



Government of **Western Australia**
Department of **Health**
Public Health and Clinical Services

The 14th Report of the Perinatal and Infant Mortality Committee of Western Australia for deaths in the triennium 2008-2010

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Public Health and Clinical Services Division
Department of Health, WA

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Members of the Perinatal and Infant Mortality Committee of Western Australia in 2013-2014 were:

Permanent members

Prof John Newnham, Chair of Committee
Dr Noel French, acting Deputy
Dr Andrew Warwyk
Dr Corrado Minutillo
Dr Ian Taylor
Prof Karen Edmond (from December 2013)
Dr Carol Bower (until November 2013)

Provisional members

Dr Michael Gannon
Dr Warren Andrew Thyer
Dr Keith Meadows
Ms Louise Keyes

Co-opted members

Dr Adrian Charles

Investigators

Dr Keren Witcombe
Dr Christine Marsack
Dr Patrick Pemberton
Dr Christopher Gunnell
Dr Ronald Hagan

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Ms Shannon Carter
Mr Peter Somerford
Mr Brian Stanley
Mr Dishan Weerasooriya

Foreword

Chairman's Report

It is with pleasure that I submit, on behalf of the Committee, the 14th Report of the Perinatal and Infant Mortality Committee of Western Australia.

This is the fourth Report of the Committee since it was re-established in October 2001. The previous Reports covered the periods 2000-2001, 2002-2004 and 2005-2007. This Report covers the triennium 2008-2010. Together, the four Reports provide a substantial description of perinatal and infant mortality in Western Australia during this decade and include 1607 investigated cases from a total 3306 perinatal and infant deaths.

The primary purpose of the Committee is educational. Cases are identified for investigation by the Executive Director, Public Health and include stillbirths and infant deaths of at least 26 weeks gestation, with the exception of known pregnancy terminations. Cases are presented to the Committee by a nominated investigator. For each case, the presentation and accompanying documentation are de-identified, both in terms of the names of the practitioners and the hospitals. The causes of death are classified using the well-established system developed by the Perinatal Society of Australia and New Zealand. Preventability is assessed and classified.

A letter is written to each medical practitioner involved in the management of the case. Each practitioner is informed of the decisions of the Committee, together with any suggestions for management. The content of these letters is entirely confidential and cannot be released to any other person.

A decade of review now enables the Committee to make assessments regarding many aspects of perinatal health care in Western Australia and to examine changes with time.

There is much to celebrate. The standard of perinatal and infant care in Western Australia is, in general, very high and outcomes compare favourably with those from eastern Australia. These good outcomes reflect the training and dedication of the medical, midwifery, nursing and allied health staff working throughout the state, together with the many systems and services that enable high quality health care to be delivered. It is particularly reassuring to note that in this triennium there has been a reduction in the Aboriginal neonatal death rate and a statistically significant reduction in the Aboriginal post-neonatal death rate.

There is, however, much room for improvement. The stillbirth rate in Western Australia has remained unchanged for 20 years and improvements in neonatal and post neonatal mortality rates have plateaued since 2004. These unchanged rates in recent years have been sustained in the face of an increasing risk profile for many women entering pregnancy. As examples, there has been a greater proportion of women in the older age groups and an increasing prevalence of fertility treatments.

Despite the improvements in survival after birth, death rates overall in young Aboriginal people remain much higher than in the remainder of the population. In this triennium, the major condition leading to stillbirth in Aboriginal people was spontaneous preterm birth. In Western Australia, preterm birth rates for the whole population remain at 8-9 per cent, but are almost double in Aboriginal people. One of the many factors contributing to this risk is smoking. The rate of smoking in pregnancy in the population as a whole has now fallen to 14 per cent, but remains unchanged at almost 50 per cent in pregnant Aboriginal women. New strategies to address this behavioural problem are required.

Preterm birth is the single greatest cause of death and disability in children up to five years of age in the developed world. The pathways leading to untimely early birth are multiple, but several of the major causes are now considered preventable. Strategies to reduce the rate of preterm birth in Western Australia are now being developed and need to be supported.

Over the decade, the Committee has worked hard to ensure that all practitioners are well-educated in the need for thorough investigation of perinatal and infant deaths. It is pleasing to note that two thirds of cases of stillbirth in this triennium had appropriate investigation and this figure compares very favourably with data from elsewhere in Australia. We can, however, do better and an educational paper outlining the steps required in appropriate investigation is included in this Report.

The Committee remains concerned by the statistically significant increase in rate of death for term babies in women who plan to give birth at home. In this triennium, when compared with birth in hospital, the perinatal mortality rate for term homebirths was 4.1 times higher. This increased number of perinatal deaths in homebirths has been consistent over the decade of investigation. In 2007, the Committee recommended a review of homebirths, and this review was followed by changes in practice. After the next triennium, in December 2010, the Committee recommended that a prospective study be commenced, capable of investigating both mortality and morbidity of planned homebirth. The Committee is hopeful that improvements resulting from these initiatives will result in a marked reduction in mortality rates associated with homebirths in the next triennial period.

Members of the Committee give their time and wisdom freely as volunteers. The various functions of the Committee are supported by dedicated and capable investigators and the secretariat. On behalf of the Committee and the many people who benefit from its activities, I would like to thank Dr Teresa Ballestas who was the primary author of this Report, Dr Ben Lacey who provided statistical support, Mrs Vivien Gee (Principal Consultant Statutory Mortality Committees), Dr Revle Bangor-Jones (former Principal Medical Advisor, Regulation, Support and Training Unit), Dr Tarun Weeramanthri (Executive Director of Public Health and Clinical Services), and the many health care providers throughout the state who enable case investigation to be so successful. It is the opinion of the Committee that this process is helping to ensure that the women, babies and families of Western Australia receive high quality perinatal and infant health care.

Respectfully submitted
Professor John Newnham AM
Chair

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Abbreviations

ABS:	Australian Bureau of Statistics
AIHW:	Australian Institute of Health and Wellbeing
CMP:	Community Midwifery Program
CMWA:	Community Midwifery WA
CI:	Confidence Intervals
EDPH:	Executive Director Public Health
NMHS:	North Metropolitan Health Service
PIMC:	Perinatal and Infant Mortality Committee
PSANZ PDC:	Perinatal Society of Australia and New Zealand Perinatal Death Classification
PSANZ NDC:	Perinatal Society of Australia and New Zealand Neonatal Death Classification
RR:	Relative risk
SEIFA	Socio-economic Indexes For Areas
SIDS:	Sudden Infant Death Syndrome
SLA:	Statistical Local Area
WA:	Western Australia
WHO:	World Health Organization

Executive Summary

This Report provides an overview of the epidemiology of perinatal and infant deaths between 2008 and 2010, with a summary of the Perinatal and Infant Mortality Committee (PIMC) findings and recommendations. The purpose is to inform clinicians and public health professionals in their efforts to improve perinatal and infant care in Western Australia. It continues upon the previous 13th Report of the Committee and marks a decade of work since re-establishment of the Committee in 2001.

Data were extracted from the Midwives' Notification System and the Perinatal and Infant Mortality Database.

A descriptive analysis was conducted to present rates of perinatal and infant mortality in WA between 2008 and 2010. Information on cause of death, preventability and trends overtime were also presented.

Data analysis showed that over the last two decades, efforts to reduce the number of deaths in the neonatal and post-neonatal periods have been very successful. Importantly, there has been a reduction in the Aboriginal neonatal death rate and a statistically significant reduction in the post-neonatal death rate. However, there are opportunities for improvement, since the stillbirth rate remains unchanged and neonatal and post-neonatal death rates have plateaued since 2004. Aboriginal babies continue to have a higher risk of perinatal and infant death compared to the non-Aboriginal population.

Key findings

- In WA, 93 158 babies were born between 2008 and 2010 (approximately 30 000 births per year). Of those, 678 babies were stillborn, 204 babies died in the neonatal period, and 116 babies died in the post-neonatal period. This represents a total of 882 perinatal (stillbirths plus neonatal) and 320 infant (neonatal and post-neonatal) deaths.
- The perinatal mortality rate was 9.5 per 1000 births in the period from 2008 to 2010. The infant mortality rate was 3.5 per 1000 live births.
- Risk factors for perinatal mortality were Aboriginal ethnicity, advanced maternal age, low birth weight, high plurality, preterm birth, living in most socio-economically deprived areas and smoking.
- A higher risk of perinatal and infant mortality for residents of the Kimberley health regions was also found. The difference may be explained by the higher proportion of Aboriginal people. However, other factors should be considered.
- Independent risk factors for infant mortality included Aboriginal ethnicity, low birth weight, preterm birth and smoking.
- Other behavioural maternal factors may have contributed to perinatal deaths including poor compliance, marijuana use, 'other serious social problems' and alcohol abuse. Other behavioural maternal factors associated with post-neonatal deaths included co-sleeping, 'other serious social problems', alcohol abuse and maternal psychiatric disorders.
- The Committee observed that the overall standard of health care in WA is high. Less than four percent (3.6 per cent) of investigated stillbirths and 7.3 per cent of all investigated neonatal deaths were considered to be medically preventable. None of the post-neonatal deaths were considered medically preventable.

- The most important system factor was documentation and communication problems between health providers. The most important medical factor was suboptimal obstetric management.
- The main causes of stillbirths and neonatal deaths were congenital abnormality and spontaneous preterm. The main causes of post-neonatal deaths were Sudden Infant Death Syndrome (SIDS) and congenital abnormality.
- For cases investigated (>26 weeks), the main causes of stillbirths were unexplained antepartum death and fetal growth restriction. The main causes of neonatal deaths were congenital abnormality and 'no obstetric antecedent'. The main causes of post-neonatal deaths were 'SIDS' and other and congenital abnormality.
- A post-mortem investigation was conducted approximately two thirds (62.2 per cent) of all perinatal and infant deaths.
- The Committee recognises the methodological challenges on interpretation of homebirth data, and is encouraged by protocols and policy changes of the Community Midwifery Program and the development of an independent research study on this topic.
- Rates of anaemia are much higher in WA Aboriginal women delivering in hospital than non Aboriginal women. More robust data are needed especially from primary care settings and through the Midwives Notification System. Iron deficiency anaemia can be prevented by improving nutrition, reducing infectious disease and improved quality of primary care services including clinical governance and culturally appropriate care.

In conclusion, this Report provides further evidence that perinatal and infant deaths are the result of the complex interaction of multiple factors, including demographic, obstetric, medical factors, behavioural parental, socio-environmental, and health care factors. Multi-sectoral strategies are needed to further reduce the number of perinatal and infant deaths, including contributions from clinicians, public health professionals and researchers.

Recommendations

1. The rate of smoking in pregnant women in WA remains too high. The Committee supports initiatives of the Department of Health for tobacco control and will encourage strategies to specifically target women of reproductive age and in pregnancy. More information on resources to assist health professionals to support quitting among women of reproductive age and in pregnancy is included in Appendix 2.
2. The prevalence of alcohol and illicit substance use in pregnant women in WA is not known with certainty. The Committee encourages better quantification of usage. Health practitioners and the general population should be aware of the harm of alcohol and illicit substance use during pregnancy.
3. Parents with risk factors for perinatal and infant deaths such as smoking, substance abuse and domestic violence need appropriate counselling and treatment, and referral to appropriate services as required.
4. One of the major preventable causes of preventative prenatal deaths in WA is errors in communication and system structure. All health providers need to be aware of the crucial need for effective prompt communication with other health providers and their patients, and the integrity of the lines of communication to ensure that appropriate action is taken following abnormal test results and in a timely manner. Such action will include identification and early referral of high risk pregnancy.

5. The Committee is supportive of ongoing research to evaluate the effects of folate supplementation to promote this proven method of preventing some birth defects.
6. The concept of establishing a state wide program to safely reduce the rate of preterm birth should be supported and facilitated.
7. The ongoing rate of SIDS in WA remains of concern and public health and educational campaigns should be promoted.
8. Health practitioners need to be aware of the need for thorough investigation of perinatal and infant deaths and refer to the guideline included in Appendix 4.
9. The rate of perinatal loss in homebirths remains of concern to the Committee. It is noted, however, that the recommendations made in previous Reports are currently being implemented and it is hoped that the excess losses will be prevented by these initiatives.
10. More robust anaemia data are needed especially from primary care settings and through the Midwives Notification System. Antenatal programs, in particular those targeting Aboriginal women, should have a greater focus on improving nutrition, reducing infectious disease and improved quality of primary care services including clinical governance and culturally appropriate care. More information on maternal anaemia is included in Appendix 5.

1. Background

Epidemiological indicators of perinatal and infant mortality are recognised as important in assessing a nation's health and wellbeing.¹ In Australia, reductions in perinatal and infant mortality over the past four decades have been impressive,²⁻⁴ but differences between population sub-groups continue to exist with important implications for public health.²

In Western Australia, the *Health Act 1911* (Part XIII s336A) requires that “whenever any child of more than 20 weeks gestation is stillborn or any child under the age of one year dies from any cause whatsoever, the fact shall be reported forthwith to the Executive Director, Public Health (EDPH)”. All notifications are entered into the perinatal and infant mortality database to monitor the number of deaths and inform public health strategies.

The *Health Act 1911* (Part XIII B) also provides the legal basis for the constitution of the Perinatal and Infant Mortality Committee (PIMC) as a statutory requirement under the direction of the EDPH. Members of the Committee comprise experts in the area of obstetrics, perinatal care, neonatal paediatrics, clinical epidemiology, general medicine, rural medicine and midwifery.

The Committee has a long history which started in 1979 when the Committee was formed, producing regular Reports until 1992. From 1992 to 2000, the Committee was formally constituted but did not function. The Committee was re-established in October 2001 and conducted a retrospective analysis of perinatal and infant deaths from 1 January 2000.¹

Currently, the Committee investigates and discusses all stillbirths and deaths of infants from at least 26 week gestational age, with the exceptions of therapeutic pregnancy terminations. The aim of the Committee is to determine whether in the opinion of the Committee the stillbirth or death could have been prevented. In order to achieve this objective, the EDPH appoints an investigator to examine all deaths requiring further investigation. The investigator prepares a de-identified report which is discussed at the Committee meetings. Subsequently, the Committee makes the determination and provides constructive comments to the attending medical practitioner. A report on the investigated cases is also submitted to the EDPH.

Since 2000, the Committee has produced three Reports.^{1, 5-6} The Committee has found that perinatal and infant care in Western Australia is of a high standard with rates of perinatal deaths among the lowest in the country. Post-neonatal mortality rates have improved while the stillbirth rate has remained stable.⁶

Throughout the decade, the Committee identified some areas for improvements, including good governance, funding and quality improvement of health services, good antenatal care, culturally appropriate services for Aboriginal people, continuous performance development of health professionals and safe homebirth services.^{1, 5-6}

In the 13th Report (2005-2007), the Committee made fourteen recommendations, including:⁶

Recommendation 1: Support Statewide Planning to optimise coordination of obstetric and neonatal care in WA

Recommendation 2: Early transfer of high-risk patients, including the delivery of very preterm babies (<32 weeks gestational age) in a tertiary centre

Recommendation 3: Improve Aboriginal care

Recommendation 4: Improve social care

Recommendation 5: Improve access to mental health care

Recommendation 6: Maintain professional and training standards

Recommendation 7: Improve monitoring for fetal wellbeing in labour

Recommendation 8: Reduce congenital abnormalities

Recommendation 9: Reduce and manage obesity

Recommendation 10: Improve data collection

Recommendation 11: Reduce preterm birth

Recommendation 12: Reduce Sudden Infant Death Syndrome

Recommendation 13: Reduce deaths in planned homebirths

Recommendation 14: Investigate cause of death.

This is the fourth Report of the Committee since re-establishment and completes the first decade of work. The Report provides an overview of the epidemiology of perinatal and infant deaths between 2008 and 2010, with a summary of the Committee findings and recommendations. The purpose is to inform clinicians and public health professionals in their efforts to improve perinatal and infant care in Western Australia.

Additional tables are included in a separate document available from: http://www.health.wa.gov.au/publications/subject_index/p/Perinatal_infant_maternal.cfm. For any questions or to request a copy of the document please email edphwa@health.wa.gov.au

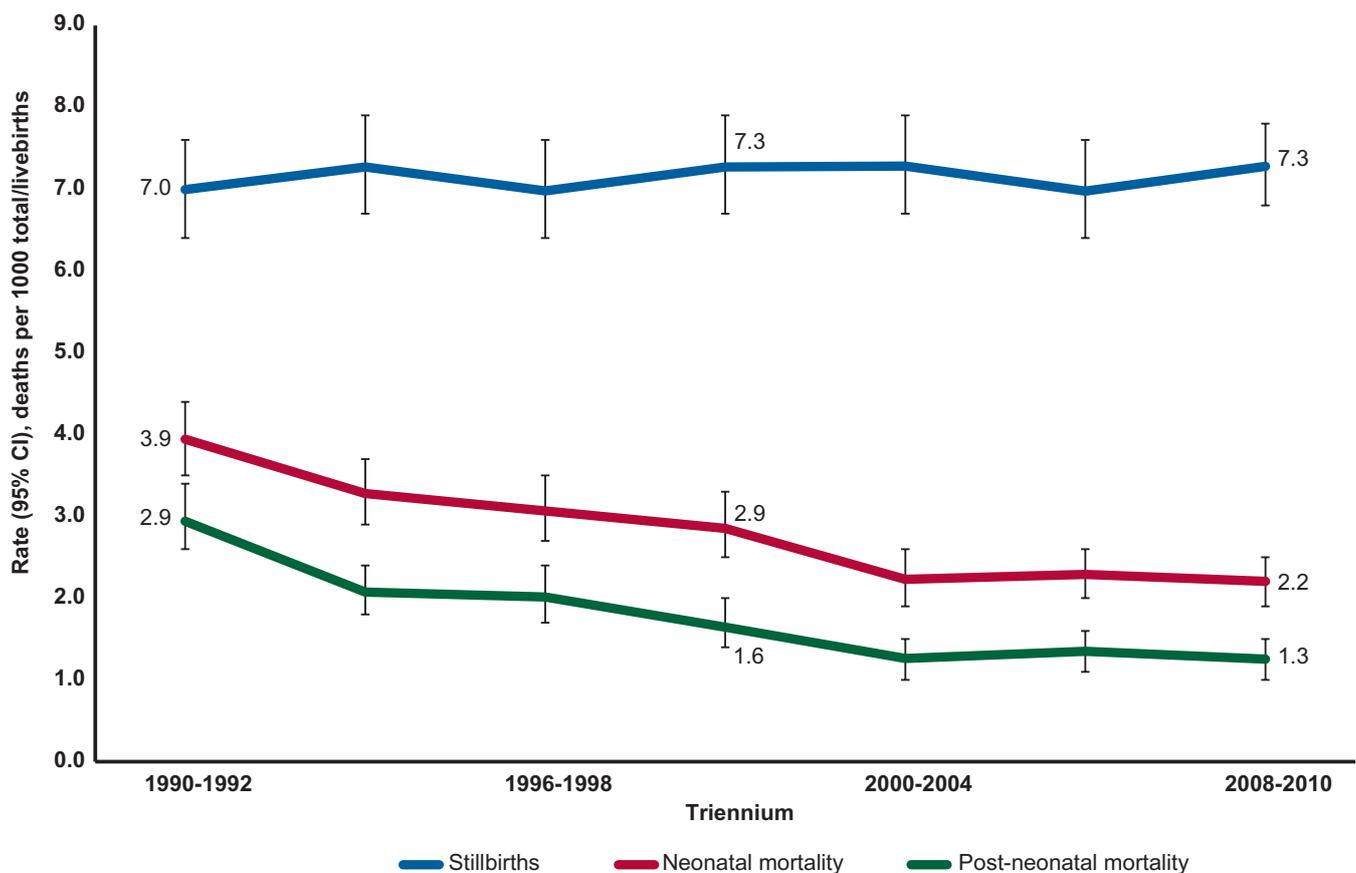
2. Epidemiology

In WA, 93 158 babies were born between 2008 and 2010 (approximately 30 000 births per year). Of those, 678 babies were stillborn, 204 babies died in the neonatal period, and 116 babies died in the post-neonatal period. This represents a total of 882 perinatal (stillbirths plus neonatal) and 320 infant (neonatal and post-neonatal) deaths.

