death of any baby showing signs of life at 20 weeks gestation or beyond (for the purposes of this PMMRC dataset) or weighing at least 400g if gestation is unknown. Early neonatal death is a death that occurs up until midnight of the sixth day of life. Late neonatal death is a death that occurs between the seventh day and midnight of the 27th day of life.
- Perinatal mortality rate is calculated in New Zealand as fetal deaths and early neonatal deaths per 1000 total babies born alive or born dead at 20 weeks gestation or beyond, or weighing at least 400g if gestation is unknown.
- Perinatal related mortality rate refers to fetal deaths and early and late neonatal deaths per 1000 total babies born at 20 weeks gestation or beyond or weighing at least 400g if gestation is unknown.
- Neonatal death rate is calculated as neonatal deaths per 1000 live born babies at 20 weeks gestation or beyond or weighing at least 400g if gestation is unknown.

Findings 2015 Report (Data 2013)

Perinatal related mortality

1. The perinatal related mortality rate in 2013 was 10.0/1000 births. This is the lowest rate reported since the PMMRC began collecting annual data in 2007 but is not a statistically significant reduction.
2. The rate of stillbirth was 5.1/1000 births in 2013, and has fallen statistically significantly since 2007 when it was 5.6/1000 births (p=0.015).
3. The rate of neonatal death was 2.6/1000 live births in 2013, and has not changed from 2007 to 2013.
4. The rate of termination of pregnancy from 20 weeks has risen significantly since 2007 from 2.2/1000 births to 2.3/1000 births in 2013 (p=0.03). This is due to an increase in terminations associated with conditions other than congenital abnormalities (eg, perinatal infection, hypertension, antepartum haemorrhage, intrauterine growth restriction and prolonged premature rupture of the membranes).
5. There was a significant reduction in perinatal related mortality (chi-squared for linear trend p=0.001 overall and p=0.0001 if congenital abnormality deaths are excluded) using the international definition, recommended by the World Health Organization, of perinatal related deaths from 1000g or 28 weeks if birthweight is unknown. This is due to significant reductions in hypoxic peripartum and unexplained antepartum deaths.

6. There was a significant reduction in the hypoxic peripartum perinatal related death rate, from 0.5/1000 in 2007 to 0.18/1000 births in 2013 (p=0.0003).

7. A multivariate analysis reported in the eighth report of the PMMRC showed that women who have a body mass index (BMI) >25, women who smoke in pregnancy, women of Indian ethnicity and women having their first birth are at increased risk of stillbirth independent of age and socioeconomic status. A combination of risks results in a higher risk of stillbirth as risks are independent of each other and so have a cumulative effect.

8. A multivariate analysis reported in the eighth report of the PMMRC showed that women of Māori and Pacific ethnicity, women who smoke in pregnancy, women living in areas of high socioeconomic deprivation and women having their first birth are at increased risk of neonatal death of babies born at 20–27 weeks independent of age and socioeconomic status. Women who smoke during pregnancy are also at increased risk of neonatal death of babies born from 28 weeks gestation, independent of ethnicity, socioeconomic deprivation, age, parity and BMI.

9. There was a significant increase from 2007 to 2013 in the perinatal related death rate among women under 20 years of age. This is associated with an increase in the proportion of births to Pacific mothers and mothers residing in the most deprived areas among under 20-year-old mothers.

10. The following district health board (DHB) areas have significantly higher unadjusted rates of perinatal related death than the New Zealand rate and may require additional assistance to address these issues:
    - Counties Manukau – all perinatal related mortality
    - Northland – stillbirth and neonatal death rate
    - Bay of Plenty – neonatal death rate.

11. There was a significant increase from 2007 to 2013 in the perinatal related mortality rate of babies born at 20–23 weeks (p=0.011) due to an increase in late termination of pregnancy. There was a 30 percent reduction in perinatal related mortality among babies born at 37–40 weeks (p=0.004) and a 50 percent reduction among babies born at 41+ weeks (p=0.002).

12. There was a reduction of 30 percent in the stillbirth rate at 37–40 weeks and 40 percent at 41+ weeks. In 2007 there were 117 stillbirths at term (37+ weeks) and in 2013 there were 69. The greatest reduction in absolute numbers of stillbirths at term in 2013 was a reduction of 30 percent in unexplained antepartum deaths and a reduction of 80 percent in hypoxic peripartum deaths from the 2007–2009 average. There was also a significant reduction in stillbirth at term from antepartum haemorrhage and perinatal infection.

13. There was a significant reduction of 78 percent in the intrapartum stillbirth rate (of babies from 24 weeks without congenital abnormality), from 0.54/1000 births in 2007 to 0.12/1000 births in 2013.

14. There were 152 neonatal deaths in 2013 in New Zealand. Of these, 49 (32 percent) died from spontaneous preterm birth.

15. Māori, Pacific and Indian neonates were significantly more likely to be born at 20–23 weeks and subsequently die than they were to die at any later gestation and also at least twice as likely to be born and die at 20–23 weeks as New Zealand European neonates. This is because of higher rates of preterm birth among these ethnic groups.

16. The increase in perinatal related deaths among multiples from 2007 noted in the previous two PMMRC reports remains statistically significant, although a reduction in death rate among multiples in the last two years is observed.

17. In 2013, 80 percent of eligible mothers were screened for diabetes. This is a higher rate than in previous years but it is not clear whether this is due to improved uptake or improved data reporting.

18. The data collected by the PMMRC on family violence screening continue to suggest that many women pass through the maternity service without being screened.

19. The rate of optimal investigation of perinatal related death at 53 percent was the highest rate since PMMRC data collection began in 2007, although this increase was not statistically significant. Among the 216 post-mortems in 2013 where value of the post-mortem was assessed, the post-mortem changed the clinical diagnosis in 41 cases (19 percent).

20. Among perinatal related deaths, 16 percent were assessed as potentially avoidable. The largest absolute number of potentially avoidable deaths in any cause of death category was 18 potentially avoidable deaths among deaths from maternal conditions (largely diabetes).

21. Barriers to access and/or engagement with care increase in frequency among women living in increasing levels of socioeconomic deprivation. One in six perinatal related deaths among women residing in the most socioeconomically deprived households might have been avoided by improved access to antenatal care.

22. Spontaneous preterm birth was a cause of death for almost 1000 babies from 2007 to 2013, accounting for 21 percent of all perinatal related deaths from 2007 to 2013.

23. Bleeding occurred at some time during pregnancy in 60 percent of women whose babies died from spontaneous preterm birth.

24. The majority of deaths (71 percent) from spontaneous preterm birth occurred among births prior to 24 weeks. Most of the remainder (21 percent) were born between 24 and 27 weeks.

25. Thirty-four percent of mothers whose babies died from spontaneous preterm birth were smokers, and this is considerably higher than rates of smoking for New Zealand mothers overall (15 percent of mothers at registration for antenatal care).

26. The relative risk of death due to spontaneous preterm birth is six to seven times higher among multiple pregnancies than among singleton pregnancies.

Maternal mortality

1. In 2013, there were 12 maternal deaths. The maternal mortality ratio in New Zealand was 20.0/100,000 maternities (95 percent confidence interval (CI) 11.4–34.9/100,000). The three-year average maternal mortality ratio for 2011–2013 was 16.8/100,000 maternities (95 percent CI 11.8–23.8/100,000). There has been no statistically significant change in the maternal mortality ratio in New Zealand since data collection by the PMMRC began in 2006.

2. Pre-existing medical disease, suicide and amniotic fluid embolism were the most frequent causes of maternal mortality in New Zealand in 2006–2013. Suicide continues to be the leading 'single' cause of maternal death in New Zealand.

3. The cause-specific maternal mortality ratio for deaths from amniotic fluid embolism from 2006 to 2013 was 5.6 times higher in New Zealand than in the UK 2006–2011 ($p<0.0001$).

4. The cause-specific maternal mortality ratio for deaths from suicide from 2006 to 2013 was seven times higher in New Zealand than in the UK 2006–2011 ($p<0.0001$).