Each death deserves consideration, and the purpose of the Committee is to make recommendations for prevention. It is encouraging that the WA data compare well with data from other states and territories and with Australia as a whole. For stillbirths, WA had the fourth lowest rate after New South Wales, Queensland and South Australia. For perinatal mortality, WA had the third lowest rate after New South Wales and South Australia. WA had the lowest neonatal and infant mortality rates.⁷⁻⁹ Figure 1 shows that major improvements in neonatal and post-neonatal mortality were achieved until 2004 and have been maintained during this reporting period.

However, there is still a need for improvement. No changes in the stillbirth rate have been observed in the last 20 years. The neonatal and post-neonatal mortality rates have remained unchanged since 2004.

Figure 1: Stillbirths, neonatal and post-neonatal mortality rates Western Australia, 1990-2010



The neonatal mortality rate declined significantly from 3.9 per 1000 live births in 1990-1992 to 2.2 per 1000 live births in 2002-2004 (correlation coefficient [r] = -0.97; p = 0.006). The neonatal mortality rate has been stable at around 2.2 per 1000 live births in 2008-2010.

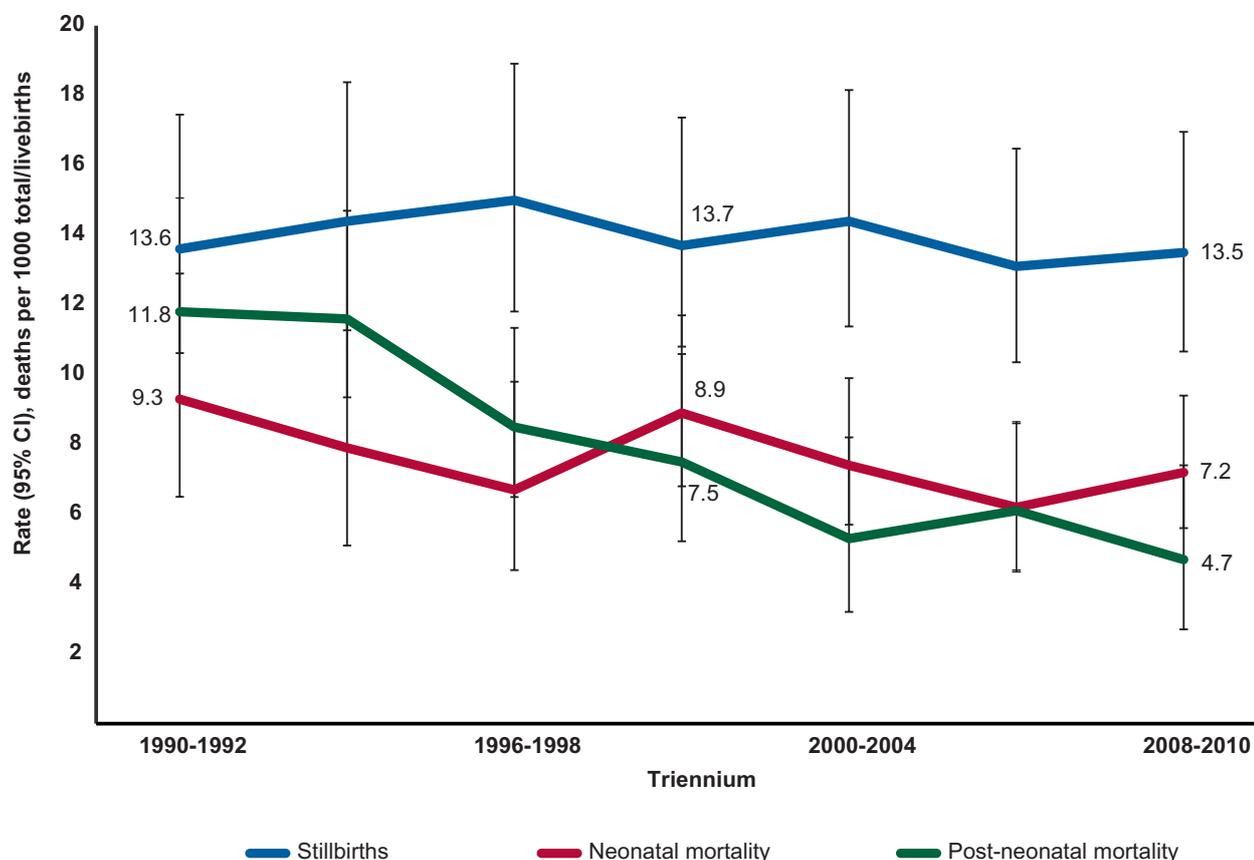
The post-neonatal mortality rate decreased significantly from 2.9 per 1000 live births in 1990-1992 to 1.3 per 1000 live births in 2002-2004 (r = -0.97; p = 0.008). Since then the rate has been stable at around 1.3 per 1000 live births in 2008-2010.

As the result of improvements made in neonatal mortality, the perinatal mortality rate decreased significantly from 10.9 per 1,000 births in 1990-1992 to 9.5 per 1,000 births in 2002-2004 (r = -0.94; p < 0.005). Since then the perinatal mortality rate has been stable. The perinatal mortality rate was 9.5 per 1000 births in 2008-2010.

The improvements in neonatal and post-neonatal mortality have resulted in a significant reduction in infant deaths rates between 1990 and 2004 (6.9 per 1,000 live births in 1990-1992 to 3.5 per 1000 live births in 2002-2004; r = -0.97, p < 0.005). No change has been observed since then.

Importantly, there has been a reduction in Aboriginal neonatal and post-neonatal deaths. Figure 2 shows a statistically significant decline in the post-neonatal mortality rate for Aboriginal people (r = -0.95, p < 0.005). As a result, there has been a statistically significant decline in the overall infant mortality rate for Aboriginal people (r = -0.94, p < 0.005).

Figure 2: Stillbirths, neonatal and post-neonatal mortality rates in the Aboriginal population, Western Australia, 1990-2010



However, Aboriginal people are still more likely to have a stillbirth than non-Aboriginal people. The gap between Aboriginal and non-Aboriginal populations for neonatal mortality rates increased from 2.6 in 1990-1992 to 3.8 in 2008-2010. The gap for post-neonatal mortality rates decreased slightly from 4.9 in 1990-1992 to 4.3 in 2008-2010.

There is limited evidence that other ethnic groups also had a higher risk of perinatal and infant death. For perinatal deaths, Aboriginal, Asian (including Indian), and 'other' babies were at higher risk of perinatal death compared with Caucasian babies (Table 1). However, the difference was statistically significant only for Aboriginal people (Relative Risk [RR], 2.5; 95 per cent CI, 2.0-3.0; $p < 0.001$).

For infant deaths, Asian, Maori and Aboriginal babies had a higher risk of death compared to Caucasian babies. The difference was statistically significant for Maori (RR, 2.5; 95 per cent CI, 1.2-5.3; $p = 0.02$) and Aboriginal babies (RR, 4.3; 95 per cent CI, 3.2-5.7; $p < 0.001$). Aboriginal ethnicity, but not Maori, remained a significant risk factor for infant death, after adjusting for maternal age, health region and socioeconomic status.

Table 1: Perinatal and infant mortality by maternal ethnicity, Western Australia, 2008-2010

Maternal ethnicity	Total births	Live births	Perinatal mortality		Infant mortality	
			N	Rate per 1,000 births (95% CI)	N	Rate per 1,000 live births (95% CI)
Caucasian	73,460	72,969	619	8.4 (7.8-9.1)	202	2.8 (2.4-3.2)
Aboriginal	5,204	5,134	107	20.6 (17.0-24.8)	61	11.9 (9.3-15.2)
Asian/Indian	7,574	7,516	78	10.3 (8.3-12.8)	28	3.7 (2.6-5.4)
Maori	1,021	1,015	9	8.8 (4.6-16.7)	7	6.9 (3.3-14.2)
Other	5,899	5,846	69	11.7 (9.3-14.8)	22	3.8 (2.5-5.7)
Total	93,158	92,480	882	9.5 (8.9-10.1)	320	3.5 (3.1-3.9)

Maternal age lower than 25 years and greater than 40 years was associated with a higher risk of perinatal death compared to maternal age between 30 and 34 years. Maternal age lower than 30 years was associated with a higher risk of infant death compared to maternal age between 30 and 34 years. After adjusting for ethnicity, health region, socioeconomic status and smoking status, maternal age >40 was still a risk factor for perinatal death; while younger age was no longer a statistically significant risk factor for infant death.

Low birth weight and high plurality were associated with a higher risk of death during the first year of life.

After adjusting for ethnicity, health region, socioeconomic status and smoking status, maternal age, low gestational age (<37 weeks) was an independent risk factor for stillbirth, neonatal mortality and post-neonatal mortality. Table 2 shows the association between low gestational age and risk of death. The majority (95.0 per cent) of babies born between 20 and 23 weeks gestational age did not survive their first year. Preterm births (<37 weeks gestational age) accounted for 8.6 per cent of all births.

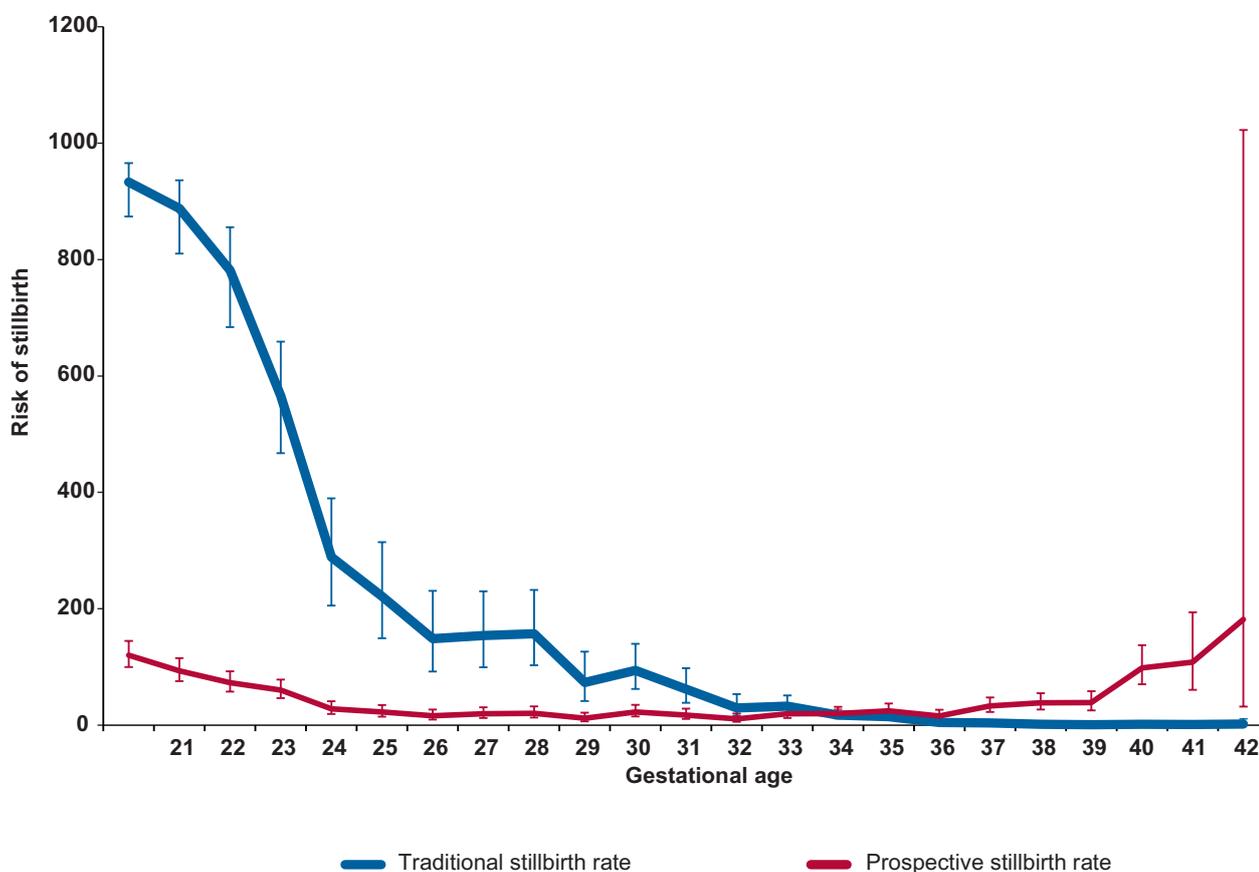
Table 2: Stillbirths, neonatal and post-neonatal mortality by gestational age at birth, Western Australia, 2008-2010

Gestational age at birth, weeks	Total births	Live births	Stillbirths		Neonatal mortality		Post-neonatal mortality	
			N	Rate per 1,000 births (95% CI)	N	Rate per 1,000 live births (95% CI)	N	Rate per 1,000 live births (95% CI)
20-23	404	81	323	799.5 (757.7-835.6)	58	716.0 (609.8-802.7)	3	37.0 (12.7-103.3)
24-25	185	138	47	254.1 (196.8-321.3)	21	152.2 (101.7-221.5)	3	21.7 (7.4-62.0)
26-31	971	871	100	103.0 (85.4-123.7)	32	36.7 (26.1-51.4)	14	16.1 (9.6-26.8)
32-36	6,472	6,390	82	12.7 (10.2-15.7)	27	4.2 (2.9-6.1)	19	3.0 (1.9-4.6)
≥ 37	85,126	85,000	126	1.5 (1.2-1.8)	66	0.8 (0.6-1.0)	77	0.9 (0.7-1.1)
Total	93,158	92,480	678	7.3 (6.8-7.8)	204	2.2 (1.9-2.5)	116	1.3 (1.0-1.5)

Epidemiologists recommend the calculation of prospective stillbirth rates by gestational age. Prospective stillbirth rates use the number of stillbirths at a given gestational age group as the numerator, but use total births at that gestational group or greater as denominator. This denominator represents a better indication of the population at risk of stillbirths which is all women who are still pregnant at that gestational age.¹⁰⁻¹¹

Figure 3 shows the prospective stillbirth rate per 100 000 fetuses at risk versus the traditional stillbirth rate per 1000 total births by gestational age group. In general the prospective rate fell substantially between 20 and 23, fluctuated between 24 and 39 weeks, and increased thereafter. There was one stillbirth at 42 weeks gestational age. There were no stillbirths reported in pregnancies 43 weeks gestational age and over. It is not clear to what extent the increase in stillbirth rate after 39 weeks is artefactual as a result of the diagnosis of stillbirths that may have occurred many weeks earlier.

Figure 3: Prospective stillbirth rate per 100,000 fetuses at risk versus traditional stillbirth rate per 1,000 total births by gestational age at birth, Western Australia, 2008-2010



The risk of perinatal and infant death varied according to place of residence. WA is a big state, covering an area of 2,532,400 square kilometres.¹² It is divided into nine health regions, two metropolitan (North and South) and seven rural (Kimberley, Pilbara, Midwest, Goldfields, Wheatbelt, South West and Great Southern). The state’s population, of around 2.2 million people in 2009, is unevenly distributed between metropolitan and rural areas, with the majority of the population living in the north and south metropolitan regions of Perth (1.8 million; map 1); The Aboriginal population accounts for 3.4 per cent of all the state’s population. However, this proportion varies by health region. The health region with the lowest proportion (1.4 per cent) of Aboriginal people is the North Metropolitan and the health region with the highest proportion (45.3 per cent) is the Kimberley. Aboriginal people accounted for 16.2 per cent of the population in the Pilbara, 11.4 per cent of the Midwest, 10.4 per cent of the Goldfields, 4.8 per cent of the Wheatbelt, 3.5 per cent of Great Southern, 2.0 per cent of South West, 1.8 per cent of South Metropolitan health region (Source: Epidemiology Branch, WA DOH, 2009 estimate).

Map 1 and 2: Total and Aboriginal population in 2009 by health regions

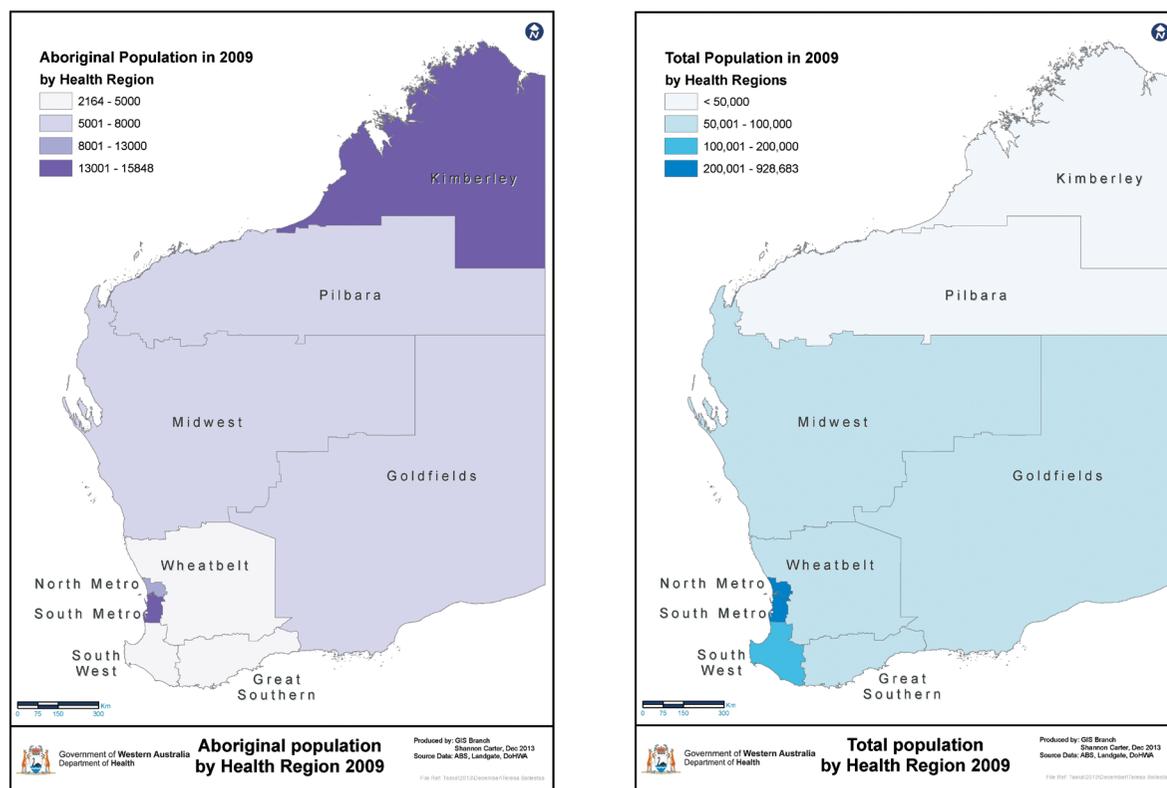


Table 3 shows data on stillbirths, neonatal, and post-neonatal mortality by health service region in WA 2008-2010. The rate for stillbirths, neonatal and post-natal mortality tended to be lower in metropolitan than WA Health Country Service (WACHS) regions. The lowest rate of neonatal mortality and infant mortality was for the North Metropolitan health region which was used as the reference category for analyses.

For stillbirths, residents of the Kimberley and Goldfields health region had a statistically significant higher risk compared to residents of the North Metropolitan health region. For neonatal deaths, residents of the Kimberley and the South Metropolitan health regions had a significant higher risk of death; however, after adjusting for ethnicity and socioeconomic status, the difference was not statistically significant.

For postneonatal mortality, residents of the Kimberley, Goldfields, Midwest, Wheatbelt and South Metropolitan health regions had a significant higher risk of death compared to residents of the North Metropolitan health region. All regions with the exception of the Goldfields remained

Table 3: Stillbirths, neonatal and post-neonatal mortality by health service region, Western Australia, 2008-2010

Health region	Total births*	Live births	Stillbirths		Neonatal mortality		Post-neonatal mortality	
			N	Rate per 1,000 births (95% CI)	N	Rate per 1,000 live births (95% CI)	N	Rate per 1,000 live births (95% CI)
Kimberley	2 061	2 035	26	12.6 (8.6-18.4)	8	3.9 (2.0-7.7)	8	3.9 (2.0-7.7)
Pilbara	2 506	2 493	13	5.2 (3.0-8.9)	8	3.2 (1.6-6.3)	3	1.2 (0.4-3.5)
Goldfields	2 870	2 837	33	11.5 (8.2-16.1)	7	2.5 (1.2-5.1)	6	2.1 (1.0-4.6)
Midwest	2 900	2 876	24	8.3 (5.6-12.3)	7	2.4 (1.2-5.0)	8	2.8 (1.4-5.5)
North Metro	37 361	37 112	249	6.7 (5.9-7.5)	64	1.7 (1.4-2.2)	23	0.6 (0.4-0.9)
South Metro	33 898	33 658	240	7.1 (6.2-8.0)	84	2.5 (2.0-3.1)	50	1.5 (1.1-2.0)
Wheatbelt	2 993	2 968	25	8.4 (5.7-12.3)	8	2.7 (1.4-5.3)	7	2.4 (1.1-4.9)
South West	6 235	6 186	49	7.9 (5.9-10.4)	12	1.9 (1.1-3.4)	7	1.1 (0.5-2.3)
Great Southern	2 253	2 235	18	8.0 (5.1-12.6)	5	2.2 (1.0-5.2)	3	1.3 (0.5-3.9)
Metro regions	71 259	70 770	489	6.9 (6.3-7.5)	148	2.1 (1.8-2.5)	73	1.0 (0.8-1.3)
WACHS regions	21 818	21 630	188	8.6 (7.5-9.9)	55	2.5 (2.0-3.3)	42	1.9 (1.4-2.6)
Total	93 077	92 400	677	7.3 (6.8-7.8)	203	2.2 (1.9-2.5)	115	1.3 (1.0-1.5)

* There were 81 births for which it was not possible to assign a health region as the mother's usual residence was outside of WA; there was one stillbirth, one neonatal death and one post-neonatal death in this group.

Likewise, living in most socio-economically deprived areas was also associated with a higher risk of perinatal and infant deaths. In this Report, socio-economic status refers to the combination of income, educational attainment, employment, occupation and housing.¹³

Residents of most socio-economically deprived areas (Quintiles 1, 2 and 3) had significantly higher rates of death during the first year of life compared to residents of least socio-economically deprived areas (Quintile 4 and 5; Figure 4 and 5). After adjusting for maternal age, ethnicity, health region and smoking status, living in most socio-economically deprived areas was an independent risk factor for perinatal deaths, but not for infant deaths.

Figure 4: Perinatal mortality by maternal socio-economic status, Western Australia, 2008-2010

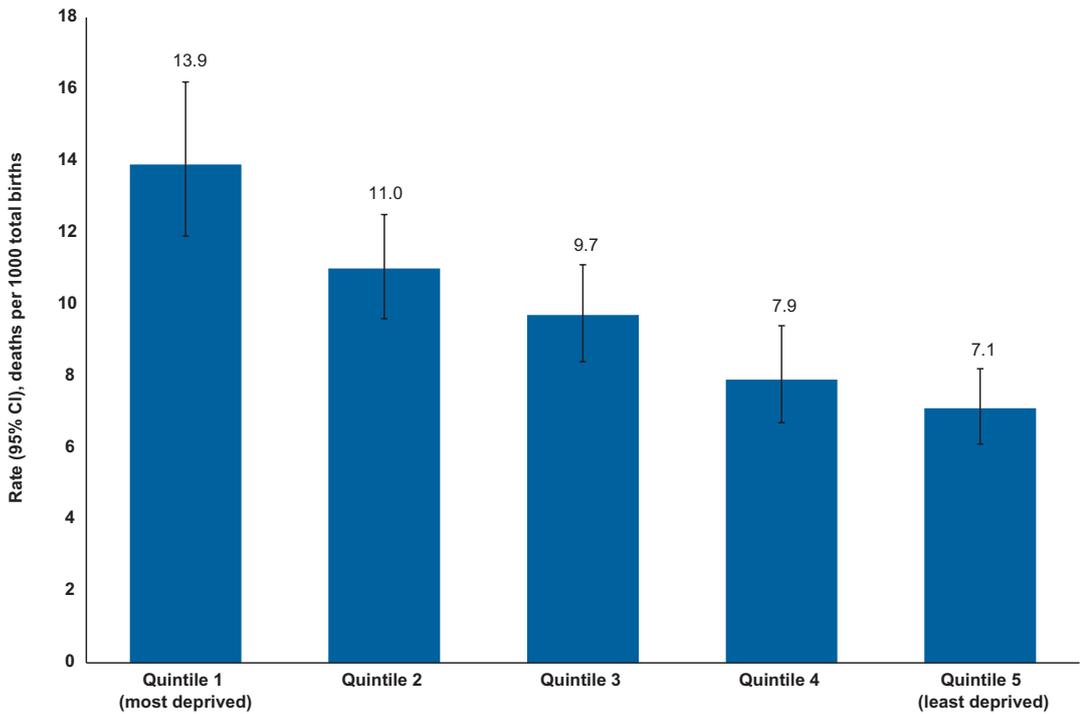
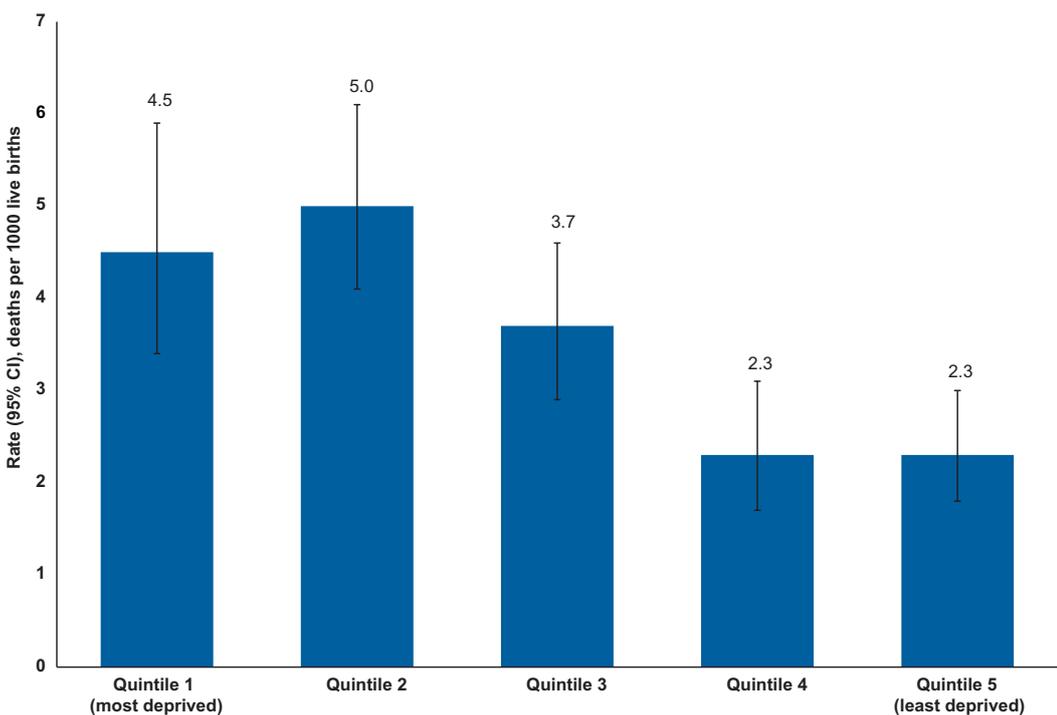


Figure 5: Infant mortality by maternal socio-economic status, Western Australia, 2008-2010



3. Causes of death

Information about causes of death is important for prevention programs and clinical practice. All notifications are entered into the perinatal and infant mortality database.

Following recommendations from the Perinatal Society of Australia and New Zealand, all notifications of perinatal death are classified using the 'Perinatal Society of Australia and New Zealand Perinatal Death Classification' (PSANZ PDC). All notifications of neonatal death are classified using the 'Perinatal Society of Australia and New Zealand Neonatal Death Classification (PSANZ NDC).¹⁴

Since there are no official classifications for infant deaths, for consistency, the Committee classifies all notifications of post-neonatal deaths using the PSANZ PDC and NDC.

The Committee investigates all deaths of 26 weeks or greater gestational age to identify preventable factors that could have contributed to the death. Between 2008 and 2010, the Committee investigated 303 stillbirths (44.7 per cent), 124 neonatal deaths (60.8 per cent) and 110 infant deaths (94.8 per cent).

A small number of deaths in babies 26 weeks or greater gestational age were not investigated. This included five stillbirths and one neonatal death. The main reason why deaths were not investigated was because of differences between the gestational age reported in the death certificate and that reported in the midwives notification form.

One neonatal and one post-neonatal deaths which occurred in babies under 26 weeks of age were investigated. These deaths have been excluded from the analyses.

Perinatal mortality

All notifications

Table 4 shows that for perinatal mortality, the most common causes of death were congenital abnormality (n=258; 29.3 per cent); spontaneous preterm (n=227; 25.7 per cent) and unexplained antepartum death (n=77; 8.7 per cent). The latter represents only stillbirths.

Fourteen neonatal deaths were classified as not having an obstetric antecedent.

The majority of stillbirths were antepartum (n= 384; 56.6 per cent); approximately a third (n= 210; 30.9 per cent) were intrapartum; and for 12.4 per cent (n=84) the type of stillbirth was unknown.

Compared with previous Reports, there was an increase in the rate of perinatal deaths related to spontaneous preterm delivery, while the proportion related to unexplained antepartum death and antepartum haemorrhage decreased significantly. This is explained by a statistically significant increase in the rate of stillbirths related to spontaneous preterm deliveries when compared with the 11th Report (n= 40; rate = 0.8 per 1,000 total births; CI, 0.6-1.1 in 2000-2001);¹ a statistically significant reduction in the rate of stillbirths due to unexplained antepartum death (n= 79; rate = 1.6 per 1,000 total births; CI, 1.3-3.2 in 2000-2001) and statistically significant reduction in the rate of stillbirths due to antepartum haemorrhage (n= 37, rate = 0.7 per 1,000 total births; CI, 0.5-1.0 in 2000-2001).

In addition, over the decade from 2000-2010, there was a small reduction in the rate of neonatal deaths related to spontaneous preterm from 1.0 per 1000 livebirths (CI=0.8-1.3) in 2000-2001;¹ while the rate of neonatal deaths due to congenital abnormality remained stable at around 0.7 per 1000 live births. In 2008-2010, it was the first time that congenital abnormality surpassed spontaneous preterm as the main cause of neonatal deaths.

Table 4: Perinatal mortality by cause of death (PSANZ-PDC), Western Australia, 2008-2010

Cause of death	Stillbirths			Neonatal mortality			Perinatal mortality		
	N	%	Rate 1,000 births (95% CI)	N	%	Rate per 1,000 live births (95% CI)	N	%	Rate per 1,000 births (95% CI)
1. Congenital abnormality	190	28.0	2.0 (1.8-2.4)	68	33.3	0.7 (0.6-0.9)	258	29.3	2.8 (2.5-3.1)
2. Perinatal infection	22	3.2	0.2 (0.2-0.4)	17	8.3	0.2 (0.1-0.3)	39	4.4	0.4 (0.3-0.6)
3. Hypertension	20	2.9	0.2 (0.1-0.3)	5	2.5	0.1 (0.0-0.1)	25	2.8	0.3 (0.2-0.4)
4. Antepartum haemorrhage	25	3.7	0.3 (0.2-0.4)	11	5.4	0.1 (0.1-0.2)	36	4.1	0.4 (0.3-0.5)
5. Maternal conditions	38	5.6	0.4(0.3-0.6)	4	2	0.0 (0.0-0.1)	42	4.8	0.5 (0.3-0.6)
6. Specific perinatal conditions	64	9.4	0.7(0.5-0.9)	7	3.4	0.1 (0.0-0.2)	71	8.0	0.8 (0.6-1.0)
7. Hypoxic peripartum death	15	2.2	0.2 (0.1-0.3)	12	5.9	0.1 (0.1-0.2)	27	3.1	0.3 (0.2-0.4)
8. Fetal growth restriction	60	8.8	0.6 (0.5-0.8)	5	2.5	0.1 (0.0-0.1)	65	7.4	0.7 (0.5-0.9)
9. Spontaneous preterm	166	24.5	1.8 (1.5-2.1)	61	29.9	0.7 (0.5-0.8)	227	25.7	2.4 (2.1-2.8)
10. Unexplained antepartum death	77	11.4	0.8 (0.7-1.0)	0	0	0 (0.0-0.0)	77	8.7	0.8 (0.7-1.0)
11. No obstetric antecedent	1	0.1	0 (0.0-0.1)	14	6.9	0.2 (0.1-0.3)	15	1.7	0.2 (0.1-0.3)
Total	678	100	7.3 (6.8-7.8)	204	100	2.2 (1.9-2.5)	882	100.0	9.5 (8.9-10.1)

Aboriginal people

For Aboriginal people, the main condition contributing to perinatal death was spontaneous preterm (n= 38; 35.5 per cent); followed by congenital abnormality (n= 23; 21.5 per cent), fetal growth restriction (n=8; 7.5 per cent) and antepartum haemorrhage (n=8; 7.5 per cent; Table 5). Compared to non-Aboriginal people, there was a statistically significant difference for spontaneous preterm, antepartum haemorrhage, congenital abnormalities, hypertension, maternal conditions, fetal growth restriction and no obstetric antecedent among Aboriginal people.

The main condition contributing to stillbirths was spontaneous preterm (n=24; 34.3 per cent), followed by congenital abnormality (n=15; 21.4 per cent), fetal growth restriction (n=7, 10.0 per cent) and unexplained antepartum death (n=7, 10.0 per cent).

The main condition contributing to neonatal death was spontaneous preterm (n=14; 37.8 per cent), followed by congenital abnormality (n=8; 21.6%), no obstetric antecedent (n=4; 10.8 per cent) and perinatal infection (n=4; 10.8 per cent)

Table 5: Aboriginal population: perinatal mortality by cause of death (PSANZ-PDC), Western Australia, 2008-2010

Cause of death	Stillbirths			Neonatal mortality			Perinatal mortality		
	N	%	Rate 1,000 births (95% CI)	N	%	Rate per 1,000 live births (95% CI)	N	%	Rate per 1,000 births (95% CI)
1. Congenital abnormality	15	21.4	2.9 (1.7-4.8)	8	21.6	1.6 (0.8-3.1)	23	21.5	4.4 (2.9-6.6)
2. Perinatal infection	0	0.0	0.0 (0.0-0.7)	4	10.8	0.8 (0.3-2.0)	4	3.7	0.8 (0.3-2.0)
3. Hypertension	3	4.3	0.6 (0.2-1.7)	1	2.7	0.2 (0.0-1.1)	4	3.7	0.8 (0.3-2.0)
4. Antepartum haemorrhage	6	8.6	1.2 (0.5-2.5)	2	5.4	0.4 (0.1-1.4)	8	7.5	1.5 (0.8-3.0)
5. Maternal conditions	5	7.1	1.0 (0.4-2.2)	1	2.7	0.2 (0.0-1.1)	6	5.6	1.2 (0.5-2.5)
6. Specific perinatal conditions	2	2.9	0.4 (0.1-1.4)	1	2.7	0.2 (0.0-1.1)	3	2.8	0.6 (0.2-1.7)
7. Hypoxic peripartum death	0	0.0	0.0 (0.0-0.7)	1	2.7	0.2 (0.0-1.1)	1	0.9	0.2 (0.0-1.1)
8. Fetal growth restriction	7	10.0	1.3 (0.7-2.8)	1	2.7	0.2 (0.0-1.1)	8	7.5	1.5 (0.8-3.0)
9. Spontaneous preterm	24	34.3	4.6 (3.1-6.9)	14	37.8	2.7 (1.6-4.6)	38	35.5	7.3 (5.3-10.0)
10. Unexplained antepartum death	7	10.0	1.3 (0.7-2.8)	0	0.0	0.0 (0.0-0.7)	7	6.5	1.3 (0.7-2.8)
11. No obstetric antecedent	1	1.4	0.2 (0.0-1.1)	4	10.8	0.8 (0.3-2.0)	5	4.7	1.0 (0.4-2.2)
Total	70	100.0	13.5 (10.7-17.0)	37	100.0	7.2(5.2-9.9)	107	100.0	20.6 (7.0-24.8)

Cases investigated by the Committee

A total of 427 (48.7 per cent) perinatal deaths were investigated by the Committee between 2008 and 2010.

For perinatal deaths, the main causes of death were congenital abnormality (n=94; 22.0 per cent), unexplained antepartum death (n=76; 17.8 per cent), fetal growth restriction (n=48; 11.2 per cent) and specific perinatal conditions (n=48; 11.2 per cent). However, it is important to note that the main causes of death were different for stillbirth and neonatal deaths (Table 6).

For stillbirths, the main causes of death were unexplained antepartum death (76; 25.1 per cent); fetal growth restriction (n=44; 14.5 per cent), and specific perinatal conditions (n=41; 13.5 per cent). The majority of unexplained stillbirths (n=60; 78.9 per cent) had a post-mortem investigation conducted.

For neonatal mortality, the main causes of death were congenital abnormality (n=56; 45.2 per cent), no obstetric antecedent (n=14; 11.3 per cent), and hypoxic peripartum death (n=12; 9.7 per cent).

Table 6: Cases investigated: perinatal mortality by cause of death (PSANZ-PDC), Western Australia, 2008-2010

Cause of death	Stillbirths		Neonatal mortality		Perinatal mortality	
	N	%	N	%	N	%
1. Congenital abnormality	38	12.5	56	45.2	94	22.0
2. Perinatal infection	17	5.6	11	8.9	28	6.6
3. Hypertension	17	5.6	4	3.2	21	4.9
4. Antepartum haemorrhage	20	6.6	9	7.3	29	6.8
5. Maternal conditions	33	10.9	4	3.2	37	8.7
6. Specific perinatal conditions	41	13.5	7	5.6	48	11.2
7. Hypoxic peripartum death	15	5.0	12	9.7	27	6.3
8. Fetal growth restriction	44	14.5	4	3.2	48	11.2
9. Spontaneous preterm	1	0.3	3	2.4	4	0.9
10. Unexplained antepartum death	76	25.1	0	0.0	76	17.8
11. No obstetric antecedent	1	0.3	14	11.3	15	3.5
Total	303	100.0	124	100.0	427	100.0

More detail for each category of the PSANZ-PDC is provided for stillbirths and neonatal deaths as follows:

Stillbirths

Stillbirths due to congenital abnormalities

Thirty eight stillbirths were caused by congenital abnormalities including: 18 chromosomal abnormalities, nine central nervous system, four cardiovascular system, two multiple non-chromosomal, two musculoskeletal, one haematological, one gastrointestinal and one unspecified.

Stillbirths due to perinatal infection

Of the 17 cases of perinatal infection, 15 were caused by bacterial infections (two by *E. Coli*, one by group B streptococcus and 12 by 'other' bacteria), one was caused by parvovirus infection, and one was caused by other specified organism.

Stillbirths due to hypertension

Hypertension caused 17 deaths. Clinical diagnosis comprised 16 cases of pre-eclampsia, and one pre-eclampsia superimposed on chronic hypertension.

Stillbirths due to antepartum haemorrhage

Of the 20 cases of antepartum haemorrhage, 17 were caused by placental abruption, and three by placental abruption with laboratory evidence of thrombophilia.