5. The risk of maternal mortality is higher for women 40 years and older than for younger women.

6. The maternal mortality ratio for Māori and Pacific mothers is two to three times that of Other Asian, Other and New Zealand European mothers. The relative maternal mortality ratios for direct and indirect deaths were 3.2 and 2.9, demonstrating that the disparity between maternal mortality among Māori and Pacific peoples at highest risk and other ethnicities is not affected by whether the maternal deaths were direct or indirect.

7. The risk of maternal mortality increased significantly with increasing deprivation quintile in 2006–2013. The risk for women living in the most deprived 20 percent of residential areas from 2006 to 2013 was 2.4 times that of those in the least deprived 20 percent.

8. Thirty-six percent of maternal deaths were identified as potentially avoidable from 2006 to 2013. Contributory factors were identified in 61 percent of maternal deaths in the years 2006–2013. The presence of contributory factors and the assessment of potentially avoidable death did not vary by whether maternal deaths were classified as direct or indirect.

Neonatal encephalopathy

1. The rate of neonatal encephalopathy as a proportion of all registered births is 1.19/1000 (95 percent CI 1.06–1.33) registered births. The rate can also be reported as 1.29/1000 births at term (≥37 weeks) (95 percent CI 1.16–1.45) as the definition is limited to term births.

2. There is a higher rate of neonatal encephalopathy among Pacific mothers than New Zealand European mothers, among babies born at 37 weeks, and an increasing rate with increasing deprivation.

3. The majority of babies diagnosed with neonatal encephalopathy have evidence of asphyxia present at the time of birth.

4. The rate of induced cooling of babies with moderate and severe neonatal encephalopathy has increased significantly from 68 percent in 2010 to 83 percent in 2013 (p=0.03).

5. The unadjusted rate of neonatal encephalopathy among women resident in the Capital & Coast DHB area was significantly higher for 2010–2013 than the national rate.

6. The Neonatal Encephalopathy Working Group (NEWG) multidisciplinary review of 83 neonatal encephalopathy babies born in 2010–2011 with abnormal cord blood gases and/or Apgar scores where there was no identifiable peripartum acute event or prelabour Caesarean found contributory factors in 84 percent of cases and found that the severity of the neonatal encephalopathy was potentially avoidable in 55 percent. The key themes identified were risk assessment and management, use of recommended best practice, fetal surveillance, resuscitation, recognition of brain injury in the neonate, and documentation.

Maternal morbidity

1. There were 12 cases of amniotic fluid embolism in New Zealand from 2010 to 2013, giving a rate of 0.5/10,000 maternities. This is higher than rates reported from the UK and the Netherlands, but similar to Australia.

2. There were 69 cases of placenta accreta in New Zealand from 2010 to 2012, giving a rate of 3.6/10,000 maternities. Sixty-five percent of these women had a previous Caesarean section and 58 percent required a hysterectomy for treatment.

Recommendations

Methodology

1. **As a matter of urgency, the Ministry of Health update the National Maternity Collection (MAT), including the ethnicity data as identified by the parents in the birth registration process.**

Justification:
As at March 2015, the MAT is incomplete as it does not include 10–15 percent of registration data from DHBs that provide primary maternity care.

As a result of these missing data, it is not possible to undertake robust multivariate analyses including ethnicity, maternal age, socioeconomic status, lead maternity carer (LMC) and DHB of residence, adjusting for smoking and maternal BMI because early pregnancy data are not available for women under the care of hospital maternity services. Women under the care of hospital maternity services are at disproportionately higher risk of perinatal related mortality and differ from the remainder of the birthing population by ethnicity, socioeconomic deprivation and DHB of residence. It is likely that they also differ by smoking and BMI. By not including data about these women, analyses will be misleading.

The PMMRC has previously identified that there are important differences in ethnicity between the National Minimum Dataset (NMDS) and registration datasets which impact on the findings of analyses of the association between ethnicity and perinatal related mortality (PMMRC 2010).

Evidence:
DHBs have service specifications that require them to collect registration data. As at March 2015, the information technology project to transfer these data from DHBs to the Ministry of Health was incomplete.

The Births and Deaths Registration dataset is the preferred source of ethnicity data for mothers and babies, and is the principal source of ethnicity data for the majority of perinatal deaths in the PMMRC collection. These data are truly self-defined as the source is a form completed by the parent(s) and returned to the Registrar of Births, Deaths and Marriages. The MAT dataset sources ethnicity data from the National Health Index, NMDS and LMC datasets. While there is a protocol for collection of ethnicity data from contacts with the health system, historical evidence suggests that there are quality issues in these collections (Cormack 2010).

Perinatal mortality

1. **That all maternity care providers identify women with modifiable risk factors for perinatal related death and work individually and collectively to address these.**

   Strategies to address modifiable risk factors include:

   a. **improving uptake of periconceptual folate**
   b. **pre-pregnancy care for known medical disease such as diabetes**
   c. **access to antenatal care**
   d. **accurate height and weight measurement in pregnancy with advice on ideal weight gain**
   e. **prevention and appropriate management of multiple pregnancy**
   f. **smoking cessation**
   g. **antenatal recognition and management of fetal growth restriction**
   h. **prevention of preterm birth and management of threatened preterm labour**
   i. **following evidence-based recommendations for indications for induction of labour**
   j. **advice to women and appropriate management of decreased fetal movements.**

   All DHBs should report the availability and uptake of relevant services in their annual clinical report to ensure that these strategies are embedded and to identify areas for improvements.

Justification:
Multivariate analysis reported in the eighth report of the PMMRC identified Indian mothers, women with a high BMI, women who smoke in pregnancy and women having their first baby to be at increased risk of stillbirth. Women of Māori and Pacific ethnicity, women who smoke in pregnancy, women living in areas of high socioeconomic deprivation and women having their first baby were identified to be at increased risk of neonatal death. Each of these risk factors is independent of other risk factors and so women with more factors are at higher risk than women with one. Māori and Pacific women are at increased risk of neonatal mortality because of an increased risk of preterm birth. Age was not an independent risk factor after accounting for other factors.

The analysis in this report shows that there are differences in mortality and morbidity by DHB, and the PMMRC has specifically noted where DHB rates fall outside the national average, indicating where urgent work is required. The PMMRC also recognises (and describes in section 1.3 Births in New Zealand 2013) the differences in demography in different regions.

The following DHBs have significantly higher rates of specific deaths than the New Zealand rate and may require additional assistance to address these issues:

- Counties Manukau – all perinatal related mortality
- Northland – stillbirth and neonatal deaths
- Bay of Plenty – neonatal deaths.

Barriers to access and/or engagement with care were the most prevalent contributory factors to perinatal related death (16 percent in 2013) and of these, no antenatal care or infrequent care were the most common. These barriers were most often identified among deaths from spontaneous preterm birth.

Evidence:
The programmes and strategies outlined below may apply to individual maternity care providers or to organisations such as the Ministry of Health, primary health organisations, DHBs and professional colleges.

Periconceptual folate: Folate taken prior to pregnancy and continued up to 12 weeks gestation reduces occurrence and reoccurrence of neural tube defects (De-Regil et al 2010). Folate needs to be taken during the period the baby is developing so it is unlikely to be as effective for women who start folate after pregnancy has been diagnosed. For this reason many countries have instituted food supplementation with folate (RCOG 2003).

Preconception care for women with diabetes: Pre-existing diabetes with poor glycaemic control is associated with fetal abnormalities. From 2007 to 2013, there were 90 perinatal deaths where the Perinatal Society of Australia and New Zealand perinatal death classification (PSANZ-PDC) code was 5.2 (maternal condition: Diabetes/Gestational diabetes).

Antenatal care: High quality evidence for antenatal care is limited. A schedule of approximately 10 visits for nulliparous women and 7 visits for multiparous women is generally recommended (NICE 2008).