Stillbirths due to maternal conditions

Thirty three stillbirths were related to maternal conditions, including 17 diabetes/gestational diabetes, five antiphospholipid syndrome, four maternal sepsis, one maternal injury, one accidental, five other specified maternal conditions.

Stillbirths due to specific perinatal conditions

Specific perinatal conditions were related to 41 stillbirths, comprising 20 antepartum cord complications, nine fetomaternal haemorrhages, eight twin-twin transfusion syndromes, and four idiopathic hydrops.

Stillbirths due to hypoxic peripartum death (typically infants of >24 weeks gestation or >600g birthweight)

Hypoxic peripartum death was found to be the cause of death for 15 stillbirths, including six stillbirths with intrapartum complications (one uterine rupture, two cord prolapse, three other); five unspecified; three with evidence of non-reassuring fetal status in a normally grown infant; and one with no intrapartum complications and no evidence of non-reassuring fetal status.

Stillbirths due to fetal growth restriction (FGR)

Fetal growth restriction was a risk factor identified for 44 deaths. Findings included 25 with evidence of reduced vascular perfusion on Doppler studies and /or placental; seven with other specified placental pathology; six with no placental pathology; four with no examination of placenta; and two with chronic villitis.

Stillbirths due to spontaneous preterm (<37 weeks gestation)

One stillbirth due to spontaneous preterm was associated with chorioamnionitis on placental histopathology.

Stillbirths due to unexplained antepartum death

Seventy six stillbirths were classified as unexplained antepartum death. Of those, 30 did not have placental pathology; 23 had evidence of reduced vascular perfusion on Doppler studies and /or placental; three had chronic villitis; 14 had other specified placental pathology; one was unexplained; and five did not have an examination of the placenta.

Stillbirths due to no obstetric antecedent

One stillbirth was classified as undetermined obstetric antecedent.

Neonatal deaths

Neonatal deaths due to congenital abnormality

Congenital abnormalities contributed to fifty six neonatal deaths, comprising 12 cardiovascular system, 11 chromosomal, eight multiple/non chromosomal, six central nervous system, four urinary system, four diaphragmatic hernia, three musculoskeletal, three respiratory, two metabolic, one haematological, one tumours, and one other specified.

Neonatal deaths due to perinatal infection

Perinatal infection contributed to 11 neonatal deaths: eight were caused by bacterial infections (three by Group B Streptococcus, two by E Coli, two other bacterial, one unspecified bacterial), and three by viral infections (one cytomegalovirus and two herpes simplex virus).

Neonatal deaths due hypertension

Hypertension contributed to four neonatal deaths, including three deaths due to pre-eclampsia, and one death due to gestational hypertension.

Neonatal deaths due antepartum haemorrhage (APH)

Antepartum haemorrhage contributed to nine neonatal deaths. Diagnosis included seven deaths due to placental abruption; one death due to vasa praevia; and one death of undetermined origin.

Neonatal deaths due to maternal conditions

Maternal conditions contributed to four neonatal deaths, including one diabetes/gestational diabetes, one non-accidental maternal injury, one obstetric cholestasis, and one other specified maternal condition.

Neonatal deaths due to perinatal conditions

Specific perinatal conditions contributed to seven neonatal deaths, comprising three twin-twin transfusion, one fetomaternal haemorrhage, and three other specified.

Neonatal deaths due to hypoxic peripartum death (typically infants of >24 weeks gestation or >600g birthweight)

Hypoxic peripartum contributed to 12 neonatal deaths. The majority of them were due to intrapartum complications (two cord prolapse, two no further classified, one shoulder dystocia, and two other); two had evidence of non-reassuring fetal status in a normally grown infant; one was unspecified; and two were no further classified.

Neonatal deaths due to fetal growth restriction

Fetal growth restriction contributed to four neonatal deaths; three with evidence of reduced vascular perfusion on Doppler studies and /or placental; and one without placental pathology.

Neonatal deaths due to spontaneous preterm (<37 weeks gestation)

Spontaneous preterm contributed to three neonatal deaths with the main findings including one case with chorioamnionitis on placental histopathology, one without chorioamnionitis on placental histopathology, and one spontaneous preterm with membrane rupture 24 hours before delivery.

Neonatal deaths due to no obstetric antecedent

Fourteen neonatal deaths did not have an obstetric antecedent. Eight of those deaths were related to SIDS (seven to SIDS Category II : Infant deaths that meet Category I except for one or more; one death due to SIDS Category IA: Classic features of SIDS present and completely); one related to postnatally acquired infection; one to other accident, poisoning or violence; two other specified; and two unknown/undetermined.

Pathology investigations into cause of death

Sixty two percent (n=545) of perinatal deaths underwent post-mortem investigation to ascertain causes of death, while 34.8 (n= 307) did not. For the remaining 30 deaths (3.4per cent), it was unknown whether post-mortem investigation was conducted or not.

For stillbirths, the proportion of cases who underwent post-mortem investigation was 67.1 per cent (n=455), while 29.8 per cent (202) did not undergo post-mortem investigation. The remaining (n=2; 3.1 per cent) was unknown.

For neonatal deaths, the proportion of cases who underwent post-mortem investigation was 44.1 per cent (n=90), while 51.5 per cent (n=105), for the remaining (n=9; 4.4 per cent) was unknown.

Infant mortality

All notifications

Table 7 shows that the majority of infant deaths were caused by congenital abnormalities (n=95; 29.7 per cent), followed by Sudden Death Infant Syndrome (SIDS) and other (n=76; 23.8 per cent), and extreme prematurity (n=63; 19.7 per cent). However, it is important to note that causes of death varied according to the period in which they occurred.

For neonatal deaths, congenital abnormality was the most common cause of death (n=68; 33.3 per cent), followed by extreme prematurity (n=59; 28.9 per cent) and neurological conditions (n=30; 14.7 per cent).

Between 2000 and 2010, there was a significant decline in the rate of neonatal deaths related to cardio-respiratory disorders from 0.4 per 1000 live births in 2000-2001 to 0.1 per 1000 live births in 2008-2010.

For post-neonatal deaths, SIDS accounted for 46 (39.7 per cent) deaths, congenital abnormality for 27 deaths (23.3 per cent) and infections for 13 deaths (11.2 per cent). These results differ from the previous Report (2005-2007) when the leading causes of post-neonatal deaths were congenital abnormality (n=39; 33.9 per cent); SIDS (n=35; 30.4 per cent) and infection (n=15; 13.0 per cent). However, similar rankings have been reported in the 2002-2004 and 2000-2001 Reports.

There have been no improvements in the rates of infant mortality due to SIDS between 2000 and 2010 in WA.

Table 7: Infant mortality by cause of death (PSANZ-NDC), Western Australia, 2008-2010

Cause of death	Neonatal mortality			Post-neonatal mortality			Infant mortality		
	N	%	Rate per 1,000 live births (95% CI)	N	%	Rate per 1,000 live births (95% CI)	N	%	Rate per 1,000 live births (95% CI)
1. Congenital abnormality	68	33.3	0.7 (0.6-0.9)	27	23.3	0.3 (0.2-0.4)	95	29.7	1.0 (0.8-1.3)
2. Extreme prematurity	59	28.9	0.6 (0.5-0.8)	4	3.4	0.0 (0.0-0.1)	63	19.7	0.7 (0.5-0.9)
3. Cardio-respiratory disorders	8	3.9	0.1 (0.0-0.2)	9	7.8	0.1 (0.1-0.2)	17	5.3	0.2 (0.1-0.3)
4. Infection	17	8.3	0.2 (0.1-0.3)	13	11.2	0.1 (0.1-0.2)	30	9.4	0.3 (0.2-0.5)
5. Neurological	30	14.7	0.3 (0.2-0.5)	2	1.7	0.0 (0.0-0.1)	32	10.0	0.3 (0.2-0.5)
6. Gastrointestinal	7	3.4	0.1 (0.0-0.2)	0	0.0	0.0 (0.0-0.0)	7	2.2	0.1 (0.0-0.2)
7.1 SIDS	9	4.4	0.1 (0.1-0.2)	46	39.7	0.5 (0.4-0.7)	54	16.9	0.6 (0.5-0.8)
7.2-7.9 Other	6	2.9	0.1 (0.0-0.1)	15	12.9	0.2 (0.1-0.3)	22	6.9	0.2 (0.1-0.3)
Total	204	100.0	2.2 (1.9-2.5)	116	100.0	1.3 (1.0-1.5)	320	100.0	3.5 (3.1-3.9)

When PSANZ-PDC and PSANZ-NDC were cross examined, it was observed that the majority of infant deaths with no obstetric antecedent (PSANZ-PDC) were caused by SIDS (n=54), other (n=20) and infection (n=11; Table 8).

Table 8: Number of infant deaths by cause of death classifications systems (PSANZ-PDC and PSANZ-NDC), Western Australia, 2008-2010

PSANZ-PDC	PSANZ-NDC								
	1. Congenital abnormality	2. Extreme prematurity	3. Cardio-respiratory disorders	4. Infection	5. Neurological	6. Gastro-intestinal	7.1 SIDS	7.2-7.9 Other	Total
1. Congenital abnormality	91	0	3	1	1	1	0	0	97
2. Perinatal infection	0	3	0	14	0	0	0	0	17
3. Hypertension	1	1	1	1	1	2	0	0	7
4. Antepartum haemorrhage	0	3	3	0	7	1	0	0	14
5. Maternal conditions	0	0	0	1	3	0	0	0	4
6. Specific perinatal conditions	1	0	5	0	2	1	0	0	9
7. Hypoxic peripartum death	0	0	1	0	11	0	0	0	12
8. Fetal growth restriction	0	1	0	1	0	1	0	2	5
9. Spontaneous preterm	2	55	4	1	6	1	1	0	70
10. Unexplained antepartum death	0	0	0	0	0	0	0	0	0
11. No obstetric antecedent	0	0	0	11	1	0	54	20	86
Total	95	63	17	30	32	7	55	22	320

Aboriginal people

For Aboriginal people, the leading PSANZ-PDC condition contributing to infant death was no obstetric antecedent (n=22, 36.1 per cent), followed by spontaneous preterm (n=17; 27.9 per cent) and congenital abnormality (n=10, 16.4 per cent). The risk of death for Aboriginal relative to non-Aboriginal people for these conditions was significantly higher (p<0.00).

For Aboriginal infants, the most common cause of death was SIDS and other (n=21; 34.4 per cent), extreme prematurity (n= 16; 26.2 per cent), and congenital abnormality (n=11; 18.0 per cent; Table 9). Compared with non-Aboriginal people, Aboriginal infants had a statistically significantly higher risk of death due to SIDS and other, extreme prematurity, congenital abnormalities and gastrointestinal disorders and infection.

For Aboriginal people, the leading cause of post-neonatal deaths was SIDS and other (n=16; 66.7 per cent).

Similar to previous Reports, the leading cause of death for Aboriginal neonates was extreme prematurity (n=14; 37.8 per cent); followed by congenital abnormality (n=10; 27 per cent), and SIDS and other (n=5; 13.5 per cent).

Table 9: Aboriginal population: infant mortality by cause of death (PSANZ-NDC), Western Australia, 2008-2010

	Neonatal mortality			Post-neonatal mortality			Infant mortality		
	n	%	OR (95% CI)	n	%	OR (95% CI)	n	%	OR (95% CI)
1. Congenital abnormality	10	27.0	1.9 (1.1-3.6)	1	4.2	0.2 (0.0-1.1)	11	18.0	2.1 (1.2-3.8)
2. Extreme prematurity	14	37.8	2.7 (1.6-4.6)	2	8.3	0.4 (0.1-1.4)	16	26.2	3.1 (1.9-5.1)
3. Cardio-respiratory disorders	0	0.0	0.0 (0.0-0.7)	2	8.3	0.4 (0.1-1.4)	2	3.3	0.4 (0.1-1.4)
4. Infection	4	10.8	0.8 (0.3-2.0)	3	12.5	0.6 (0.2-1.7)	7	11.5	1.4 (0.7-2.8)
5. Neurological	2	5.4	0.4 (0.1-1.4)	0	0.0	0.0 (0.0-0.7)	2	3.3	0.4 (0.1-1.4)
6. Gastrointestinal	2	5.4	0.4 (0.1-1.4)	0	0.0	0.0 (0.0-0.7)	2	3.3	0.4 (0.1-1.4)
7.1 SIDS	2	5.4	0.4 (0.1-1.4)	13	54.2	2.5 (1.5-4.3)	15	24.6	2.9 (1.8-4.8)
7.2-7.9 Other	3	8.1	0.6 (0.2-1.7)	3	12.5	0.6 (0.2-1.7)	6	9.8	1.2 (0.5-2.5)
Total	37	100.0	7.2 (5.2-9.9)	24	100.0	4.7 (3.1-6.9)	61	100.0	11.9 (9.3-15.2)

Cases investigated by the Committee

Two hundred and thirty four infant deaths (73.1 per cent) were investigated by the Committee. The main causes of death for infant deaths were congenital abnormality (n=81; 34.6 per cent), SIDS and other (n=76; 32.5 per cent) and neurological disorders (n=28; 11.9 per cent; Table 10).

Table 10: Cases investigated: number of infant deaths by cause of death classifications systems (PSANZ-PDC and PSANZ-NDC), Western Australia, 2008-2010

PSANZ-PDC	PSANZ-NDC							Total
	1. Congenital abnormality	2. Extreme prematurity	3. Cardio-respiratory disorders	4. Infection	5. Neurological	6. Gastro-intestinal	7. SIDS and other	
1. Congenital abnormality	79	0	2	1	1	1	0	84
2. Perinatal infection	0	0	0	11	0	0	0	11
3. Hypertension	1	1	1	1	1	1	0	6
4. Antepartum haemorrhage	0	1	3	0	7	1	0	12
5. Maternal conditions	0	0	0	1	3	0	0	4
6. Specific perinatal conditions	1	0	5	0	2	1	0	9
7. Hypoxic peripartum death	0	0	1	0	11	0	0	12
8. Fetal growth restriction	0	0	0	1	0	1	2	4
9. Spontaneous preterm	0	0	4	0	2	0	1	7
10. Unexplained antepartum death	0	0	0	0	0	0	0	0
11. No obstetric antecedent	0	0	0	11	1	0	73	85
Total	81	2	16	26	28	5	76	234

As expected, congenital abnormalities contributed to a higher proportion of neonatal deaths compared with post-neonatal deaths; while SIDS and other contributed to a higher proportion of post-neonatal deaths compared to post-neonatal deaths.

When PSANZ-PDC and PSANZ-NDC were cross examined, it was observed that the majority of neonatal deaths had an antenatal factor (i.e. congenital abnormality, Table 11).

Table 11: Cases investigated: number of neonatal deaths by cause of death classifications systems (PSANZ-PDC and PSANZ-NDC), Western Australia, 2008-2010

PSANZ-PDC	PSANZ-NDC							Total
	1. Congenital abnormality	2. Extreme prematurity	3. Cardio-respiratory disorders	4. Infection	5. Neurological	6. Gastro-intestinal	7. SIDS and other	
1. Congenital abnormality	53	0	1	0	1	1	0	56
2. Perinatal infection	0	0	0	11	0	0	0	11
3. Hypertension	1	1	0	0	1	1	0	4
4. Antepartum haemorrhage+	0	1	1	0	6	1	0	9
5. Maternal conditions	0	0	0	1	3	0	0	4
6. Specific perinatal conditions	0	0	4	0	2	1	0	7
7. Hypoxic peripartum death	0	0	1	0	11	0	0	12
8. Fetal growth restriction	0	0	0	1	0	1	2	4
9. Spontaneous preterm	0	0	1	0	2	0	0	3
10. Unexplained antepartum death	0	0	0	0	0	0	0	0
11. No obstetric antecedent	0	0	0	1	0	0	13	14
Total	54	2	8	14	26	5	15	124

In contrast the majority of post-neonatal deaths were caused by SIDS and other. The majority of neonatal and post-neonatal deaths caused by SIDS did not have an obstetric antecedent (Table 12).

Table 12: Cases investigated: number of post-neonatal deaths by cause of death classifications systems (PSANZ-PDC and PSANZ-NDC), Western Australia, 2008-2010

PSANZ-PDC	PSANZ-NDC							Total
	1. Congenital abnormality	2. Extreme prematurity	3. Cardio-respiratory disorders	4. Infection	5. Neurological	6. Gastro-intestinal	7. SIDS and other	
1. Congenital abnormality	26	0	1	1	0	0	0	28
2. Perinatal infection	0	0	0	0	0	0	0	0
3. Hypertension	0	0	1	1	0	0	0	2
4. Antepartum haemorrhage	0	0	2	0	1	0	0	3
5. Maternal conditions	0	0	0	0	0	0	0	0
6. Specific perinatal conditions	1	0	1	0	0	0	0	2
7. Hypoxic peripartum death	0	0	0	0	0	0	0	0
8. Fetal growth restriction	0	0	0	0	0	0	0	0
9. Spontaneous preterm	0	0	3	0	0	0	1	4
10. Unexplained antepartum death	0	0	0	0	0	0	0	0
11. No obstetric antecedent	0	0	0	10	1	0	60	71
Total	27	0	8	12	2	0	61	110

More detail for each category of the PSANZ-NDC is provided for neonatal and post-neonatal deaths as follows:

Neonatal deaths

Neonatal deaths due to congenital abnormality

Fifty four neonatal deaths were caused by congenital abnormalities, comprising: 14 cardiovascular system, nine chromosomal, eight multiple/non chromosomal, five central nervous system, three urinary system, four diaphragmatic hernia, three musculoskeletal, four respiratory, two metabolic, one tumour, and one other specified.

Neonatal deaths due to extreme prematurity (typically infants of <24 weeks gestation or <600g birthweight)

Two neonatal deaths were caused by extreme prematurity.

Neonatal deaths due cardio-respiratory disorders

Cardio-respiratory disorders were responsible for eight neonatal deaths, comprising two hyaline membrane disease/respiratory distress syndrome, one meconium aspiration syndrome, one primary persistent pulmonary hypertension, one pulmonary hypoplasia, one chronic neonatal lung disease and two other.

Neonatal deaths due to infection

Of the 14 cases of neonatal death due to infection, 10 were caused by bacterial infections (seven congenital infections, two acquired and one not further classified), and four by viral infections (three congenital and one not further classified).

Neonatal deaths due neurological disorder

Neurological disorders were the cause of 26 deaths. Diagnosis included 22 deaths due to hypoxic ischaemic encephalopathy/perinatal asphyxia; two deaths due to intracranial haemorrhage; and two not further classified.

Neonatal deaths due to gastrointestinal tract disorders.

Five neonatal deaths were caused by necrotising enterocolitis.

Neonatal deaths due to other causes

Fifteen neonatal deaths were caused by other pathologies. There were nine neonatal deaths caused by SIDS (1 category IA-Classic features of SIDS present but incompletely, and eight category II-Infant deaths that meet category I except for one or more). In addition, one death was caused by trauma, one by multisystem failure, two other specified, one unknown, and one other undetermined.

Post-neonatal deaths

Post-neonatal deaths due to congenital abnormality

Twenty seven post-neonatal deaths were caused by congenital abnormality, comprising eight deaths due to abnormality of the central nervous system, 10 cardiovascular system, two chromosomal, one multiple non-chromosomal, one urinary system, one metabolic, and four other congenital abnormality (two tumour, one other specified, one not further classified).

Post-neonatal deaths due to cardio-respiratory disorders

Cardio-respiratory disorders were identified as the cause of death for eight post-neonatal deaths. Diagnosis included: seven chronic lung diseases and one pulmonary hypoplasia.

Post-neonatal deaths due to infection

Of the 12 neonatal deaths caused by infection, eight were caused by acquired bacterial infections, three by acquired viral infections and one by protozoan infection.

Post-neonatal deaths due neurological disorders

Two deaths were caused by neurological disorders, comprising one death due to hypoxic ischaemic encephalopathy/perinatal asphyxia and one to intracranial haemorrhage.