BMI: Excessive weight gain during pregnancy, regardless of pre-pregnancy weight, is associated with increased maternal and neonatal risks. The Institute of Medicine has made recommendations about the ideal weight gain in pregnancy (Institute of Medicine and National Research Council 2009) and this is highlighted in the eighth report of the PMMRC (see 'A health BMI in pregnancy', page 53). More detailed information is available from the Ministry of Health at:
http://www.health.govt.nz/publication/guidance-healthy-weight-gain-pregnancy.

A study from Christchurch published in 2014 showed that self-reported height and weight resulted in an under-reported BMI for 69 percent of women, and that as measured BMI increased, self-reported BMI was more likely to be lower and by a greater magnitude (Jeffs et al 2014).

Multiple pregnancy: Close management of ovulation induction and a single embryo transfer protocol for in vitro fertilisation are recommended to limit multiple pregnancies arising from assisted reproductive technologies.

The rate of multiple pregnancy is significantly reduced by a policy of single embryo transfer while the cumulative live birth rate is not reduced if repeated single embryo transfer is compared to one multiple embryo transfer (Pandian et al 2013).

Monochorionic pregnancies are responsible for a disproportionate number of perinatal related deaths in multiple pregnancies. Management of monochorionic pregnancies is outlined in the New Zealand Maternal Fetal Medicine Network (2010) guideline *Monochorionic Twin Pregnancy.*

The *Guidelines for Consultation with Obstetric and Related Medical Services (Referral Guidelines)* (Ministry of Health 2012b) recommend transfer of care from primary to secondary care for any multiple pregnancy.

Smoking: *The New Zealand Guidelines for Helping People to Stop Smoking* (Ministry of Health 2014c) recommend routinely offering all smokers referral to a smoking cessation service. These services provide behavioural support which is effective in reducing smoking in late pregnancy and reducing the risk of preterm birth and low birthweight (Chamberlain et al 2013). Nicotine replacement therapy during pregnancy is considered to be safer than continuing to smoke.

Antenatal detection of fetal growth restriction: Observational evidence is available to support the antenatal recognition, surveillance and management of small for gestational age (SGA) babies. Some of this evidence is usefully outlined in the New Zealand Maternal Fetal Medicine Network (2013) *Guideline for the Management of Suspected Small for Gestational Age Singleton Pregnancies after 34 Weeks' Gestation,* and in the Royal College of Obstetricians and Gynaecologists (RCOG 2013) guideline *The Investigation and Management of the Small-for-Gestational-Age Fetus.* Further discussion of the detection of SGA can be found under recommendation 4.

Prevention of preterm birth and management of threatened preterm labour: Evidence supports a number of strategies (1) that may reduce the rate of spontaneous preterm birth and (2) to manage women who are likely to deliver preterm to reduce the risk of mortality and morbidity.

These strategies include addressing smoking (Been et al 2014), family violence, alcohol and substance use, and screening for and treating asymptomatic urinary tract infection. Evidence supports cervical length screening for women at risk (eg, because of previous preterm birth or following cervical excisional surgery) followed by cervical cerclage or vaginal progesterone for women with a shortened cervix (Conde-Agudelo et al 2013; Dodd et al 2013; Fonseca et al 2007).

Antenatal corticosteroids reduce neonatal mortality from preterm birth by approximately 30 percent (Roberts and Dalziel 2007). Magnesium sulphate infusion for women at risk of preterm birth reduces the risk of cerebral palsy by about 30 percent but does not alter risk of neonatal mortality (Doyle et al 2009). In utero transfer to tertiary facilities reduces mortality and morbidity in preterm babies (Chien et al 2001).

Smarter use of technologies such as quantitative fetal fibronectin and cervical length measurement increase the appropriate use of antenatal corticosteroids, magnesium sulphate and in utero transfer to improve mortality and morbidity for babies who deliver at early gestations, while also minimising overuse of medications, disruption to family lives, and hospital bed stays (Liggins Institute 2015; Kuhrt et al 2015).

Multiple pregnancies are more than six times more likely to suffer perinatal related death from spontaneous preterm birth compared to singleton pregnancies. Strategies to reduce iatrogenic multiple pregnancy include monitoring the use of ovulation induction agents and single embryo transfer in assisted reproductive treatments (Pandian et al 2013).

Induction of labour for postdates pregnancy: Induction of labour at 41 weeks or beyond significantly reduces perinatal deaths. The number needed to treat to prevent one death is 410 (Gülmezoglu 2012).

Fetal movements: A guideline for the management of women presenting with decreased fetal movements is available from the Australian and New Zealand Stillbirth Alliance, although the level of evidence supporting this guideline is limited (Preston et al 2010).

2. **Offer education to all clinicians so they are proficient at screening women, and are aware of local services and pathways to care, for the following:**
   a. **family violence**
   b. **smoking**
   c. **alcohol and other substance use.**

Justification:
There were 35 perinatal related deaths from 2009 to 2013 where there were barriers to access and/or engagement with care identified due to family violence.

There have been low rates of screening for family violence among mothers of babies who die in the perinatal period reported to the PMMRC since collection of data began in 2007 in spite of the existence of the Ministry of Health Violence Intervention Programme. There is a paucity of national data on family violence in pregnancy and on use of alcohol and other substances in pregnancy.

Alcohol or other substances were used by one-quarter of New Zealand mothers who died from 2006 to 2012, and one-half of mothers who died from suicide (PMMRC 2014b).

Feedback from LMCs, DHBs and professional colleges suggests that there is a lack of confidence in the workforce in the availability of supportive services for women who disclose family violence or alcohol and substance use to their caregivers. Knowledge of the pathways to local support for care of women is an essential part of screening.

Feedback also suggests that, while there is frequently training in place for midwifery and nursing staff and this training is sometimes compulsory, the provision of, requirement for and uptake of training by medical staff is anecdotally less robust.

This is a complex area and screening and referral for family violence, smoking and alcohol and substance use requires confidence in conducting difficult conversations, and ensuring these conversations are culturally appropriate.

There is Ministry of Health targeted funding for maternity care providers to access family violence and smoking education but not for education around alcohol and other substance use. Discussion within the sector is required to determine how this education will be funded and provided.

See 'Practice Point: Alcohol in Pregnancy' on page 56[1] and 'Practice Point: Family Violence' on page 82.

Evidence:
Family violence: Maternal exposure to domestic violence is associated with increased risk of preterm birth. Women living with domestic violence are more likely to smoke and use other drugs and to be non-attenders to antenatal care. Violence continues into the postpartum period and in the long term is associated with violence to children (Chambliss 2008; Shah et al 2010).

Please refer to *Family Violence Intervention Guidelines: Child and Partner Abuse* (Ministry of Health 2002) for more information.

A systematic review published in 2012 reported good accuracy of screening tools in identifying intimate partner violence, noted that benefits depended on the population screened, and noted that potential adverse effects were minimal (Nelson et al 2012).

There are insufficient studies currently to comment on the effect of interventions to prevent family violence on perinatal mortality (Jahanfar et al 2013; Van Parys et al 2014).

Alcohol: Alcohol is a teratogen which passes freely through the placenta and reaches concentrations in the fetus that are as high as those in the mother. As well as risks of increased perinatal mortality, significant morbidities (such as fetal alcohol spectrum disorder; prematurity; brain damage; birth defects; growth restriction; developmental delay; and cognitive, social, emotional and behavioural deficits) are associated with alcohol consumption during pregnancy.

1 Cross references in this summary document are to pages and sections in the full version of the PMMRC ninth annual report, available at http://www.hqsc.govt.nz/our-programmes/mrc/pmmrc/publications-and-resources/publication/2123/.

Brief, reliable screening tools are available to assist practitioners to recognise and refer women who drink alcohol in pregnancy. In 2012 the Ministry of Health published a practical guideline for practitioners on alcohol in pregnancy (Ministry of Health 2012c).

3. **That multi-disciplinary fetal surveillance training be mandatory for all clinicians involved in intrapartum care.**
   a. **This training includes risk assessment for mothers and babies throughout pregnancy as well as intrapartum observations.**
   b. **The aims include strengthening of supervision and support to promote professional judgment, interdisciplinary conversations and reflective practice.**

Justification:
Review of neonatal encephalopathy cases found the most frequent theme raised was fetal surveillance, including appropriate place of birth; choice of intrapartum fetal surveillance method; interpretation of fetal monitoring; escalation of recognised cardiotocograph (CTG) abnormalities; and management of CTG abnormalities.

The most prevalent personnel contributory factors among perinatal deaths reviewed from 2009 to 2013 were failure to offer or follow recommended best practice; lack of knowledge and skills; failure of communication between staff; failure to seek help/supervision; and lack of recognition of complexity or seriousness of the patient's condition by the caregiver. These factors were often associated with hypoxic peripartum death.

Evidence:
A systematic review of CTG training programmes including 20 studies found that 'training was associated with increased CTG knowledge and interpretive skills, higher interobserver agreement, better management of intrapartum CTG, and improved quality of care' (Pehrson et al 2011).

Studies from the UK and Queensland have reported significant reductions in hypoxic ischaemic encephalopathy and Apgar scores less than 7 at five minutes following introduction of universal or mandatory CTG education (Byford et al 2014; Draycott et al 2006).

Fetal surveillance training should incorporate the concepts outlined in the Royal Australian and New Zealand College of Obstetricians and Gynaecologists' (RANZCOG) *Intrapartum Fetal Surveillance Clinical Guidelines* (RANZCOG 2014a), which was endorsed by the New Zealand College of Midwives.

4. **There is observational evidence that improved detection of fetal growth restriction, accompanied by timely delivery, reduces perinatal morbidity and mortality. The PMMRC recommends (amended from previous PMMRC reports) that assessment of fetal growth should incorporate a range of strategies including:**
   a. **assessment and appropriate referral for risk factors for fetal growth restriction at first antenatal visit and throughout pregnancy**
   b. **accurate measurement of maternal height and weight at first antenatal assessment**
   c. **ongoing assessment of fetal growth by measuring fundal-symphysial height in a standardised way, recorded at each antenatal appointment, preferably by the same person**
   d. **plotting of fundal height on a tool for detection of fetal growth restriction, such as a customised growth chart, from 26 weeks gestation**
   e. **if fetal growth restriction is confirmed by ultrasound, appropriate referral and assessment of fetal and maternal wellbeing and timely delivery are recommended. The New Zealand Maternal Fetal Medicine guideline (2013) describes criteria for the management of small for gestational age (SGA) pregnancies after 34 weeks.**

The PMMRC supports the Ministry of Health initiative to explore the evidence and validate the use of customised growth charts in New Zealand, and to investigate the appropriate way to incorporate these into the national maternity record.

Justification:
Babies who die are at least 2.3 times, and possibly as much as 3.5 times, as likely to be SGA as all babies born in New Zealand, as measured using customised birthweight centiles.

Evidence:
Customised birthweight centiles have been shown to identify a higher proportion of babies who suffered perinatal mortality than population centiles (Anderson et al 2012).

International evidence shows that serial plotting of fundal height on a customised growth chart doubles antenatal detection of SGA (Roex et al 2012).

Observational data suggest that implementation of a standardised methodology to measure fundal height, including adequate training, led to a reduction in stillbirth in the UK (Gardosi et al 2013).

Maternal mortality

5. **Seasonal or pandemic influenza vaccination is recommended for all pregnant women regardless of gestation, and for women planning to be pregnant during the influenza season.**
    a. **Vaccination is also recommended for maternity care providers to reduce the risk to the women and babies under their care.**
    b. **The PMMRC recommends that the Ministry of Health consult with women and maternity care providers to address barriers to the uptake of influenza vaccination in pregnancy and implement strategies to increase access to and awareness of the benefit of vaccination.**

Justification:
Five women died from influenza in pregnancy from 2009 to 2013, none of whom had been immunised.

Despite national campaigns, uptake of influenza vaccination among pregnant women continues to be modest (NISG 2013).

This recommendation should be considered in association with calls for more effective vaccination in pregnancy against pertussis, because both influenza and pertussis vaccination provide protection to the newborn against these infections.

One baby in the years 2007–2013 died from neonatal pertussis infection in the first 27 days of life.

Evidence:
Pregnancy is a risk factor for poor outcome from influenza infection. Compared with non-pregnant populations, pregnant women with either seasonal or pandemic influenza are at increased risk of serious complications including hospitalisation, admission to intensive care units, cardiorespiratory complications (pneumonia, acute respiratory distress syndrome, respiratory failure) and death (Cantu and Tita 2013). These risks increase with gestation and are highest in the third trimester and in the first two weeks postpartum (Memoli et al 2013; Mertz et al 2013). Risks are also higher in pregnant women with comorbidities.

Influenza in pregnancy is also associated with adverse fetal outcomes including miscarriage, stillbirth, neonatal death, preterm birth and low birth weight, mainly due to consequences of severe maternal illness (Cantu and Tita 2013; Memoli et al 2013).

Inactivated influenza vaccination in pregnancy is effective in reducing the rate of influenza illness in pregnant women and provides protection from influenza to the infant for up to six months after birth (Naleway et al 2014; Zaman et al 2008).

Resources for influenza in pregnancy relevant to the New Zealand setting are available on the websites of RANZCOG (RANZCOG 2014b) and the National Influenza Specialist Group (NISG 2015).

Mothers are the most common source of infant infection with pertussis. Health care personnel are also an important source. The highest risk of infant death from pertussis is during the first six months of life. Passive

antibodies following maternal vaccination pass to the baby and help to protect the baby from infection until the time when the baby starts his/her immunisation programme at six weeks of age. The ideal time for maternal vaccination is from 30 to 36 weeks gestation. Immunisation before 20 weeks gestation is not recommended (Auckland Regional Public Health Service, nd).

See 'Practice Point: Influenza in Pregnancy' on page 126.

6. **All pregnant women with epilepsy on medication should be referred to a physician.**
    a. **Women with a new diagnosis of epilepsy or a change in seizure frequency should be referred urgently.**
    b. **The PMMRC recommends a review of epilepsy in the *Guidelines for Consultation with Obstetric and Related Medical Services (Referral Guidelines)*.**

Justification:
Three women died of sudden unexpected death in epilepsy from 2006 to 2013. All three had sub-optimal levels of anticonvulsants.

Evidence:
The Confidential Enquiries into Maternal Deaths in the UK found women with epilepsy are 10 times more likely to die in pregnancy than women without epilepsy (Kapoor and Wallace 2014; Lewis et al 2011) and sudden unexpected death in epilepsy remains the major cause of death in pregnant or postpartum women with epilepsy (Kapoor and Wallace 2014; Kelso and Wills 2014).

The pharmacokinetics of anti-epileptic drugs is affected by pregnancy, particularly lamotrigine and also levetiracetam, phenytoin and carbamazepine, and may lead to loss of seizure control (Harden et al 2009; Hoeritzauer et al 2012).

There has been a change to epilepsy medications recommended in pregnancy to less teratogenic medications and these new medications need to be titrated/increased as pregnancy advances.

Currently the *Guidelines for Consultation with Obstetric and Related Medical Services (Referral Guidelines)* state that women with controlled epilepsy are suitable for a consultation with their primary practitioner and that women with poorly controlled epilepsy or on multiple medications require a transfer of care to a specialist service. However, given the increased risks for pregnant women with epilepsy, the PMMRC recommends that all women with epilepsy on medication are referred for specialist input.

See 'Practice Point: Epilepsy in Pregnancy' on page 127.

Neonatal encephalopathy

7. **Widespread multidisciplinary education is required on the recognition of neonatal encephalopathy with a particular emphasis on babies with evidence of intrapartum asphyxia (eg, babies who required resuscitation) for all providers of care for babies in the immediate postpartum period.**

    This should include:

    a. **recognition of babies at increased risk by their history**
    b. **signs suggestive of encephalopathy**
    c. **knowledge of clinical pathways to induced cooling if required.**

See 'Practice Point: Recognising the Baby at Risk of Neonatal Encephalopathy' on page 147 outlining babies at risk.