Post-neonatal deaths due to other causes

Sixty one post-neonatal deaths were caused by other pathologies. Causes included 45 deaths caused by SIDS (13 category IA-Classic features of SIDS present but incompletely, and 32 category II-Infant deaths that meet category I except for one or more); six deaths were caused by trauma; five other specified; two unknown; one unclassified; one other unknown and one not further classified.

Pathology investigations into cause of death

Fifty two percent (n=166) of infant deaths underwent post-mortem investigation to ascertain cause of death, while 42.5 (n= 136) did not. For the remaining, it was (n = 18; 5.6%) unknown whether post-mortem investigation was conducted or not.

For neonatal deaths, the proportion of cases who underwent post-mortem investigation was 44.1% (n=90), while 51.5% did not (n=105), for the remaining (n=9; 4.4%) was unknown.

For post-neonatal deaths, the proportion of cases who underwent post-mortem investigation was 65.5% (n=76), while 26.7% (31) did not undergo post-mortem investigation, for the remaining (n=9; 7.8%) was unknown.

4. Preventable factors

Medical preventability

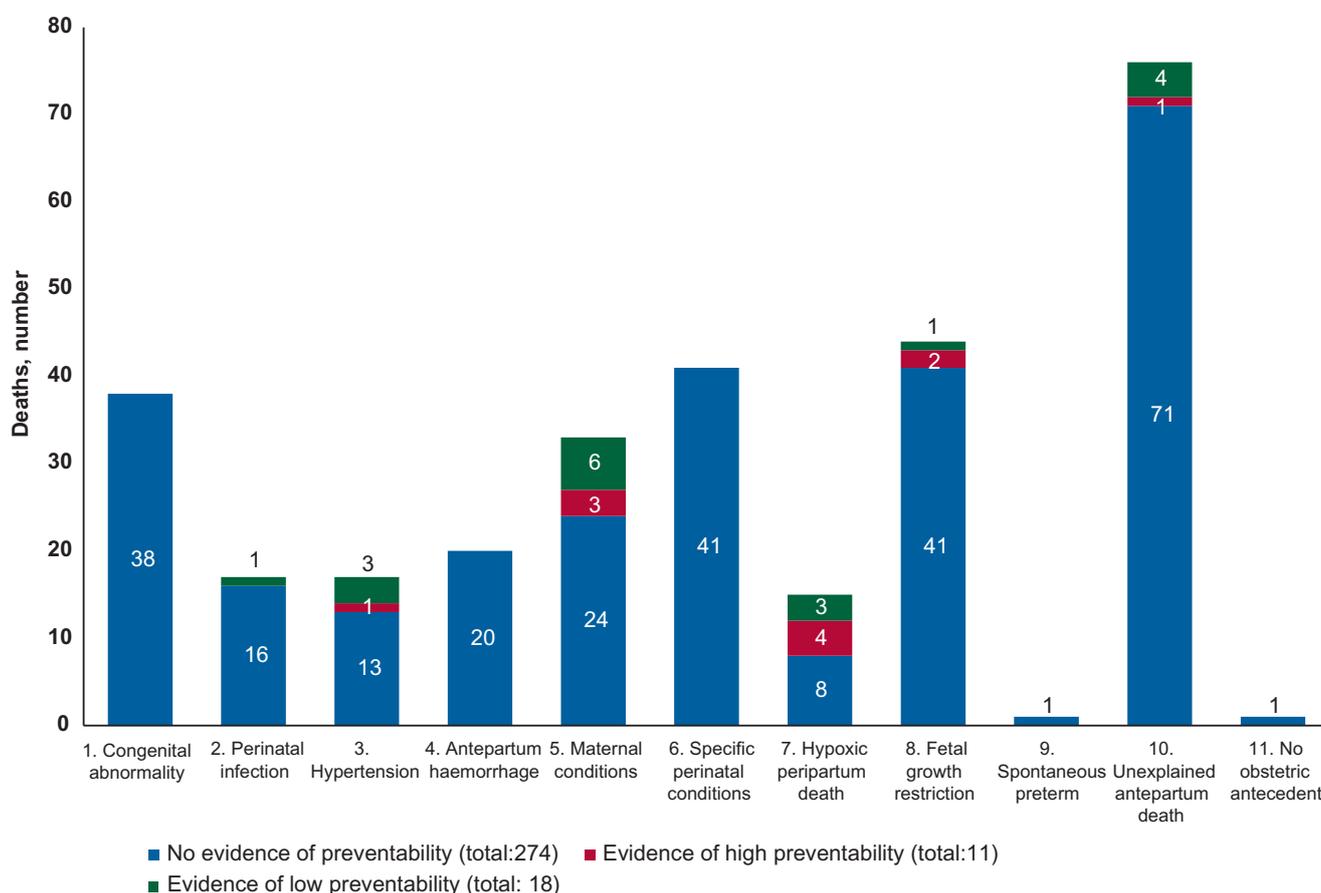
All investigated deaths were classified using a preventability scale to distinguish those with possible preventable medical factors. A preventability score of one indicates no evidence of preventability, a score between two and three indicates low preventability and a score between four and six indicates high preventability. A small number of cases, including six stillbirths and one neonatal death, were not classified because the Committee decided the preventability could not be coded appropriately.

The majority of investigated stillbirths (n= 274; 90.4 per cent) had no evidence of preventability, 18 stillbirths (5.9 per cent) had low preventability, and 11 stillbirths (3.6 per cent) had high preventability. Figure 6 shows the number of stillbirths with evidence of medical preventability by cause of death. In keeping with previous Reports, the majority of stillbirths were related to maternal conditions and hypoxic peripartum deaths.

Of those considered highly preventable, the majority of stillbirths (n= 8; 72.7 per cent) were antepartum death, 1 stillbirth (9.1 per cent) was an intrapartum death and two were unknown (18.2 per cent).

Compared with the 13th Report, there was an increase in the number and the proportion of stillbirths with evidence of high preventability after adjusting for population increase. Between 2005 and 2007, the number of cases with evidence of high preventability was four (1.6 per cent) and the number of cases with low preventability was 20 (8.0 per cent).⁶

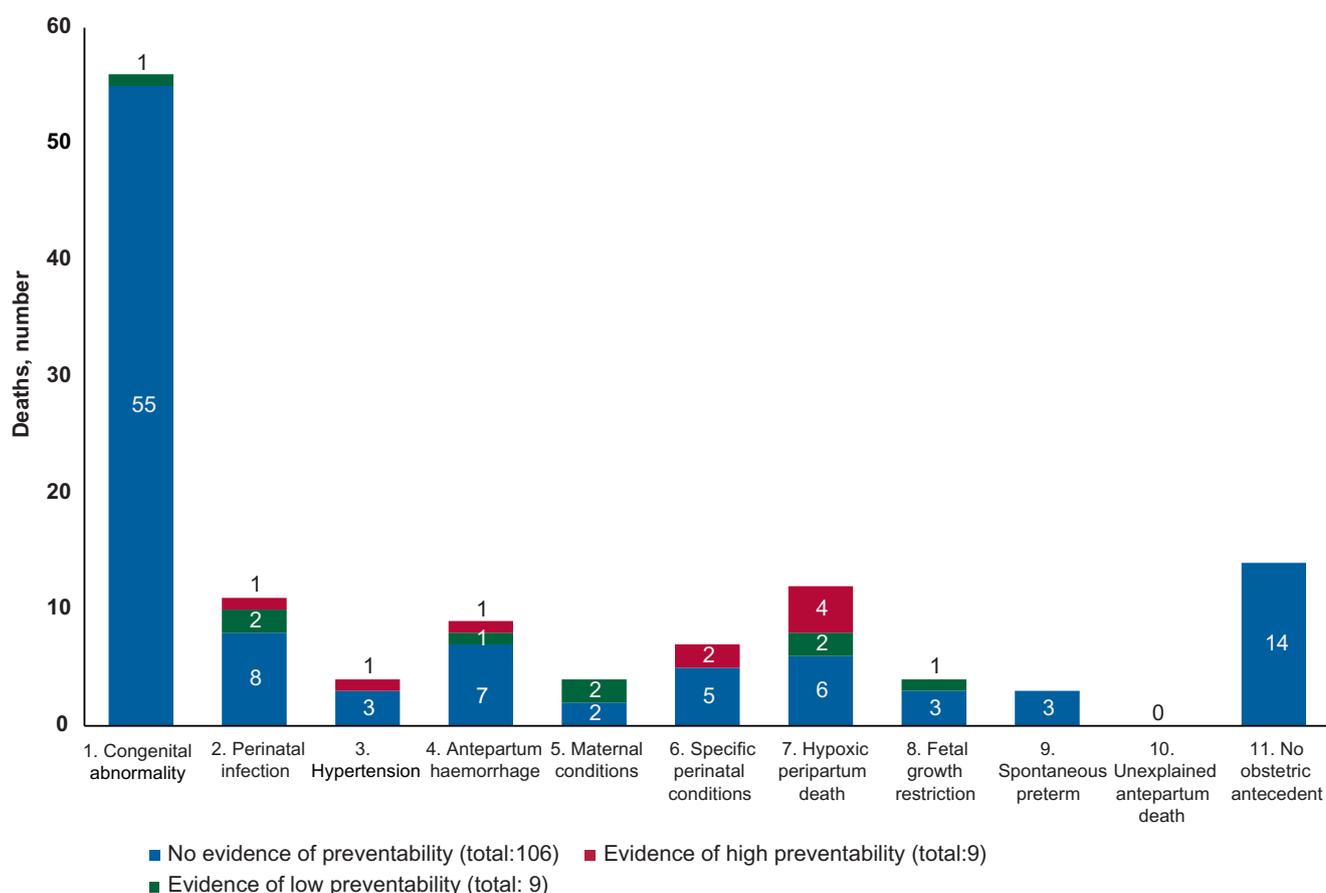
Figure 6: Number of stillbirths >= 26 weeks gestations with some evidence of medical preventability by cause of death (PSANZ-PDC), Western Australia, 2008-2010



The majority of investigated neonatal deaths had no evidence of preventability (n=106; 85.5 per cent), nine neonatal deaths had low preventability (7.3 per cent), and nine neonatal deaths had high preventability (7.3 per cent). Figure 7 shows the number of neonatal deaths with evidence of medical preventability by cause of death. The majority of possible preventable deaths were related to hypoxic peripartum and perinatal infection.

Compared to the 12th and 13th Report there was a reduction in the number and the proportion of neonatal deaths. In 2002-2004, the number with low preventability was 19 (19.6 per cent).⁵ There were no changes in the proportion of neonatal deaths with high preventability over the same period.

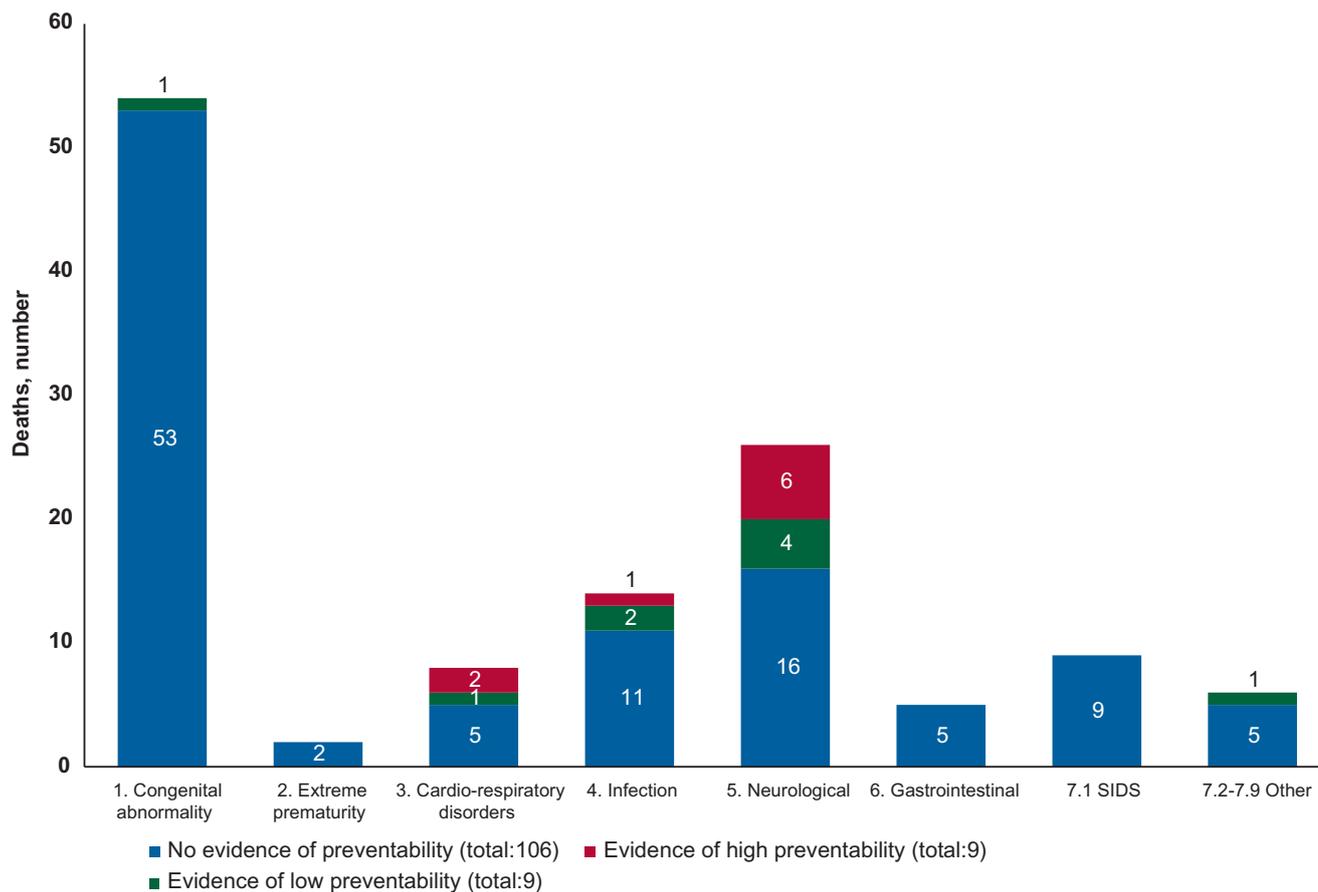
Figure 7: Number of neonatal deaths >= 26 weeks gestations with some evidence of medical preventability by cause of death (PSANZ-PDC), Western Australia, 2008-2010



When neonatal deaths were classified using the PSANZ-NDC, the majority of possible preventable deaths were caused by neurological conditions (n=10), infection (n=3), and cardiorespiratory disorders (n=3; Figure 8).

Notably, none of the post-neonatal deaths were found to be medically preventable.

Figure 8: Number of neonatal deaths \geq 26 weeks gestations with some evidence of medical preventability by cause of death (PSANZ-NDC), Western Australia, 2008-2010



The Committee identified the reasons why these stillbirths and neonatal deaths were considered preventable. Table 13 shows system and medical factors for stillbirths and neonatal deaths considered highly preventable. A small number of stillbirths and neonatal deaths had more than one factor. The most important system factor was communication and documentation problems between health providers. The most important medical factor was suboptimal obstetric management.

Table 13: System and medical factors in investigated deaths with preventability score ≥ 4 , Western Australia, 2008-2010

System factor	Stillbirths	Neonatal deaths
Communication and documentation problems between staff in same or different medical services	4	3
Equipment problem (i.e. ambulance availability, resuscitation equipment)		2
Problem with follow up of abnormal result	1	
Medical factor		
Sub-optimal obstetric management	5	2
Failure to act on a non-reassuring CTG	2	1
Fetal heart rate monitoring not performed		1
Insufficient technical skills for obstetric delivery (i.e. use of kiwi cups and obstetric forceps)	0	1
Problems in medical care of baby		1
Earlier referral indicated	1	2
Other	1	

Alternative management decisions would have improved outcomes in the following areas:

- identification of risk factors such as previous history of neonatal death, rapid labour and drug use
- group B Streptococcus screening and management of sepsis
- management of hypertension during pregnancy
- medical management of post maturity syndrome
- management of fetal growth restriction
- management of Graves Disease during pregnancy
- management of maternal injury.

Behavioural factors

Smoking

Overall, the prevalence of smoking has continuously declined from 21.3 per cent in 2000-2001 to 14.2 per cent in 2008-2010.

The proportion of Aboriginal women who report smoking during pregnancy was higher (49.8 per cent) compared to non-Aboriginal women (14.2 per cent). The prevalence of smoking reported by Aboriginal women has been stable. It was 52.3 per cent in 2001 and 47.9 per cent in 2010.

Table 14 shows that smoking during pregnancy was significantly associated with a higher risk of perinatal death (RR: 1.8, 95 per cent CI 1.6-2.1, $p < 0.0001$). Twenty two per cent of stillbirths and 26.5 per cent of neonatal deaths were associated with smoking during pregnancy.

Smoking during pregnancy was significantly associated with a higher risk of infant deaths (RR: 2.9, 95 per cent CI 2.3-3.6, $p < 0.0001$) compared to non-smokers. One quarter of neonatal deaths and almost half of post-neonatal deaths were associated with smoking during pregnancy.

Smoking during pregnancy remained an independent risk factor for perinatal and infant death after adjusting for maternal age, ethnicity, health region and socioeconomic status.

Table 14: Stillbirths, neonatal and post-neonatal mortality by reported smoking status during pregnancy, Western Australia, 2008-2010

Reported smoking during pregnancy	Stillbirths			Neonatal mortality			Post-neonatal mortality		
	N	%	Rate 1,000 births (95% CI)	N	%	Rate per 1,000 live births (95% CI)	N	%	Rate per 1,000 births (95% CI)
Yes	149	22	11.4 (9.7-13.3)	54	26.5	4.2 (3.2-5.4)	49	42.2	3.8 (2.9-5.0)
No	529	78	6.6 (6.1-7.2)	150	73.5	1.9 (1.6-2.2)	67	57.8	0.8 (0.7-1.1)
Total	678	100.0	7.3 (6.8-7.8)	204	100.0	2.2 (1.9-2.5)	116	100.0	1.3 (1.0-1.5)

Other factors

Other maternal factors that might have contributed to perinatal and infant deaths were discussed by the Committee and recorded in the investigated cases.

Table 15 shows that other behavioural maternal factors contributed to 19.9 per cent of investigated perinatal deaths, including 18.8 per cent of stillbirths and 22.6 per cent of neonatal deaths. The main contributors were poor compliance, marijuana use, 'other serious social problems' and alcohol abuse.

Other behavioural maternal factors contributed to 30.8 per cent of investigated infant deaths, including 22.6 per cent of neonatal deaths and 40.0 per cent of post neonatal deaths. The main contributors were co-sleeping, 'other serious social problems', alcohol abuse and maternal psychiatric disorders.

Table 15: Cases investigated: perinatal mortality by behavioural maternal factors, Western Australia, 2008-2010

Maternal behavioural factor	Stillbirths		Neonatal mortality		Post-neonatal mortality	
	N	%	N	%	N	%
Poor compliance	14	24.6	5	17.9	0	0.0
Alcohol abuse	8	14.0	3	10.7	4	9.1
Marijuana	12	21.1	3	10.7	3	6.8
Iv drugs	3	5.3	2	7.1	1	2.3
Homebirth	6	10.5	2	7.1	1	2.3
Domestic violence	4	7.0	1	3.6	3	6.8
Co-sleeping	0	0.0	7	25.0	22	50.0
Other serious social problems	6	10.5	5	17.9	3	6.8
Maternal psychiatric disorder	4	7.0	0	0.0	7	15.9
Total	57	100.0	28	100.0	44	100.0

Homebirths

Currently, in WA, homebirth services are provided by independent midwives who work privately and by the Community Midwifery Program which is publicly funded.¹²

The Community Midwifery Program (CMP) has a long history, starting in 1995 under the management of Fremantle Community Midwives (later known as Community Midwifery WA, CMWA). In 2000, the midwives became employed by the Community and Primary Care section of the WA Department of Health but remained professionally responsible to the CMWA. Within the WA Department of Health, the employer changed to the Women's and Children's Health Service in 2004 and the North Metropolitan Area Health Service (NMHS) in 2006. In 2009 the CMP became the sole responsibility of NMHS.¹⁵⁻¹⁶

In 2007, the 12th Report of the Committee identified a higher perinatal mortality rate in term babies whose mothers intended to deliver their babies at home compared to those who intended to deliver in a hospital. Accordingly, the Committee recommended a review of homebirths in WA.⁵ The review was conducted in 2008.¹⁵

Following the recommendations, several changes in governance and policy have occurred to achieve better case selection, and improve the safety and quality of the service from 2008 onwards.¹⁵⁻¹⁷ A review on the progress of the 2008 homebirth review was undertaken in 2011.¹⁶ The complete Report is available at <http://www.healthnetworks.health.wa.gov.au/docs/WA-Homebirth-Report2011-FINAL.pdf>

Many of the recommendations suggested by the review require system and legislative changes that are still ongoing. The latest WA Health Policy for publicly funded Home Births was issued in 2013.¹⁷

The policy sets out the home birth:

- selection criteria for pregnant women considering home birth
- description of the services provided by CMP and WA Health hospital maternity services
- care pathways and referral protocols
- performance development for workforce
- clinical safety and quality guidelines and reporting mechanisms.

This section provides an overview of homebirth related perinatal and infant deaths between 2008 and 2010 in WA. It is too early to make any assessment on the effectiveness of the changes implemented after the 2008 and 2011 homebirth program reviews. However, these data would provide a baseline for the future.

Unless otherwise stated, data are analysed by planned place of birth.

Between 2008 and 2010, the majority of women planned to have their babies in a hospital (96.6 per cent), while only a small number of women planned to have their babies at home (1.0 per cent: Table 16).

Overall, the risk of perinatal death was slightly higher for those who planned to have a homebirth compared with hospital births. As the p value was so large, there was no evidence that the difference was statistically significant (RR= 1.3; 95 per cent CI, 0.7-2.3; p = 0.4)

Notably, no post-neonatal deaths were reported among those who planned to have their babies born at home.

Table 16: Rate of stillbirths and neonatal mortality by planned place of birth, Western Australia, 2008-2010

Planned place of birth	Total births		Live births	Stillbirths		Neonatal mortality	
	N	%	N	N	Rate per 1,000 births (95% CI)	N	Rate per 1,000 live births (95% CI)
Hospital	89957	96.6	89305	652	7.2 (6.7-7.8)	195	2.2(1.9-2.5)
Birth centre	2145	2.3	2138	7	3.3 (1.6-6.7)	2	0.9 (0.3-3.4)
Home	916	1.0	908	8	8.7 (4.4-17.1)	3	3.3 (1.1-9.6)
Other ^a	140	0.1	129	11 ^b	78.6 (44.4-135.2)	4 ^c	31.0 (12.1-77.0)
Total	93 158	100.0	92 480	678	7.3 (6.8-7.8)	204	2.2 (1.9-2.5)

^a) Refers to those who had not booked a hospital, birth centre or homebirth services at onset of labour.

^b) The majority of these stillbirths (n=9) were in pregnancies less than 26 weeks.

^c) All cases were Aboriginal. The majority of these neonatal deaths (n=3) were in pregnancies less than 26 weeks.

Of the 303 investigated stillbirths and 124 neonatal deaths, there were six stillbirths and three neonatal deaths associated with planned homebirth.

For stillbirths associated with homebirth, the main causes of death were hypoxic peripartum death, congenital abnormality and unexplained antepartum death.

For neonatal deaths, the main caused of death were perinatal infection, hypoxic peripartum and no obstetric antecedent.

As in the 13th Report⁶ when data analysis was limited to pregnancies more than 37 weeks the risk for stillbirth and neonatal deaths for planned homebirths was significantly higher than for planned hospital births (Table 17).

Table 17: Rate of stillbirths and neonatal mortality for full term pregnancies (>= 37 weeks gestational age) by planned place of birth, Western Australia, 2008-2010

Planned place of birth	Total births	Live births	Stillbirths		Neonatal mortality	
			N	Rate per 1,000 births (95% CI)	N	Rate per 1,000 live births (95% CI)
Hospital	82 093	81 976	117	1.4 (1.2-1.7)	62	0.8 (0.6-1.0)
Birth centre	2 062	2 059	3	1.5 (0.5-4.3)	1	0.5 (0.1-2.7)
Home	895	890	5	5.6 (2.4-13.0)	3	3.4 (1.1-9.7)
Other	76	75	1	13.2 (2.3-70.8)	0	0.0 (0.0-48.7)
Total	85 126	85 000	126	1.5 (1.2-1.8)	66	0.8 (0.6-1.0)

The significantly higher risk of stillbirth and neonatal death by planned home birth for full term pregnancies contrasts with the slightly higher but not significantly higher risk of stillbirth and neonatal death by planned home birth for all pregnancies as a whole. Interpretation of these results is difficult due to the many methodological challenges in trying to compare the risk of perinatal and infant deaths between homebirths and hospital births. These challenges include decisions on the inclusion or exclusion of high risk pregnancies, and the classification of intrapartum transfer as home or hospital births; avoiding bias due to not preventable deaths, the small sample size; inclusion of separate analysis according to different types of hospital birth; use of statistical methods to ascertain confounders and mediators; and analysis of subgroup variations.¹⁸

An independent research study that addresses methodology changes is currently been undertaken by a team from the University of Western Australia. This study may provide some answers on the safety of homebirths compared to hospital births.

The Committee recognises the methodological challenges on interpretation of homebirth data and is reassured by the development of an independent research study on this topic. The Committee is encouraged by the protocols and policy changes of the CMP. Better case selection and governance might contribute to an improvement in outcomes.

Discussion

Over the last two decades, efforts to reduce the number of deaths in the neonatal and post-neonatal periods have been very successful. Importantly, there has been a reduction in the Aboriginal neonatal death rate and a statistically significant reduction in post-neonatal death rate.

However, there are opportunities for improvement, since the stillbirth rate remains unchanged and neonatal and post-neonatal death rates have remained stable since 2004. Aboriginal babies continue to have a higher risk of perinatal and infant death compared to the non-Aboriginal population.

Many factors have been associated with a higher risk of perinatal and infant mortality, including demographic factors, obstetric history and medical risk factors, behavioural maternal factors, social and environmental factors, and the quality of health care.¹⁹⁻²¹ The impact of these factors is not uniform. The World Health Organization found that the provision of appropriate health care is particularly important for stillbirths and babies dying in the early neonatal period, whereas behavioural factors were associated with a significant proportion of infant deaths.¹⁹

Demographic, obstetric and medical risk factors

The increasing prevalence of women with combination of advanced maternal age, multiple births, fertility treatments and pre-existing medical conditions are likely to be counteracting areas of health care improvement and stabilising perinatal and infant mortality rates.

It has previously been reported that the proportion of older mothers (>35 years of age) has continually increased from 9.4 per cent in 1990, and 16 per cent in 2000, to 21 per cent in 2010. On the other hand, the proportion of teenage mothers (<19 years of age) has decreased from 6.5 per cent in 1990, 6.0 per cent in 2000, to 4.4 per cent in 2010.²²

The proportion of multiple births rose from 1.2 per cent in 1990, 3.2 per cent in 2000 (n = 810) to 2.7 per cent in 2010.²²

The proportion of women who received fertility treatments also increased from 1.2 per cent (n=307) in 1994, when fertility treatment started to be reported, and 1.7 per cent in 2000 (n=433), to 3.6 per cent (n=1113 women) in 2010.²²

The proportion of women who had a caesarean section in 1990 was 18.8 per cent (n= 4831), 25.3 per cent in 2000 (n= 6280) and 33.6 per cent (n= 10 360) in 2010.²²

A recent description on the epidemiology of preterm birth in WA also reported increasing rates of pre-existing medical conditions in particular diabetes, asthma and genital herpes, among pregnant women, between 1984 and 2006.²³

Behavioural factors

Major, potentially modifiable, risk factors associated with a high proportion of adverse perinatal and infant outcomes include smoking, alcohol and drug use, and obesity.²⁴⁻²⁵ Using a whole population approach, smoking, harmful alcohol use and obesity are priority areas of the WA Health Promotion Strategic Framework 2012-2016.²⁴ Well designed population wide programs combined with programs targeting pregnant women could further reduce the number of perinatal and infant deaths.

Consistent with previous national and international reports, smoking has been identified as a top risk factor for perinatal and infant mortality. Smoking and passive smoking have been associated with fetal growth restriction and sudden death infant syndrome.²⁶⁻²⁷ Encouragingly, the prevalence of smoking during pregnancy declined between 2000 and 2010. Previous studies have shown that smoking cessation programs started in early pregnancy can reduce the risk of small for gestational age, prematurity and, subsequently, reduce the risk of neonatal and post-neonatal death.²⁸⁻²⁹ Public health programs to reduce smoking during pregnancy, such as 'Quit for you quit for two', are already underway. A number of resources to assist clinicians and public health professionals to support quitting among women of reproductive age and in pregnancy are available. More information on strategies to reduce smoking during pregnancy is included in appendix 2.

The association between alcohol consumption during pregnancy and Fetal Alcohol Spectrum Disorders has been described previously.³⁰⁻³¹ Other effects of using illegal substances, such as marijuana, cocaine, amphetamines and heroine in pregnancy include drug withdrawal and toxicity in the fetus or neonate and associated maternal lifestyle and health issues. An increased risk of perinatal mortality due to placental abruption has been reported with amphetamines, tobacco and cocaine use. It is important to note that most studies of adverse perinatal outcomes examine the association with poly drug use, making ascertainment of the effect of individual substances difficult.³⁰ Current policies and programs to target alcohol consumptions during pregnancy include the Fetal Alcohol Spectrum Disorder Model of Care developed by the Health Networks Branch,³¹ The Women and Newborn Drug and Alcohol Service (WANDAS) and the BLOOM Program (Better Lifestyle and Obstetric Outcomes for Mothers). At a National level, the Australian Guidelines to Reduce Health Risks from alcohol developed by the National Health and Medical Research Council with the message "if you are pregnant the safest option is not to drink alcohol" have been widely discussed and distributed.³² Some challenges remain. For example, alcohol consumption is not routinely assessed by the Midwives Notification System (MNS). Collection of data on alcohol and drug use during pregnancy by the MNS remains a priority to better define the contribution of these factors to perinatal and infant deaths in WA.

Obesity (Body Mass Index [BMI] of >30 kg/m²) has also been identified as a top modifiable risk factor for stillbirth and neonatal deaths.³³⁻³⁵ A Swedish study reported that the risk of stillbirth increased linearly with increasing weight suggesting a causal relationship.³¹ The risk was stronger for term babies than for preterm babies, and some authors postulate a relationship between BMI and placental function.³⁴ Maternal obesity increases the risk of congenital abnormalities, gestational hypertension, pre eclampsia, gestational diabetes, macrosomia, dystocia, labour induction, and caesarean section.^{33,35} Importantly, weight gain during pregnancy modifies the effect of maternal pre-pregnancy obesity.³³ The Royal Australian and New Zealand College of Obstetricians and Gynaecologists have recently issued guidelines for the management of obesity in pregnancy.³⁶ Data quality is important to inform prevention strategies in this area. The MNS started collating weight data in 2012. These data would be available for future reports.

Social and environmental factors

Residents of the most socioeconomically deprived areas had a higher risk of perinatal and infant deaths than residents of the least socioeconomically deprived areas. A meta-analysis of five studies on the contribution of socioeconomic status reported a 70 per cent increase in the odds of stillbirth with a population attributable risk of approximately five per cent.³⁷ Improvements in socio-economic status can lead to a reduction in perinatal and infant mortality. The World Health Organization has shown that maternal education, literacy, household income, safe water supply, and quality of housing all have an impact on health during the post-neonatal period.¹⁹

This Report found that there is continuing higher risk of perinatal and infant deaths for residents of rural areas, in particular the Kimberley, compared to metropolitan areas. Factors such as lack of access to health services, longer distances, access to healthy food, and lower socioeconomic status might explain part of the difference. The higher rates of perinatal and infant deaths in the Kimberley are likely to be related to remoteness of the region and the higher proportion of Aboriginal residents compared to other regions.

Factors that affect the health of the Aboriginal population must be considered when interpreting data on perinatal and infant death. These include: remoteness of residency, access to culturally appropriate health services, socio-economic status, education, the effects of discrimination, high levels of smoking, and harmful alcohol and drug use. These factors have been recognised by the “Closing the Gap” campaign developed by the Council of Australian Governments in 2010.³⁸ This initiative funds interventions developed in partnership between Aboriginal communities, government and non-government organisations. A number of programs have been created to provide culturally appropriate antenatal care and hospital care, and campaigns have been mounted to reduce smoking and harmful alcohol use. These programs should be evaluated to continuously improve access and health outcomes in Aboriginal communities.

Quality of care

The Committee observed that the overall standard of health care in WA is high. Less than four per cent (3.6 per cent) of investigated stillbirths and 7.3 per cent of all investigated neonatal deaths were considered to be medically preventable. None of the post-neonatal deaths were considered medically preventable. Some areas for improvement include documentation and communication between health professionals.

Poor access to antenatal care has previously been identified as a risk factor for perinatal and infant deaths. National data shows that 99 per cent of women who gave birth in New South Wales, Queensland, South Australia, Tasmania, the Australian Capital Territory and the Northern Territory had at least one antenatal visit, with 94.4 per cent having five or more. When Aboriginal and non-Aboriginal women who gave birth at more than 32 weeks gestational age were compared, 84.6 per cent Aboriginal women and 95.6 per cent of non-Aboriginal women reported five or more visits.²⁵ Data on gestational age at first antenatal visit and the total number of antenatal visits has been collated by the MNS since 2010 and 2012, respectively. This data should be available for future reports.

Causes of death

Causes of death data provided useful information for clinical practice, research areas and public health strategies. In keeping with published studies, most stillbirths occurred before labour. Most investigated stillbirths were associated with fetal growth restriction and specific perinatal conditions, such as cord complications, fetomaternal haemorrhage, twin-twin transfusion, and idiopathic hydrops. However, the majority of investigated stillbirths remained unexplained.

Although most cases of fetal growth restriction do not become apparent until the third trimester of pregnancy, the risk of stillbirth due to fetal growth restriction could be decreased by early identification and referral for ultrasound and Doppler blood flow studies.³⁹ A recent study from South Australia found that the antenatal detection rate of small for gestational age can be increased to 50.6 per cent using customised charts supported by a clinical practice guideline.⁴⁰ However, this rate can range from 12.5 per cent to 50.0 per cent depending on staff training and adherence to protocols, highlighting the importance of standardisation and continuous quality improvement.²⁶

Additional strategies to identify the pregnancy at risk in the apparent well woman, better means of identifying growth restriction, the role of monitoring fetal movements and the ways for assessing fetal wellbeing are all areas of active research.

Overall, the main cause of death for stillbirths and neonatal death was congenital abnormality. Most congenital abnormalities reflect the genetic complexity of humans and its interaction with environmental factors. Congenital abnormalities do not represent a single pathological category. Many sporadic losses in the first trimester are due to chromosomal abnormalities. There is also though an increased fetal loss rate of many congenital abnormalities in the second and third trimester, with spontaneous loss rates increased in trisomy 21 and 18.⁴¹

An important example of the potential for prevention of some congenital abnormalities is the reduction in the number of neural tube defects after the introduction of folic acid supplements and voluntary food fortification.⁴² The introduction of mandatory fortification of wheat flour for the making of bread in 2009 should result in a further decrease in this type of congenital abnormalities.⁴²

Screening and early diagnosis of congenital abnormalities form the basis of a management plan for the mother and the baby. Screening tests to identify the risk of congenital abnormalities are offered at nine weeks to 14 weeks, follow by ultrasound imaging at 14 to 18 weeks of pregnancy.⁴³ The recent availability of non invasive prenatal testing (NIPT) poses new opportunities and challenges, and all health practitioners will need to be aware of the indications and limitations of this technology.

Overall, the second most common cause of fetal and neonatal death was spontaneous preterm birth, accounting for 24.5 per cent of all stillbirths and 29.9 per cent of all neonatal deaths. Interestingly, among cases investigated by the Committee, spontaneous preterm birth accounted for only 0.3 per cent of stillbirths and 2.4 per cent of all neonatal deaths. This discrepancy is explained by the methodology used by the Committee which codes by the cause of preterm birth classifying cases into various components such as chorioamnionitis.

Worldwide, preterm birth is the second most common cause of death for children under five years of age and is the leading cause of death for children in almost all high income countries.⁴⁴ Preterm birth includes provider initiated preterm birth for maternal, fetal or other non-medical reasons, and spontaneous preterm birth. Factors triggering spontaneous preterm birth are still not completely understood.⁴⁵ Risk factors that have been associated with spontaneous preterm birth included individual or family history, maternal smoking, young or advanced maternal age, short inter-pregnancy intervals, high and low BMI, multiple pregnancies, and some pre-existing medical conditions.⁴⁵ Recommended cost-effective interventions include smoking cessation, reducing multiple embryo-transfers during assisted reproductive technologies, cervical cerclage, progesterone supplementation and reduction of non-medically indicated labour induction or caesarean delivery.⁴⁶ Nevertheless, these strategies do not offer guidance on clinical decision making and the potential risks associated with cervical cerclage and progesterone supplementation are yet to be elucidated.⁴⁶ More research and translation of those findings into clinical practice are required to reduce the rate of preterm birth in WA.

The main cause of post-neonatal death was “SIDS and other”. This category includes SIDS, trauma, and other unclassified causes. The rate of SIDS from 2000 to 2010 has remained stable in WA. Although, many deaths due to SIDS remained unexplained, several modifiable postnatal factors have been identified including prone sleeping, unsafe sleeping environment, co-sleeping and parental smoking, drug and alcohol use.⁴⁸⁻⁴⁹ Action should be taken to minimise these risks. The DOH has recently issued the Safe Infant Sleeping Policy and Framework to provide direction on reducing the risk and incidence of SIDS.⁴⁸

In general, good preconceptional, antenatal care and post-neonatal care are important strategies for prevention. Nutritional education, including folic acid intake; quit smoking service; substance abuse treatment and alcohol use education should be routinely offered by health professionals to all women in childbearing age.

Finally, a post-mortem investigation was conducted in approximately two thirds (62.2 per cent) of all perinatal and infant deaths. The aim of the post-mortem investigation is to determine any factors contributing to the death that could inform strategies for prevention in the future, and together with the exam of the placenta offers valuable information in most cases as to the cause of the fetal loss, and associated factors.

The main strength of this report is its population based approach. The sample size makes it possible to calculate trends. However, the data have some limitations. First, it is difficult to determine the reasons for change over time. Second, the small sample size makes it difficult to calculate differences between subgroups. Third, it is possible that some deaths of WA residents that occurred in another state may not have been reported to WA Department of Health. However, this proportion should be very small as only 0.1 per cent of WA resident women gave birth outside the state.⁷ Finally, the analysis of the homebirths data analysis presents methodological challenges and this issue remains a topic for national debate. The Committee would expect changes in governance and protocols to lead to favourable outcomes in this area.

Conclusions and recommendations

In conclusion, this Report provide further evidence that perinatal and infant deaths are the result of the complex interaction of multiple factors, including demographic, obstetric, medical, behavioural parental, socio-environmental, and health care. Multi-sectoral strategies are needed to further reduce the number of perinatal and infant deaths, including contributions from clinicians, public health professionals and researchers.