Justification:
Review of contributory factors for hypoxic peripartum deaths, and the more recent review of neonatal encephalopathy cases, consistently identifies high rates of personnel contributory factors and high rates of potentially avoidable death and morbidity. The neonatal encephalopathy case review identified neonatal recognition of encephalopathy as one key issue.

Evidence:
Induced cooling (therapeutic hypothermia) reduces the risk of mortality or developmental disability in babies with moderate or severe neonatal encephalopathy by 25 percent and is most beneficial if commenced as soon as diagnosis is made and at least within six hours of birth. This requires vigilance in assessment and observation of newborn babies and readily accessible referral and transfer systems between primary and secondary maternity services and neonatal units.

Information on recognition of babies at risk of neonatal encephalopathy who might benefit from induced cooling and on implementation of a therapeutic hypothermia programme can be found in 'Establishing a hypothermia service for infants with suspected hypoxic ischemic encephalopathy' (Saliba et al 2015).

Local arrangements between the six individual tertiary centres and the centres that transfer to them should include ongoing education, guidelines on selection for cooling therapy and clear routes of communication to cover discussion of individual cases. The New Zealand Neonatal Network is preparing an overarching national guideline on neonatal encephalopathy and therapeutic hypothermia including prediction of outcome and follow-up recommendations.

Data on babies receiving induced cooling in New Zealand are currently collected by the NEWG and also by the Australia and New Zealand Neonatal Network.

8. **That all DHBs review local incident cases of neonatal encephalopathy. The findings of these reviews should be shared at a multidisciplinary local forum and form the basis of quality improvement activities as appropriate.**
    a. **Capital & Coast DHB should review cases of neonatal encephalopathy from 2010 to 2013.**

Justification:
Comparison of individual DHB neonatal encephalopathy rates to the national rate has identified two DHBs with rates significantly above the average – Waikato DHB (identified in the seventh and eighth reports of the PMMRC) and Capital & Coast DHB (identified in this report).

The rate of potentially avoidable deaths among hypoxic peripartum perinatal related deaths is consistently greater than 50 percent. There has been a significant reduction in hypoxic peripartum perinatal related deaths from 2007 to 2013. Although these things may not be linked, it suggests that a significant proportion of hypoxic peripartum injury is potentially avoidable. This was also reported in a paper from Scotland (Becher et al 2007).

The NEWG reviewed 83 neonatal encephalopathy cases born in 2010 and 2011, and found the death or severity of morbidity to be potentially avoidable in 55 percent of cases.

Evidence:
A review of neonatal encephalopathy deaths and survivors using the confidential enquiries into stillbirths and deaths in infancy model in the UK identified suboptimal care in more than 50 percent of cases, with the majority involving the care provided by health professionals (Draper et al 2002). A similar approach applied locally was validated in a study in Scotland reviewing deaths and neonatal encephalopathy due to intrapartum events (Kernaghan and Penney 2006).

Overview of the 2015 Report of the PMMRC

Perinatal mortality

Perinatal related mortality rate

In 2013, the perinatal related mortality rate in New Zealand was 10/1000 births or one baby death for every 100 babies born. This was the lowest rate since the PMMRC started collecting data on baby deaths, but not yet low enough to be sure that the apparent reduction is not due to chance.

The perinatal related mortality rate in New Zealand is similar to the rate reported by England and Wales for 2013 and by Australia for 2012.

Stillbirth rate

The rate of stillbirth in New Zealand has dropped significantly since 2007. In 2007, there was one stillbirth for every 180 births but in 2013 there was one stillbirth for every 200 births, which is a small but significant improvement. The reduction in stillbirths is a reduction in babies dying at term (from 37 weeks onwards).

The reduction has occurred among babies dying before birth without a known cause (unexplained antepartum death), babies dying from lack of oxygen around the time of birth (hypoxic peripartum death), babies dying following bleeding in pregnancy and babies dying of infections prior to birth. There has been an 80 percent reduction in babies dying of lack of oxygen in labour and a 30 percent reduction in babies dying without an identified cause.

Neonatal death rate

The rate of neonatal death has not changed in New Zealand since 2007.

Late termination of pregnancy rate

There has been a significant increase in the rate of terminations of pregnancy from 20 weeks since 2007. This is because of an increase in late terminations in mothers with very early ruptured membranes, perinatal infections, high blood pressure and serious bleeding in pregnancy.

Teen mothers

There has been an increase in the rate of perinatal death among teen mothers (mothers under 20 years old).

In 2013, 3436 teen mothers gave birth, one-third fewer than the 5091 in 2007.

A higher proportion of teen mothers in 2013 were Pacific than in 2007, and more were living with socio-economic deprivation. Both of these factors are associated with increased risk of perinatal death and so may explain some of the increase in the perinatal death rate among young mothers.

Analyses reported in the PMMRC report last year showed that young age is not directly associated with perinatal related death. Young age is associated with higher risk of perinatal death because teen mothers are more likely to be having their first baby, to smoke, to be overweight and to live with socioeconomic deprivation.

Māori, Pacific and Indian mothers

Māori, Pacific and Indian mothers have higher risks of perinatal deaths than mothers of Other Asian and New Zealand European ethnicity for reasons other than having their first baby, smoking, obesity and socioeconomic deprivation, but it is not known why.

DHB perinatal mortality differences

There are differences in perinatal related mortality rates according to the DHB area where mothers live. These rates are calculated from the number of deaths among mothers who live in the DHB area and are not adjusted for differences in age, ethnicity, smoking, obesity and deprivation, which vary by DHB, even though it is known that these factors affect mortality. The PMMRC does not adjust for these factors because they are highlighting areas in the country where health care services need to respond to address these higher rates.

It is not assumed that there are any differences in the quality of care provided by LMCs or hospitals that provide care in these DHB areas, but that there are differences in the needs of families who live in these regions. This year the report highlights the higher perinatal death rate in the Counties Manukau DHB area, the higher stillbirth and neonatal death rates in the Northland DHB area, and the higher neonatal death rate in the Bay of Plenty DHB area. The PMMRC recommends that these DHBs examine why their rates are significantly higher than national rates.

Screening in pregnancy

There was an increase in the proportion of mothers who were screened for diabetes in pregnancy prior to their baby dying, although it is not certain that this is due to an increase in screening. It may be due to an improvement in the completeness of data provided by LMCs to the PMMRC.

There are still many mothers who do not seem to be asked about family violence during their pregnancy, even though family violence is a health issue and known to lead to poor perinatal outcomes.

Every time we screen for family violence we are giving an educational message that family violence is common, it affects people's health, it is okay to talk about it and help is available now or in the future. It doesn't matter if we get a 'yes' or 'no' answer; asking is the intervention.

Where intimate partner violence occurs, there is a 30 to 60 percent chance that child abuse is also occurring (Edleson 1999).

This PMMRC report includes a practice point highlighting education for health providers on screening for family violence (page 82).

Investigation of perinatal death

In 2013, the rate of optimal investigation of perinatal deaths was 53 percent. While this is still low, it is higher than in previous years. The PMMRC has highlighted the importance of post-mortem investigation of perinatal deaths to clinicians and LMCs so families are fully informed and supported in making this decision. The PMMRC has also advocated for an increase in perinatal pathologists to provide post-mortem services.

In 2013, a post-mortem changed the clinical diagnosis of cause of a baby's death for 19 percent of families who agreed to post-mortem.

Spontaneous preterm birth

Spontaneous preterm birth was a cause of perinatal death for almost 1000 babies from 2007 to 2013. It is the cause of death for 21 percent of perinatal deaths.

We know that death from spontaneous preterm birth is more common in multiple pregnancies, among smokers, among users of marijuana and alcohol, among mothers living with socioeconomic deprivation, among young mothers and among Māori and Pacific mothers. Some of these risk factors are independent of the others so that the co-occurrence of more than one factor further increases the risk for that woman.

Bleeding occurred at some time during pregnancy in 60 percent of women whose babies died from spontaneous preterm birth. Bleeding is an important indicator of increased risk and women need to be advised of this and counselled to report any indication that labour might be starting early. Bleeding is also

associated with fetal growth restriction and so, for both of these reasons, is an important indicator of a pregnancy at risk. This is true even when there are small amounts of bleeding and when the reason for the bleeding is not clear.

It may be possible to reduce the risk of preterm birth for some women, and treatments are available to reduce the morbidity and mortality of babies who are born early.

Modifiable risk factors and labour

While most babies are fit to withstand the stress of labour, some are not. Some of these babies will die in labour or suffer from hypoxic damage (due to lack of oxygen around the time of birth) which may lead to neonatal death or to neonatal encephalopathy. In this report and previous reports of the PMMRC, local review of hypoxic peripartum deaths and national review of babies with neonatal encephalopathy has identified a high rate of potentially avoidable morbidity and mortality. It is reassuring that there has been a significant reduction in perinatal mortality in this group between 2007 and 2013.

The key issues identified are risk assessment and management, adequate fetal surveillance in labour and early recognition of brain injury in the newborn to facilitate early treatment with induced cooling. Risk assessment is dynamic and occurs in pregnancy, at the start of labour, and throughout labour. A combination of risks is likely to increase the danger to the mother and the baby more than any one factor alone. Risk assessment may indicate the need for a change in location of birth to a place where more rigorous surveillance and operative facilities to expedite birth are available.

A clinical practice point on page 147 provides information on recognising the baby at risk of neonatal encephalopathy.

Potentially avoidable deaths

Approximately 16 percent of perinatal deaths were assessed at review to be potentially avoidable in 2013. This means that if at least one of the factors identified as contributing to the death had been absent then the death may not have occurred. The largest absolute number of potentially avoidable perinatal deaths was among deaths due to maternal conditions (18 deaths), most of which are diabetes.

Barriers to access and/or engagement with antenatal care are more common for women living with socioeconomic deprivation. One in six perinatal related deaths among women residing in the most socioeconomically deprived households might potentially have been avoided by improved access to antenatal care.

Maternal mortality

In 2013, there were 12 maternal deaths. The maternal mortality ratio in New Zealand for 2011–2013 was 16.8/100,000 maternities, which is one maternal death for every 6000 babies born at 20 weeks or more. New Zealand has a comprehensive system for the reporting of maternal deaths and this probably explains the higher rate of mortality seen in New Zealand compared to Australia, which does not have a comprehensive national surveillance system.

Maternal deaths are more common among Māori and Pacific mothers, and mothers aged 40 years and older, and increase with increasing socioeconomic deprivation.

Causes of maternal death

Maternal deaths are reported as direct or indirect. Direct deaths are due to diseases or complications of pregnancy such as bleeding and sepsis. There has been a trend in developed countries, including New Zealand, towards a reduction in direct deaths.

However, there is a six times higher rate of direct deaths due to amniotic fluid embolism in New Zealand compared to the UK. It is not known why and the PMMRC is planning further work to investigate this during 2015–2016.

Indirect deaths result from pre-existing conditions or non-pregnancy related conditions which are worsened by pregnancy. Indirect deaths have been seen to increase in the UK and in the USA. There has been a trend towards an increase in these deaths in New Zealand as well. This may be associated with mothers having babies at an older average age and with increasing obesity in the population.

The most common indirect cause of death in New Zealand is maternal suicide, and maternal suicide is seven times more common in New Zealand than in the UK. This comparative analysis has also led to the PMMRC planning to do further analysis of death from suicide in 2015–2016.

Practice points for improved maternal health

In this report, the Maternal Mortality Working Group of the PMMRC has written practice points for clinicians on epilepsy, influenza in pregnancy, sepsis in and after pregnancy, and perimortem Caesarean section.

It is recommended that women with epilepsy who are on medication should be reviewed by a physician in pregnancy because some epileptic medications need to be increased during pregnancy.

The PMMRC recommends that pregnant women are vaccinated against influenza and whooping cough (pertussis) to protect both mother and baby.

Neonatal encephalopathy

There is a higher rate of neonatal encephalopathy among Pacific mothers than New Zealand European mothers, among babies born at 37 weeks, and among mothers living with socioeconomic deprivation.

The majority of babies diagnosed with neonatal encephalopathy have evidence of asphyxia (lack of oxygen) present at the time of birth. Therefore education in fetal surveillance during labour to detect this is important for all clinicians involved in intrapartum care.

The rate of induced cooling of babies with moderate and severe neonatal encephalopathy has increased significantly from 68 percent in 2010 to 83 percent in 2013. Receiving induced cooling means that babies diagnosed with neonatal encephalopathy have a lower risk of subsequent disability.

The unadjusted rate of neonatal encephalopathy among women resident in the Capital & Coast DHB area was significantly higher for 2010–2013 than the national rate. The PMMRC has recommended that Capital & Coast DHB review all of their cases from 2010 to 2013.

Maternal morbidity

Twelve women who had an amniotic fluid embolism were reported in New Zealand between 2010 and 2013.

There were 69 women who had placenta accreta (excessively adherent or embedded into the uterine wall) reported in New Zealand from 2010 to 2012. Forty-five of these women had previously had a Caesarean section. More than half of the 69 women required a hysterectomy because of this placental disorder.

References

Anderson N, Sadler L, Stewart A, et al. 2012. Maternal and pathological pregnancy characteristics in customised birthweight centiles and identification of at-risk small-for-gestational-age infants: a retrospective cohort study. *BJOG* 119(7): 848–56. doi: 10.1111/j.1471-0528.2012.03313.x
URL: http://onlinelibrary.wiley.com/doi/10.1111/j.1471-0528.2012.03313.x/pdf (accessed May 2015).

Auckland Regional Public Health Service. nd. *Fact Sheet: Information about whooping cough vaccination in pregnancy.*
URL: http://www.arphs.govt.nz/Portals/0/Health%20Information/Communicable%20Disease/Pertussis/Pertussis%20fact%20sheets%20March%202013/GPFax%20Dec%202012.pdf (accessed June 2015).

Becher J, Stenson B, Lyon A. 2007. Is intrapartum asphyxia preventable? *BJOG* 114(11): 1442–4.
URL: http://onlinelibrary.wiley.com/doi/10.1111/j.1471-0528.2007.01487.x/pdf (accessed April 2015).

Been JV, Nurmatov UB, Cox B, et al. 2014. Effect of smoke-free legislation on perinatal and child health: a systematic review and meta-analysis. *The Lancet* 383(9928): 1549–60.
URL: http://www.sciencedirect.com/science/article/pii/S0140673614600829 (accessed May 2015).

Byford S, Weaver E, Anstey C. 2014. Has the incidence of hypoxic ischaemic encephalopathy in Queensland been reduced with improved education in fetal surveillance monitoring? *Australian and New Zealand Journal of Obstetrics and Gynaecology* 54(4): 348–53 doi: 10.1111/ajo.12200.
URL: http://onlinelibrary.wiley.com/doi/10.1111/ajo.12200/pdf (accessed May 2015).

Cantu J, Tita A. 2013. Management of influenza in pregnancy. *Am J Perinatol* 30(2): 99–104.
doi: 10.1055/s-003-24513.
URL: http://www.ncbi.nlm.nih.gov/pubmed/23271379 (accessed March 2015).

Chamberlain C, O'Mara-Eves A, Oliver S, et al. 2013. Psychosocial interventions for supporting women to stop smoking in pregnancy. *Cochrane Database Syst Rev* 10: CD001055.
URL: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4022453/pdf/emss-58399.pdf (accessed May 2015).

Chambliss LR. 2008. Intimate partner violence and its implication for pregnancy. *Clinical Obstetrics and Gynecology* 51(2): 385–97.
URL: http://www.ncbi.nlm.nih.gov/pubmed/18463468 (accessed June 2015).