1. The rate of smoking in pregnant women in WA remains too high. The Committee supports initiatives of the Department of Health for tobacco control and will encourage strategies to specifically target women of reproductive age and in pregnancy. More information on resources to assist health professionals to support quitting among women of reproductive age and in pregnancy is included in Appendix 2.
2. The prevalence of alcohol and illicit substance use in pregnant women in WA is not known with certainty. The Committee encourages better quantification of usage. Health practitioners and the general population should be aware of the harm of alcohol and illicit substance use during pregnancy.
3. Parents with risk factors for perinatal and infant deaths such as smoking, substance abuse, and domestic violence need appropriate counselling and treatment, and referral to appropriate services as required.
4. One of the major preventable causes of preventative prenatal deaths in WA is errors in communication and system structure. All health providers need to be aware of the crucial need for effective prompt communication with other health providers and their patients; and the integrity of the lines of communication to ensure that appropriate action is taken following abnormal test results and in a timely manner. Such action will include identification and early referral of high risk pregnancy.
5. The Committee is supportive of ongoing research to evaluate the effects of folate supplementation to promote this proven method of preventing some birth defects.
6. The concept of establishing a state wide program to safely reduce the rate of preterm birth should be supported and facilitated.
7. The ongoing rate of SIDS in WA remains of concern and public health and educational campaigns should be promoted.
8. Health practitioners need to be aware of the need for thorough investigation of perinatal and infant deaths and refer to the guideline included in Appendix 4.
9. The rate of perinatal loss in homebirths remains of concern to the Committee. It is noted, however, that the recommendations made in previous Reports are currently being implemented and it is hoped that the excess losses will be prevented by these initiatives.
10. More robust anaemia data are needed especially from primary care settings and through the Midwives Notification System. Antenatal programs, in particular those targeting Aboriginal women, should have a greater focus on improving nutrition, reducing infectious disease and improved quality of primary care services including clinical governance and culturally appropriate care. More information on maternal anaemia is included in Appendix 5.

References

1. Douglass Catherine. The 11th Report of the Perinatal and Infant Mortality Committee of Western Australia: 2000-01. Perth: Department of Health Western Australia; [cited 2013 Nov 22]. Available from <http://www.health.wa.gov.au/publications/documents/mortality.pdf>
2. Australian Bureau of Statistics. Deaths, Australia, 1990-2012 [Internet]. 2013 [cited 2014 Jan 20]; ABS cat. No. 3302.0. Available from: <http://www.abs.gov.au/AUSSTATS/abs@.nsf/second+level+view?ReadForm&prodno=3302.0&viewtitle=Deaths,%20Australia~2012~Latest~07/11/2013&&tabname=Past%20Future%20Issues&prodno=3302.0&issue=2012&num=&view=&>
3. Australian Bureau of Statistics. Causes of death, Australia 2012. [Internet]. 2013 [cited 2014 Jan 20]; ABS cat. No 3303.0. Available from: <http://www.abs.gov.au/AUSSTATS/abs@.nsf/second+level+view?ReadForm&prodno=3303.0&viewtitle=Causes%20of%20Death,%20Australia~2009~Previous~03/05/2011&&tabname=Past%20Future%20Issues&prodno=3303.0&issue=2009&num=&view=&>
4. Australian Bureau of Statistics. Year Book Australia, 1975-76. [Internet]. 1976 [cited 2014 Jan 20]; ABS cat. No 1301.0. Available from: <http://www.abs.gov.au/ausstats/abs@.nsf/Lookup/by%20Subject/1301.0~2012~Main%20Features~Past%20and%20Future%20Releases~600>
5. Douglass Catherine. The 12th Report of the Perinatal and Infant Mortality Committee of Western Australia: Deaths 2002-04. Perth: Department of Health Western Australia; 2007 [cited 2013 Nov 22]. Available from <http://www.health.wa.gov.au/publications/documents/mortality.pdf>
6. Douglass Catherine. The 13th Report of the Perinatal and Infant Mortality Committee of Western Australia for Deaths in the Triennium 2005–07. Perth: Department of Health Western Australia; 2010 [cited 2013 Nov 22]. Available from <http://www.health.wa.gov.au/publications/documents/mortality.pdf>
7. Australia's mothers and babies 2009. Perinatal statistics series no. 25. Cat. no. PER 52. Canberra: AIHW. Viewed 3 April 2014 <<http://www.aihw.gov.au/publication-detail/?id=10737420870>>.
8. Laws P, Li Z & Sullivan EA 2010. Australia's mothers and babies 2008. Perinatal statistics series no. 24. Cat. no. PER 50. Canberra: AIHW. Viewed 3 April 2014 <<http://www.aihw.gov.au/publication-detail/?id=6442472399>>.
9. Li Z, Zeki R, Hilder L & Sullivan EA. Australia's mothers and babies 2010. Perinatal statistics series no. 27. Cat. no. PER 57. Canberra: AIHW National Perinatal Epidemiology and Statistics Unit. 2012.
10. MacDorman MF, Kirmeyer SE, Wilson EC. Fetal and perinatal mortality, United States, 2006. National vital statistics reports; vol 60 no 8. Hyattsville, MD: National Center for Health Statistics. 2012.
11. Kramer SM, Liu S, Luo Z, Yuan H, Platt RW, Joseph KS, for the Fetal and Infant Health Study Group of the Canadian Perinatal Surveillance System. Analysis of Perinatal Mortality and Its Components: Time for a Change?. *Am. J. Epidemiol.* 2002; 156 (6): 493-497.

12. Australian Bureau of Statistics Western Australia at a Glance. 2011. [Internet]. 2012 [cited 2014 Jan 20]; ABS cat. No 1306.5. Available from: <http://www.abs.gov.au/AUSSTATS/abs@.nsf/allprimarymainfeatures/AA19BFAD6F7D5F0FCA2579D700118549?opendocument>
13. Pink B. Socio-economic Indexes for Areas (SEIFA). Technical paper 2006. Canberra: Australian Bureau of Statistics. 2008.
14. Flenady V, King J, Charles A, Gardener G, Ellwood D, Day K, et al for the Perinatal Society of Australia and New Zealand (PSANZ) Perinatal Mortality Group. PSANZ Clinical Practice Guideline for Perinatal Mortality. Version 2.2, Brisbane April 2009. www.psanzpnmsig.org
15. Homer C, Nicholl M. Review of homebirths in Western Australia Department of Health Western Australia. Perth: Department of Health Western Australia; 2008.
16. Homer C, Nicholl M. Review of homebirths in Western Australia – Progress Report 2011. Perth: Department of Health Western Australia; 2011.
17. Home Birth Policy and Guidance for Health Professionals, Health Services and Consumers. Perth: Health Networks Branch, Department of Health Western Australia; 2013.
18. Nove A, Berrington A, Matthews Z. The methodological challenges of attempting to compare the safety of home and hospital birth in terms of the risk of perinatal death. *Midwifery*. 2012; 28(5):619-26.
19. The World Health Report: 2005: make every mother and child count. Geneva: World Health Organization; 2005.
20. Flenady V, Koopmans L, Middleton P, et al. Major risk factors for stillbirth in high-income countries: a systematic review and meta-analysis. *Lancet* 2011; DOI:10.1016/S0140-6736(10)62233-7. Published online April 14.
21. Flenady V, Middleton P, Smith GC, et al for The Lancet's Stillbirths Series steering Committee. Stillbirths: the way forward in high-income countries. *Lancet* 2011;10.1016/S0140-6736(11) 60064-0. Published online April 14.
22. Joyce A, Hutchinson M. Western Australia's Mothers and Babies, 2010: Twenty-eighth Annual Report of the Western Australian Midwives' Notification System. Perth: Department of Health Western Australia; 2012
23. Hammond G, Langridge A, Leonard H, Hagan R, Jacoby P, Deklerk N, et al. Changes in risk factors for preterm birth in Western Australia 1984–2006. *BJOG*. 2013;120(9):1051– 60.
24. WA Health Promotion Strategic Framework 2012– 2016. Perth: Chronic Disease Prevention Directorate, Department of Health Western Australia; 2012.
25. Li Z, Zeki R, Hilder L, Sullivan EA. Australia's mothers and babies 2011. Perinatal statistics series no. 28. Cat. no. PER 59. Canberra: AIHW National Perinatal Epidemiology and Statistics Unit; 2013.
26. Gardosi J, Madurasinghe V, Williams M, Malik A, Francis A. Maternal and fetal risk factors for stillbirth: population based study. *BMJ*. 2013; 346:f108.

27. Anderson HR, Cook DG, Passive smoking and sudden infant death syndrome: review of the epidemiological evidence, *Thorax*. 1997; 52 (11) 1003–1009.
28. McCowan LM, Dekker GA, Chan E, Stewart A, Chappell LC, Hunter M, et al; SCOPE consortium. Spontaneous preterm birth and small for gestational age infants in women who stop smoking early in pregnancy: prospective cohort study. *BMJ*. 2009;338:b1081.
29. Johansson ALV, Dickman PW, Kramer MS, Cnattingius S. Maternal smoking and infant mortality: Does quitting smoking reduce the risk of infant death? *Epidemiology*. 2009;20:1–8.
30. Kennare R, Heard A, Chan A. Substance use during pregnancy: risk factors and obstetric and perinatal outcomes in South Australia. *Aust N Z J Obstet Gynaecol*. 2005; 45 (3) 220–225.
31. Fetal Alcohol Spectrum Disorder Model of Care. Perth: Health Networks Branch, Department of Health Western Australia; 2010.
32. Australian Guidelines to reduce health risks from drinking alcohol. Canberra: National Health and Medical Research Council. Commonwealth of Australia; 2009.
33. Chen A, Feresu SA, Fernandez C, Rogan WJ. Maternal obesity and the risk of infant death in the United States. *Epidemiology*. 2009;13:74–81. doi: 10.1097/EDE.0b013e3181878645.
34. Villamor E, Cnattingius S. Interpregnancy weight change and risk of adverse pregnancy outcomes: a population-based study. *The Lancet*. 2006; 368 (9542) 1164 – 1170.
35. Catalano PM, Ehrenberg HM. The short- and long-term implications of maternal obesity on the mother and her offspring. *BJOG*. 2006; 113(10):1126-33.
36. RANZCOG. C-Obs 49, Management of Obesity in Pregnancy, March 2013.
37. Flenady V, Koopmans L, Middleton P, Froen JF, Smith GC, Gibbons K, et al. Major risk factors for stillbirth in high-income countries: a systematic review and meta-analysis. *Lancet*. 2011;13:1331–1340. doi: 10.1016/S0140-6736(10)62233-7.
38. Our Footprints – A traveller’s guide to the COAG implementation process in Western Australia. Perth: Department of Health.
39. Alfirevic Z, Nielson JP. Doppler ultrasonography in high risk pregnancies: systematic review with meta-analysis. *Am J Obstet Gynecol*. 1995;172:1379-87.
40. Roex A, Nikpoor P, van Eerd E, Hodyl N, Dekker G. Serial plotting on customised fundal height charts results in doubling of the antenatal detection of small for gestational age fetuses in nulliparous women. *Aust N Z J Obstet Gynaecol*. 2012; 52(1):78-82
41. Reddy UM, Goldenberg R, Silver R, Smith GCS, Pauli RM, Wapner RJ. et al. Stillbirth classification - developing an international consensus for research. *Obstet Gynecol*. 2009;114:901–914.
42. Bower C, Rudy E, Callaghan A, Quick J, Cosgrove P, Nassar, N. Report of the Birth Defects Registry of Western Australia 1980-2009. Perth: King Edward Hospital, Women and Newborn Health Service; 2010. Number 17.
43. Australian Health Ministers’ Advisory Council 2012, Clinical Practice Guidelines: Antenatal Care – Module 1. Canberra: Australian Government Department of Health and Ageing; 2012.

44. L Liu, H Johnson, S Cousens, for the Child Health Epidemiology Reference Group of WHO and UNICEF et al. Global, regional, and national causes of child mortality: an updated systematic analysis for 2010 with time trends since 2000. *The Lancet*. 2012;
45. Blencowe H, Cousens S, Oestergaard MZ, Chou D, Moller AB, Narwal R, et al. National, regional, and worldwide estimates of preterm birth rates in the year 2010 with time trends since 1990 for selected countries: a systematic analysis and implications. *The Lancet*. 2012; 379 (9832): 2162-2172.
46. Chang HH, Larson J, Blencowe H, Spong CY, Howson CP, Cairns-Smith S, on behalf of the Born Too Soon preterm prevention analysis group, et al. Preventing preterm births: analysis of trends and potential reductions with interventions in 39 countries with very high human development index. *The Lancet*. 2013; 381(9862):223-234.
47. Twenty Six Report of the Maternal Perinatal and Infant Mortality Committee on Maternal, Perinatal and Infant Mortality in South Australia 2010. Adelaide: SA Health, Government of South Australia; 2012.
48. Safe Infant Sleeping Policy and Framework 2013. Health Networks Branch, Department of Health, Western Australia; 2013.
49. Stewart AJ, Williams SM, Mitchell EA, Taylor BJ, Ford RPK, Allen EM. Antenatal and intrapartum factors associated with sudden infant death syndrome in the New Zealand Cot Death Study. *J Paediatr Child Health* 1995; 31: 473-8.
50. Joyce A, Tran BN. Western Australia's Mothers and Babies, 2009: Twenty-seventh Annual Report of the Western Australian Midwives' Notification System. Perth: Department of Health Western Australia: 2010.
51. Gee V. Perinatal, Infant and Maternal Mortality in Western Australia, 2006-2010. Department of Health, Perth, Western Australia. 2013.
52. Newcombe RG, Altman DG. Proportions and their differences. In: Altman DG et al, editors. *Statistics with confidence*. 2nd edn. London: BMJ Books; 2000: 46–8.
53. APHO, Association of Public Health Observatories. *Analytical Tools for Public Health*. 2008. 2007 [cited 2013 Nov 22].. Available from: <http://www.apho.org.uk/resource/item.aspx?RID=48617>
54. Altman DG. Proportions and their differences. In Altman DG et al. (eds). *Statistics with confidence* (2nd edn). London: BMJ Books; 2000: 46–8.
55. Wilson RMcL, Runciman WB, Gibberd RW, Harrison BT, Newby L, Hamilton JDI. The Quality in Australian Health Care Study. *Med J Aust* 1995; 163: 458-471.

Appendix 1. Methods

Databases

Midwives' Notification System (MNS)

In Western Australia (WA), the *Health Act 1911, Part XIII Section 335(1)* requires that midwives inform the Executive Director, Public Health (EDPH) of every case attended whether of living, premature or full-term birth, or stillbirth, or abortion. The Health (Notifications by Midwives) Regulations 1994 require that all midwives submit a Notification of Case Attended (NOCA) to the Department of Health.⁵⁰

All notifications are collated into the Midwives Notification System (MNS) of the Department of Health. The MNS contains midwives notifications for births since January 1980, where the infant is of a gestational age of 20 weeks or more or a birth weight of 400 grams or more if gestation is unknown. It contains information about the mother, labour, pregnancy, delivery and baby.⁵⁰

All notifications are cross-checked with the Registry of Birth and Hospital Morbidity Data in a mutual validation of cases process.

Perinatal and infant mortality database

All notifications of perinatal and infant deaths are recorded into the Perinatal and infant mortality database.⁵¹

These notifications are supplemented with data from the Western Australian Midwives' Notification System for fetal deaths, and from the Registry of Births, Deaths and Marriages and the Hospital Morbidity Data System.

It contains information about the mother, the baby, the causes of death and preventable factors as classified by Perinatal and Infant Mortality Committee.

Glossary 6

Aboriginal: An infant was nominated "Aboriginal" if the mother identified as an Aboriginal or Torres Strait Islander. Please note that within Western Australia, the term Aboriginal is used in preference to Aboriginal and Torres Strait Islander, in recognition that Aboriginal people are the original inhabitants of Western Australia. No disrespect is intended to our Torres Strait Islander colleagues and community.

Birthweight: The first weight, measured of the infant, to the nearest five grams. Usually obtained within the first hour of birth.

Gestational age: The duration of pregnancy in completed weeks from the first day of the last normal menstrual period.

Infant death: The death within a year of birth of a live born infant.

Livebirth: The complete expulsion or extraction from its mother of an infant irrespective of duration of pregnancy, which after birth shows signs of life.

Mortality rates:

Stillbirth rate: the number of stillbirths per 1000 total births in a year.

Neonatal mortality: the number of neonatal deaths per 1000 live births in a year.

Perinatal mortality: the number of stillbirths and neonatal deaths per 1000 total births in a year.

Post-neonatal mortality rate: the number of post-neonatal deaths per 1000 live births
Infant mortality rate: Number of deaths of infants per 1000 live births.

Neonatal death: The death of a liveborn infant within 28 days of birth

Parity: The total number of pregnancies resulting in one or more infants born alive or stillborn.
Nulliparous: never having completed a pregnancy beyond 20 weeks gestation prior to the index pregnancy.

Multiparous: having completed one or more pregnancies beyond 20 weeks gestation.

Perinatal death: A stillbirth (fetal death) or neonatal death.

Post-neonatal death: The death of a liveborn infant from 28 to 364 days after birth.

Stillbirth or Fetal death: The complete expulsion or extraction from its mother of an infant weighing at least 400 grams birthweight or at least 20 weeks gestation, which shows no sign of life from the time of birth.

Term Infants: Infants born at gestational age of 37 weeks or greater.

Data analysis

All data were analysed using SAS (version 9.4) and graphs were produced using “R” (version 3.0.1). Data from the Perinatal and infant death were linked to data held in the Midwives’ Notification System.

Perinatal deaths were reported for all WA births during the calendar year of reporting irrespective of the year in which the death occurred.

Post-neonatal and infant deaths were reported where the person was a resident in WA and died in WA during the calendar year of reporting. Deaths of WA residents that occurred in other states were not included. In mortality rates, deaths of non-residents were not included unless the case was born in WA.

The infant mortality rate was calculated based on the number of infants born during the calendar year of reporting who subsequently died within 364 days irrespective of which calendar year the death occurred.

The overall perinatal mortality results for WA were compared with the results from other states and Australia as a whole using data from Australia’s mothers and babies reports 2008-2010. These reports did not include rates for Victoria for 2009 or 2010.⁷⁻⁹

The results for infant mortality were compared to other states using the ABS report. The ABS did not report the total number of live births used in their calculations. These were therefore estimated from the reported number of deaths and mortality rates, and then used to calculate confidence intervals.²

Confidence intervals for the mortality rates were produced using a Microsoft Excel spreadsheet developed by Association of Public Health Observatories.⁵²⁻⁵⁴

When appropriate, categories were aggregated or multiple years of data combined to avoid small numbers and to provide more reliable statistics.

Frequencies and proportions were used to analyse cause of death and preventable factors.

Analyses were conducted to examine trends in stillbirth rates, neonatal mortality, post-neonatal mortality, prevalence of smoking and rates of SIDS. Trends were calculated using correlation analysis. A negative correlation coefficient indicates a decline, while a positive correlation coefficient indicates an increase. To verify the correlation analysis, Poisson regression was performed. A trend was considered statistically significant when p-value <0.05.

Logistic regression analysis was used to calculate relative risks and ascertain whether a particular risk factor such as race, smoking, health region, socioeconomic status had a statistical significant influence in the outcome (e.g. perinatal and infant mortality). Logistic regression was also used to ascertain the interaction between risk factors.

Data for socio-economic indexes for areas (SEIFA) was analysed using postcode of mother's usual residence for all births 2008-10. Where the SEIFA score for a particular postcode was missing, the statistical local area (SLA) of the mother usual residence was used to assign the SEIFA score (there were 763 births for which a SLA was used). The SLA for each birth was also used to identify the health service region of mother's usual residence.

Data was analysed for the nine WA health regions. Health regions consist of aggregations of the state's health districts which are defined by the ABS statistical local areas. The health regions are Great Southern, Goldfields, Kimberley, Midwest, North Metropolitan, Pilbara, South Metropolitan, South West and Wheatbelt.

There were 81 births for which it was not possible to assign a SEIFA score or health region as the mother's usual residence was outside of WA. There was one stillbirth and one neonatal death in this group.