Chien L-Y, Whyte R, Aziz K, et al for The Canadian Neonatal Network. 2001. Improved Outcome of Preterm Infants When Delivered in Tertiary Care Centers. *Obstet Gynecol* 98(2): 247–52.
URL: http://www.sciencedirect.com/science/article/pii/S0029784401014387 (accessed May 2015).

Conde-Agudelo A, Romero R, Nicolaides K, et al. 2013. Vaginal progesterone vs cervical cerclage for the prevention of preterm birth in women with a sonographic short cervix, previous preterm birth, and singleton gestation: a systematic review and indirect comparison metaanalysis. *Am J Obstet Gynecol* 208(1): 42.e1–18.
URL: http://www.ajog.org/article/S0002-9378(12)01977-1/pdf (accessed May 2015).

Cormack D. 2010. *The practice and politics of counting: ethnicity data in official statistics in Aotearoa/New Zealand*. Wellington: Te Rōpū Rangahau Hauora a Eru Pōmare.
URL: http://www.ethnicity.maori.nz/files/politics_and_practice_of_counting.pdf (accessed April 2015).

De-Regil LM, Fernández-Gaxiola AC, Dowswell T, et al. 2010. Effects and safety of periconceptional folate supplementation for preventing birth defects. *The Cochrane Library* 2010(10).
URL: http://onlinelibrary.wiley.com/doi/10.1002/14651858.CD007950.pub2/pdf (accessed May 2015).

Dodd JM, Jones L, Flenady V, et al. 2013. Prenatal administration of progesterone for preventing preterm birth in women considered to be at risk of preterm birth (Review). *The Cochrane Library* 2013(7). URL: http://onlinelibrary.wiley.com/doi/10.1002/14651858.CD004947.pub3/pdf (accessed May 2015).

Doyle LW, Crowther CA, Middleton P, et al. 2009. Magnesium sulphate for women at risk of preterm birth for neuroprotection of the fetus. *The Cochrane Library* 2009(2).
URL: http://apps.who.int/rhl/reviews/CD004661.pdf (accessed May 2015).

Draper ES, Kurinczuk JJ, Lamming CR, et al. 2002. A confidential enquiry into cases of neonatal encephalopathy. *Arch Dis Child Fetal Neonatal Ed* 87(3): F176–80. doi: 10.1136/fn.87.3.F176.
URL: http://fn.bmj.com/content/87/3/F176.full (accessed May 2015).

Edleson JL. 1999. The overlap between child maltreatment and woman battering. *Violence Against Women* 5(2): 134–54.
URL: http://vaw.sagepub.com/content/5/2/134.full.pdf+html (accessed May 2015).

Fonseca EB, Celik E, Parra M, et al for the Fetal Medicine Foundation Second Trimester Screening Group. 2007. Progesterone and the Risk of Preterm Birth among Women with a Short Cervix. *N Engl J Med* 357: 462–9.
URL: http://www.nejm.org/doi/pdf/10.1056/NEJMoa067815 (accessed May 2015).

Gardosi J, Giddings S, Clifford S, et al. 2013. Association between reduced stillbirth rates in England and regional uptake of accreditation training in customised fetal growth assessment. *BMJ Open* 3: e003942. doi: 10.1136/bmjopen-2013-003942.
URL: http://bmjopen.bmj.com/content/3/12/e003942.full (accessed May 2015).

Gülmezoglu AM, Crowther CA, Middleton P, et al. 2012. *Induction of labour for improving birth outcomes for women at or beyond term (Review)*.
URL: http://onlinelibrary.wiley.com/doi/10.1002/14651858.CD004945.pub3/abstract (accessed April 2015).

Harden C, Pennell P, Koppel B, et al. 2009. Practice parameter update: management issues for women with epilepsy – focus on pregnancy (an evidence-based review): vitamin K, folic acid, blood levels, and breastfeeding: report of the Quality Standards Subcommittee and Therapeutics and Technology Assessment Subcommittee of the American Academy of Neurology and American Epilepsy Society. *Neurology* 73(2): 142–9. doi: 10.1212/WNL.0b013e3181a6b325 (accessed March 2015).
URL: http://www.neurology.org/content/73/2/142.long (accessed June 2015).

Hoeritzauer I, Mawhinney E, Irwin B, et al. 2012. Increased levetiracetam clearance in pregnancy: is seizure frequency affected? *Seizure* 21(7): 559–60. doi: 10.1016/j.seizure.2012.05.004.
URL: http://www.sciencedirect.com/science/article/pii/S1059131112001203 (accessed May 2015).

Institute of Medicine and National Research Council. 2009. *Weight Gain During Pregnancy. Re-examining the Guidelines*. Washington DC: National Academies Press.
URL: http://www.ncbi.nlm.nih.gov/books/NBK32813/pdf/TOC.pdf (accessed May 2015).

Jahanfar S, Janssen PA, Howard LM, et al. 2013. Interventions for preventing or reducing domestic violence against pregnant women (review). *The Cochrane Library* 2013(2).
URL: http://onlinelibrary.wiley.com/doi/10.1002/14651858.CD009414.pub2/pdf (accessed April 2015).

Jeffs E, Sharp B, Gullam J, et al. 2014. Weight and height measurement: potential impact in obstetric care. *NZ Med J* 127(1392): 17–26.
URL: https://www.nzma.org.nz/journal/read-the-journal/all-issues/2010-2019/2014/vol-126-no-1392/article-jeffs (accessed May 2015).

Kapoor D, Wallace S. 2014. Trends in maternal deaths from epilepsy in the United Kingdom: a 30-year retrospective review. *Obstetric Medicine* 7(4): 160–4. doi: 10.1177/1753495X14553257.
URL: http://obm.sagepub.com/content/7/4/160 (accessed May 2015).

Kelso A, Wills A. 2014. On behalf of the MBRRACE-UK neurology chapter writing group. Learning from neurological complications. In Knight M, Kenyon S, Brocklehurst P, et al (eds) on behalf of MBRRACE-UK, *Saving Lives, Improving Mothers' Care – Lessons learned to inform future maternity care from the UK and Ireland Confidential Enquiries into Maternal Deaths and Morbidity 2009–12* (pp. 73–9). Oxford: National Perinatal Epidemiology Unit, University of Oxford.
URL: https://www.npeu.ox.ac.uk/downloads/files/mbrrace-uk/reports/Saving%20Lives%20Improving%20Mothers%20Care%20report%202014%20Full.pdf (accessed June 2015).

Kernaghan D, Penney GC. 2006. Do panels vary when assessing intrapartum adverse events? The reproducibility of assessments by hospital risk management groups. *Qual Saf Health Care* 15: 359–62. doi: 10.1136/qshc.2006.018572.
URL: http://qualitysafety.bmj.com/content/15/5/359.long (accessed May 2015).

Kuhrt K, Smout E, Hezelgrave N, et al. 2015. Development and validation of a predictive tool for spontaneous preterm birth incorporating cervical length and quantitative fetal fibronectin in asymptomatic high-risk women. [Epub ahead of print].
URL: http://onlinelibrary.wiley.com/doi/10.1002/uog.14865/pdf (accessed May 2015).

Liggins Institute. 2015. *Antenatal corticosteroids given to women prior to birth to improve fetal, infant, child and adult health: New Zealand and Australian clinical practice guidelines.* Auckland: The University of Auckland.
URL: http://www.liggins.auckland.ac.nz/en/about/research-themes/life-path_1/clinical-research-1_1/antenatal-corticosteroid-guideline.html (accessed June 2015).

Memoli M, Harvey H, Morens D, et al. 2013. *Influenza in pregnancy. Influenza Other Respir Viruses 7*(6): 1033–9. doi: 10.1111/irv.12055.
URL: http://onlinelibrary.wiley.com/doi/10.1111/irv.12055/full (accessed May 2015).

Mertz D, Kim T, Johnstone J, et al. 2013. Populations at risk for severe or complicated influenza illness: systematic review and meta-analysis. *BMJ* 347. doi: http://dx.doi.org/10.1136/bmj.f5061.
URL: http://www.bmj.com/content/347/bmj.f5061 (accessed May 2015).

Ministry of Health. 2002. *Family Violence Intervention Guidelines: Child and Partner Abuse.* Wellington: Ministry of Health.
URL: http://www.health.govt.nz/publication/family-violence-intervention-guidelines-child-and-partner-abuse (accessed March 2015).

Ministry of Health. 2012b. *Guidelines for Consultation with Obstetric and Related Medical Services (Referral Guidelines).* Wellington: Ministry of Health.
URL: http://www.health.govt.nz/system/files/documents/publications/referral-glines-jan12.pdf (accessed March 2015).

Ministry of Health. 2012c. *Alcohol and Pregnancy: A practical guide for health professionals.* Wellington: Ministry of Health.
URL: http://www.health.govt.nz/system/files/documents/publications/alcohol-pregnancy-practical-guide-health-professionals.pdf (accessed April 2015).

Ministry of Health. 2014c. *The New Zealand Guidelines for Helping People to Stop Smoking.* Wellington: Ministry of Health.
URL: http://www.health.govt.nz/system/files/documents/publications/nz-guidelines-helping-people-stop-smoking-jun14.pdf (accessed April 2015).

Naleway A, Irving S, Henninger M, et al. 2014. Safety of influenza vaccination during pregnancy: a review of subsequent maternal obstetric events and findings from two recent cohort studies. *Vaccine* 32(26): 3122–7. doi: 10.1016/j.vaccine.2014.04.021.
URL: http://www.sciencedirect.com/science/article/pii/S0264410X14005234 (accessed May 2015).

Nelson HD, Bougatsos C, Ian Blazina I. 2012. Screening Women for Intimate Partner Violence: A Systematic Review to Update the U.S. Preventive Services Task Force Recommendation. *Ann Intern Med* 156: 796–808.
URL: http://annals.org/article.aspx?articleid=1170891 (accessed May 2015).

New Zealand Maternal Fetal Medicine Network. 2010. *Monochorionic Twin Pregnancy.*
URL: http://www.healthpoint.co.nz/public/new-zealand-maternal-fetal-medicine-network/?solo=otherList&index=1 (accessed April 2015).

New Zealand Maternal Fetal Medicine Network. 2013. *Guideline for the management of suspected small for gestational age singleton pregnancies after 34 weeks' gestation.*
URL: http://www.healthpoint.co.nz/public/new-zealand-maternal-fetal-medicine-network/?solo=otherList&index=1 (accessed March 2015).

NICE. 2008. *Antenatal care: Clinical guideline* 62.
URL: http://www.nice.org.uk/guidance/cg62/chapter/guidance (accessed May 2015).

NISG. 2013. *Immunise to protect pregnant women and their babies.* National Influenza Specialist Group. Auckland: University of Auckland, Immunisation Advisory Centre.
URL: http://www.influenza.org.nz/immunise-protect-pregnant-women-and-their-babies (accessed March 2015).

NISG. 2015. *Everything Healthcare Professionals need to know about the 2015 Influenza Season.* National Influenza Specialist Group: Influenza Info for Health Professionals. Auckland: University of Auckland, Immunisation Advisory Centre.
URL: http://www.influenza.org.nz/ (accessed March 2015).

Pandian Z, Marjoribanks J, Ozturk O, et al. 2013. Number of embryos for transfer following in vitro fertilisation or intra-cytoplasmic sperm injection. *The Cochrane Library* 2013(7).
URL: http://onlinelibrary.wiley.com/doi/10.1002/14651858.CD003416.pub4/pdf (accessed May 2015).

Pehrson C, Sorensen JL, Amer-Wåhlin I. 2011. Evaluation and impact of cardiotocography training programmes: a systematic review. *BJOG* 118(8): 926–35.
URL: http://onlinelibrary.wiley.com/doi/10.1111/j.1471-0528.2011.03021.x/pdf (accessed May 2015).

PMMRC. 2010. *Fourth annual report of the Perinatal and Maternal Mortality Review Committee: reporting mortality 2008.* Wellington: Health Quality & Safety Commission, Perinatal and Maternal Mortality Review Committee.
URL: http://www.hqsc.govt.nz/our-programmes/mrc/pmmrc/publications-and-resources/publication/29/ (accessed May 2015).

PMMRC. 2014b. *Eighth annual report of the Perinatal and Maternal Mortality Review Committee: reporting mortality 2012.* Wellington: Health Quality & Safety Commission, Perinatal and Maternal Mortality Review Committee.
URL: http://www.hqsc.govt.nz/assets/PMMRC/Publications/eighth-PMMRC-report-June-2014.pdf (accessed March 2015).

Preston S, Mahomed K, Chadha Y, et al for the Australia and New Zealand Stillbirth Alliance (ANZSA). 2010. *Clinical practice guideline for the management of women who report decreased fetal movements.* Brisbane: ANZSA.
URL: https://www.ranzcog.edu.au/doc/dfm.html (accessed May 2015).

RANZCOG. 2014a. *Intrapartum fetal surveillance, clinical guidelines – third edition 2014.* Melbourne: RANZCOG.
URL: https://www.ranzcog.edu.au/intrapartum-fetal-surveillance-clinical-guidelines.html (accessed March 2015).

RANZCOG. 2014b. *Pregnancy and Influenza.*
URL: https://www.ranzcog.edu.au/womens-health/resources-for-women-a-practitioners/pregnancy-and-influenza.html (accessed March 2015).

RCOG. 2003. *Periconceptional Folic Acid and Food Fortification in the Prevention of Neural Tube Defects: Scientific Impact Paper No. 4.*
URL: https://www.rcog.org.uk/globalassets/documents/guidelines/scientific-impact-papers/sip_4.pdf (accessed May 2015).

RCOG. 2013. *The Investigation and Management of the Small-for-Gestational-Age Fetus.* URL: https://www.gestation.net/RCOG_Green_Top_-_SGA_2013.pdf (accessed April 2015).

Roberts D, Dalziel SR. 2007. Antenatal corticosteroids for accelerating fetal lung maturation for women at risk of preterm birth. *The Cochrane Library* 2007(4). URL: http://apps.who.int/rhl/reviews/CD004454.pdf (accessed May 2015).

Roex A, Nikpoor P, van Eerd E, et al. 2012. Serial plotting on customised fundal height charts results in doubling of the antenatal detection of small for gestational age fetuses in nulliparous women. *Australian and New Zealand Journal of Obstetrics and Gynaecology* 52(1): 78–82. doi: 10.1111/j.1479-828X.2011.01408.x (accessed April 2015). URL: http://onlinelibrary.wiley.com/doi/10.1111/j.1479-828X.2011.01408.x/pdf (accessed June 2015).

Saliba E, Fakhri N, Debillon T. 2015. Establishing a hypothermia service for infants with suspected hypoxic ischemic encephalopathy. *Seminars in Fetal & Neonatal Medicine* 20(2): 80–6. URL: http://www.sciencedirect.com/science/article/pii/S1744165X15000219 (accessed May 2015).

Shah PS, Shah J, on behalf of the Knowledge Synthesis Group on Determinants of Preterm/LBW Births. 2010. Maternal Exposure to Domestic Violence and Pregnancy and Birth Outcomes: A Systematic Review and Meta-Analyses. *Journal of Women's Health* 19(11): 2017–31. URL: http://online.liebertpub.com/doi/abs/10.1089/jwh.2010.2051 (accessed May 2015).

Van Parys A-S, Verhamme A, Temmerman M, et al. 2014. Intimate Partner Violence and Pregnancy: A Systematic Review of Interventions. *PLoS ONE* 9(1): e85084. URL: http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0085084

Zaman K, Roy E, Arifeen S, et al. 2008. Effectiveness of maternal influenza immunization in mothers and infants. *N Engl J Med* 359(15): 1555–64. doi: 10.1056/NEJMoa0708630. URL: http://www.nejm.org/doi/full/10.1056/NEJMoa0708630 (accessed May 2015).

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