Medical preventability was determined using the following preventability scale: ⁵⁵

No preventability

1 = Virtually no evidence for preventability

Low preventability

2 = Slight-to-modest evidence for preventability

3 = Preventability not likely, less than 50-50 but close call

High preventability

4 = Preventability more likely than not, more than 50-50 but close call

5 = Strong evidence for preventability

6 = Virtually certain evidence for preventability

Appendix 2. Current initiatives addressing maternal smoking in WA

WA Health has a multi-faceted approach to reducing smoking in the population, and to targeting women who smoke during pregnancy. WA Health's work is consistent with the *National Tobacco Strategy* and aligns with state wide and national campaigns. This approach consists of the following initiatives which, when linked to health services contribute to reductions in smoking within the population.

1. The National Tobacco Campaign, run by the Commonwealth Department of Health and Ageing, launched a nationwide campaign in 2013 on smoking and pregnancy called *Quit for you – Quit for two*. Information and resources are available from:

<http://quitnow.gov.au/internet/quitnow/publishing.nsf/Content/mta-2012-13>

General information on smoking in pregnancy, including links to further information and resources in other languages, are available from: <http://www.quitnow.gov.au/internet/quitnow/publishing.nsf/Content/pregnancy-and-quitting>

2. The Smoking cessation guidelines for Australian general practice and the supporting resource material provide practical information on smoking cessation and effective strategies that general practitioners and other practice staff can apply to identify smokers and assist them to stop smoking.

- http://www.health.gov.au/internet/main/publishing.nsf/Content/health-pubhlth-publicat-document-smoking_cessation-cnt.htm

Smoking cessation referral form (PDF 134 KB)

The Royal Australian College of General Practitioners has also published the following guidelines:

- Red Book
<http://www.racgp.org.au/your-practice/guidelines/redbook/>
- Green Book
<http://www.racgp.org.au/your-practice/guidelines/greenbook/>

3. **WA Health's Chronic Disease Prevention Directorate (CDPD)** is guided by the *Health Promotion Strategic Framework 2012-2016*, in which further reducing tobacco use is identified as a major public health priority.

It is sound public health practice to place population-wide approaches at the centre of health promotion strategies for curbing the epidemic of chronic disease. However it is also understood that some groups are more vulnerable, or are at greater risk of developing chronic disease and injury due to their age or circumstances. For these groups, additional targeted interventions are needed. The Health Promotion Strategic Framework (HPSF) complements, and does not replicate, work done by other parts of WA Health. The HPSF is available at: http://www.public.health.wa.gov.au/2/1588/2/the_wa_health_promotion_strategic_framework_pm

CDPD purchases services and provides policy support for the delivery of state wide tobacco control programs. *Make Smoking History*, delivered by the Cancer Council WA, is a state wide mass media campaign which targets all smokers. The Cancer Council WA promotes smoke-free homes and cars, the primary beneficiaries being infants and children. See: <http://www.cancerwa.asn.au/prevention/tobacco/>

CDPD is responsible for provision of *Quitline* services state wide. Quitline counselling is delivered by the Alcohol and Drug Information Service of the Drug and Alcohol Office, under the policy direction of the CDPD. The Quitline is well-resourced to provide pregnant women, their partners and families with tailored, one on one support, smoking cessation planning, referral to community programs and advice on evidence based quitting strategies.

Coordinated by the CDPD in partnership with the Drug and Alcohol Office, WA's *Quitline Enhancement Project* has actively and successfully linked with the range of state and federal Tackling Smoking programs state-wide. This project has been funded through the National Partnership Agreement on Closing the Gap in Indigenous Health Outcomes (NPA CTG). This project has promoted Quitline uptake, culturally appropriate educational messaging about smoke free homes, cars and the risks associated with smoking during pregnancy. In addition, the project provides training in smoking cessation skills and Quitline referral for health workers throughout metropolitan, regional and remote Aboriginal communities. WA Quitline counsellors are specifically trained in assisting Aboriginal clients, and appropriate referral forms and educational resources have been developed.

4. At a health system level, the **Smokefree WA Health System Policy** emphasises the requirement for all WA Health facilities to be smokefree (with limited exemptions for involuntary mental health patients). Health staff are expected to record smoking history of their patients as a matter of routine, and where appropriate, to provide brief intervention to encourage and support cessation. Training for staff in brief intervention is provided free of charge, online, on the Smokefree WA Health website: <http://www.health.wa.gov.au/smokefree/staff/index.cfm>

5. The **Women's and Newborns Health Network** provides links to the WA Health website 'Having a Baby' which provides a one-stop information point for expecting and new parents. The website includes information on smoking, and is currently being updated. See: <http://www.health.wa.gov.au/havingababy/during/lifestyle.cfm>

6. **Child health nurses** provide safe infant sleeping information and promote healthy lifestyle messages, which include smoking cessation, to mothers, fathers, carers and grandparents when appropriate. These messages are reinforced through information provided in the Personal Health Record and Welcome to your new baby magazine. If a client does not wish to give up smoking, they are encouraged to keep their homes and cars smoke free. Pictorial information and updated graphics within these documents strengthen the message for families to give up smoking, and promote the use of Quitline.

Appendix 3. The Perinatal Autopsy

Author: Dr Adrian Charles

The Role of Perinatal Post-Mortems & Services Offered in Western Australia

“It is every parent’s right to be offered a post-mortem examination of their child, and equally their right to refuse.”

In Western Australia we have amongst the highest rate in the country for perinatal post-mortem examinations of around 50-55 per cent, although this figure seems to have declined a little over recent years. During the Committee meetings the post mortem examination has often provided useful information for the assessment of the causes of death, and this has been formally assessed in this document.

Is the autopsy still useful?

The post-mortem examination significantly affects the overall understanding of the cause of a perinatal death. Recent series of post mortems examinations on neonates have shown that in somewhere between 30 and 50 per cent of cases significant information is gained, and this leads to a change of classification in around 20 per cent of cases.

Recent publications have examined whether the post-mortem examination is still useful or can be supplanted by other examinations such as MRI scans. The overwhelming consensus is that the full post-mortem examination still provides more information than available from other techniques (although some techniques such as the MRI may come into their own for some neurological conditions).

Recent studies have also shown that in general parents are more likely to regret not having an autopsy than to regret having an autopsy of their baby. Many wish to understand as much as possible why the tragedy occurred.

There are good guidelines for approach to the workup of a perinatal death produced by the Perinatal Society of Australia and New Zealand (PSANZ) (see <http://www.psanz.com.au/special-interest/perinatal-mortality-group/psanzcpg>), and the related courses called IMPROVE are regularly held in WA (contact the Perinatal loss clinic).

Coronial autopsies.

The coroner may request an autopsy, and the Office of the State Coroner must be notified if it is a reportable death (see Coroners Act 1996), such if it is anaesthetic related, follows injury, or is unexpected such as SIDS. It is worth discussing any case if there is any doubt with the Coroner’s Office. These autopsies are not consented, although there are legal means for the parents to object to the examination. The coronial examination takes place usually at the state mortuary at Pathcentre with the coroner’s pathologists.

Non-coronial, consented autopsies

Fetal and most perinatal autopsies are performed at KEMH by one of the perinatal/paediatric pathologists. Cases are transferred from all over the state and returned usually within two to three working days. The Post Mortem Coordinator (9340 2730) is available for details on forms, transport advice and other information. This service includes mementoes (such as handprints, social photographs), as well as the autopsy with medical photographs and radiology. With parental consent, stillborn babies under 28 weeks gestation can be cremated, with individual ashes.

Some infants and older children have autopsies at PMH, where the technician is available for information and forms.

The autopsy - full or limited?

The formal autopsy involves examination of the cranial contents, the abdomen and the thorax, with the placenta being a particularly important part of any perinatal examination. Many parents consent to this, however some request that the brain is not examined. Obviously this may affect the diagnosis. Some parents will ask only a particular system is examined, or that a step approach is taken where the examination stops when an adequate cause of death is established. In practice in perinatal cases this is not often clear macroscopically.

Some parents do not wish for any incisions, but an external examination, with weight, measurements, radiology, pictures in case of genetic review, and an examination of the placenta can be helpful.

No whole major organ is retained (i.e. brain, heart, lungs, liver or kidneys) without specific consent. In cases of abnormal CNS development or a complicated cardiac defect, it is useful to get consent for retention for a better examination.

Unless there is an objection, small pieces of the major organs are routinely taken for histology. Small samples may be taken for other investigations (e.g. microbiological, metabolic, cytogenetic) as appropriate.

The Consent for Autopsy (non-coronial).

The current law in WA, with the recent rules of practice means that the consent form is detailed, covering the full or limited examination, clearly indicating parents wishes. If an organ is to be retained there needs to be a plan if there is to be a delay in burial of the body, allowing the return (usually a week or so) of the organ. The organ can be cremated and returned, or donated for research or teaching. There are places on the form to indicate consent for tissue to be retained for teaching or research.

The consent form needs to be signed by a parent. The referring clinician (or midwife) can provide clinical information. The human tissue act officer for the institution needs to sign that there is satisfactory evidence of parental consent, and the post mortem coordinator also signs the form.

Other Forms

The certificate of stillbirth or neonatal death needs to be completed, and if appropriate the cremation paperwork.

The Autopsy Report (non-coronial) A typed macroscopic report is available within two working days, and a full report including ancillary investigations, and conclusions usually within 2-6 weeks. This report can be provided to the parents, but there is also the provision of a plain language report for the parents, to be given, after discussion by the clinician.

The Perinatal Loss Clinic

Perinatal losses are not common, and KEMH has set up a multidisciplinary clinic, consisting of a fetal medicine specialist, neonatologist, pathologist, research midwife, social worker, psychologist and chaplain. The aim is to support and counsel parents, investigate if appropriate using protocols for the different modes of perinatal loss, and also provide support for health workers. Telehealth facilities are sometimes used for rural hospital links. Contact the Clinical Midwife Consultant (phone 9340 2222 pager 3430, or phone 9340 2128 answering machine).

Interpreting the Autopsy report

The pathophysiology of perinatal death is complicated and much research is needed in this area. The best way to investigate a perinatal death undoubtedly involves a review of all the clinical investigations, together with the pathology reports. Often the autopsy finds a complete explanation of the cause of death, but frequently there is only a partial explanation, such as unexpected growth restriction, or placental abnormality.

There are also a number of cases where, to the frustration of all concerned, no significant abnormalities are identified at autopsy. Recently diseases such as obstetric cholestasis are being recognised, with a high incidence of stillbirth at term, with no post mortem features. The post mortem examination is not good at detecting transient physiological mechanisms. The purpose of the autopsy is to exclude many potential recurrent conditions.

Concluding comments

Leaflets for parents and healthcare workers are available from KEMH (Post Mortem Coordinator, phone 9340 2730) or PMH (Mortuary Technical, phone 9340 8619). Consultant Pathologists are available to discuss cases (phone 9340 8279).

We are grateful to the health professionals who have spent their time counselling parents to obtain consent and provide feedback, to allow this service to work.

Appendix 4. What to do when there is a stillbirth or infant death

1. Make detailed legible notes about the event.

2. Carefully examine the infant and placenta.

Document relevant “positive and negative” findings.

Ensure that relevant investigations (as below) are instigated

3. Notify the Executive Director, Public Health, preferably by sending a copy of the Death Certificate to: edphwa@health.wa.gov.au or by mail to

Regulatory Support and Training Unit
Public Health and Clinical Services Division
Department of Health
PO Box 8172
Perth Business Centre WA 6849

4. Notify the Coroner if required:

Extract from the Coroners Act 1996:

A “**reportable death**” means a Western Australian death –

(a) that appears to have been unexpected, unnatural or violent or to have resulted, directly or indirectly, from injury;

(b) that occurs during an anaesthetic;

(c) that occurs as a result of an anaesthetic and is not due to natural causes;

(d) that occurs in prescribed circumstances;

(e) of a person who immediately before death was a person held in care;

(f) that appears to have been caused or contributed to while the person was held in care;

(g) that appears to have been caused or contributed to by any action of a member of the Police Force;

(h) of a person whose identity is unknown;

(i) that occurs in Western Australia where the cause of death has not been certified under section 44 of the Births, Deaths and Marriages Registration Act 1998; or

(j) that occurred outside Western Australia where the cause of death is not certified to by a person who, under the law in force in that place, is a legally qualified medical practitioner.

5. Refer to Guidelines for the arrangement of appropriate investigations.

In particular, encourage the parents to consent to post mortem examination. There are options for full and modified (such as external examination only) post-mortem examinations.

Contact the pathology technician at King Edward Memorial Hospital (KEMH) on 9340 2730 to arrange for appropriate transfer of the body. Take microbiological swabs of the placenta prior to transfer. Do not put the baby or placenta in formalin.

Multi-lingual information brochures and consent forms may be obtained on-line:

<http://www.health.wa.gov.au/postmortem/>

6. “De-brief” for staff involved in the case.

This will depend on the hospital involved. Where possible, it is preferable for hospitals to review cases with poor outcomes, to provide emotional support for involved staff and to reflect on any useful learning experience that may have come from the event.

7. Counselling for the parents and follow up appointment and contacts are given.

8. Mementos such as photos and footprints are suggested.

9. Notify the General Practitioner, Child Health Nurse, and/or other relevant care providers.

10. Complete Death Certificates (and Cremation Certificates where required).

11. Consider professional counselling for oneself.

Appropriate Investigations Following Stillbirth, Neonatal and Post-neonatal deaths

Thorough investigation into the cause of death is recommended. Even where the cause appears obvious, additional information may be obtained that may assist in the management of the woman and in her future pregnancies. In this sensitive period it may be difficult to discuss investigations, but if not requested at the appropriate time, the opportunity to obtain valuable information may be lost.

When fetal death is diagnosed, or following a stillbirth, review the antenatal and peripartum notes with attention to past medical and obstetric history, family history (e.g. genetic disorders/ hypertension/ thrombophilia/ diabetes/ thyroid disease), possible infections, exposure to animals or toxic chemicals and substance use. History may provide information suggestive of pre-eclampsia, diabetes, cholestasis of pregnancy, or antepartum infection. There should be a review of the routine antenatal blood tests (maternal full blood count and blood group antibody screen), and antenatal infectious disease screening (rubella, syphilis, HIV, Hepatitis B & C).

Autopsy examination of the infant should be encouraged at all times. Where parents decline full autopsy, options for “external only” or a step-wise approach are available. Placental histopathology provides much information, and most parents will consent to this even if they decline autopsy examination. Where autopsy is declined, consent should also be sought for metabolic studies using a blood spot (collected on a Guthrie card), x-ray (babygram) and clinical photographs of the infant.

Post-mortem ultrasound (either in utero or ex utero) provides anatomical information which is particularly useful for the pathologist for assessing intra-cranial anatomy, as the brain is often autolysed and difficult to examine. Amniocentesis samples are recommended for karyotyping and microbiology.

Samples of tissues collected post-mortem have a high failure rate for chromosomal studies, so samples obtained earlier through amniocentesis are recommended. Amniotic fluid samples also provide helpful microbiological information where there is a question of ascending genital infection or viral infection.

For stillbirth of a hydropic fetus, discussion with a maternal fetal medicine specialist is recommended in order to tailor specific investigations.

The Kleihauer-Betke test is recommended as a routine. This test detects fetal blood cells in the maternal circulation, indicating feto-maternal haemorrhage. This test is of little use unless performed prior to the onset of labour.

A measurement for glycated haemoglobin (HbA1C) is suggested to assist in diagnosis of diabetes. Women with unexplained stillbirth have an increased risk of glucose abnormalities in subsequent pregnancies. Therefore, if gestational diabetes mellitus is suspected, formal glucose testing should be undertaken in the next pregnancy.

In the presence of pre-eclampsia, maternal liver function, uric acid and coagulation studies may be indicated. In the presence of maternal pruritus, check maternal serum bile acids and liver function.

It is recommended to routinely perform urine toxicology screening for illicit substances but consent should be obtained for this.

Placental swabs are recommended as a routine. Other microbiological swabs (maternal high vaginal, endocervical and throat swabs) and maternal blood cultures are only recommended in the presence of maternal fever. Routinely recommended maternal serological tests are for

Cytomegalovirus, Toxoplasma gondii, Parvovirus B19 and Herpes simplex virus. Testing for syphilis and other infectious diseases is suggested where clinically indicated.

Six weeks following a perinatal loss, consultant liaison is advised in order to tailor investigations appropriately. Note that thrombophilia screening and auto-immune studies are only recommended in the presence of placental pathology and/or evidence of fetal growth restriction. These costly investigations have a low yield.

For neonatal deaths, many of the above investigations will be appropriate. Liaison with a paediatrician is recommended to assist in appropriate investigations.

Consultant Advice:

Perinatal Loss Service:

King Edward Memorial Hospital

Coordinator: Phone 9340 2222, page 3430, or 9340 2128

or page on-call Senior Registrar in Obstetrics, via switchboard 9340 2222

Neonatal deaths:

Princess Margaret Hospital for Children

Page the on-call Neonatal Intensive Care Consultant, via switchboard 9340 8222

Post-Neonatal deaths:

Princess Margaret Hospital for Children

Page the on-call Paediatric Intensive Care Consultant, via switchboard 9340 8222

Investigations Following Stillbirth:

Prior to induction of labour or as soon as possible after stillbirth:

- Maternal blood tests:
 - full blood picture
 - coagulation screen (where clinically indicated)
 - blood group antibody screen (where clinically indicated)
 - Kleihauer-Betke test (before the onset of labour where possible)
 - glycated haemoglobin
 - glucose
 - liver function, uric acid (where clinically indicated)
 - serology: Cytomegalovirus, Herpes simplex virus, Toxoplasma gondii, Parvovirus B19
 - Serology (where clinically indicated): Rubella virus, Treponema pallidum
 - Consideration of amniocentesis for microbiology and cytogenetics
- Obstetric ultrasound and amniocentesis
- Maternal urine toxicology screen
- In the presence of maternal fever >38 degrees Celsius, maternal samples:
 - high vaginal swab
 - endocervical swab
 - blood cultures
 - throat swab

After delivery:

- Careful examination of the infant including standardised clinical photographs, noting weight, measurements, maturity, degree of maceration, and whether dysmorphic or not.
- Autopsy
If autopsy (including external only) is declined, consider:
blood spot test (Guthrie card)
babygram (x-ray)
infant ear and throat swabs for microbiology tests
sample of placenta for microarray/ cytogenetic analysis
- Cranial ultrasound of infant (if not already performed in utero)
- Placental histopathology and swab for microbiology tests

Six weeks postnatal:

- Consultant liaison recommended
Consider additional tests where clinically indicated, such as:
convalescent serology
thrombophilia screening
glucose tolerance testing
auto-immune tests

Appendix 5. Anaemia and antenatal care for Aboriginal women in Western Australia

Authors: Karen Edmond, Dorota Doherty, Teresa Ballestas

Despite Australia's capacity, generally excellent health services and substantial investments from federal and state governments, it is a major concern that the health of Australian Aboriginal mothers and young infants continues to be poor^{1,2} There is increasing concern in the Aboriginal community that many Aboriginal mothers and infants have micronutrient malnutrition and iron deficiency anaemia,^{2,3} which are preventable conditions associated with severe medical and neurodevelopmental outcomes in poor and marginalised communities worldwide.⁴⁻⁶ Important contributing factors include poor diet, infectious diseases and other stressors.³ Indeed, iron deficiency anaemia has been described as a proxy for the effect of deprivation on the health and wellbeing on mothers and infants who live in disadvantaged communities.⁷⁻⁹ Over 90% of anaemia is due to iron deficiency anaemia in Australia and globally.⁶⁻¹¹ The other causes are thalassemia, sickle cell anaemia and anaemia of chronic disease.⁶ Iron deficiency anaemia is completely preventable. Women with a nutritious diet and women who receive a full course of iron supplementation will not develop iron deficiency anaemia. Iron deficiency anaemia can also be treated with iron supplementation or infusions.⁶

Aboriginal mothers in Australia are scheduled to receive at least ten contacts with primary care providers during pregnancy and the postpartum period.^{10,11} This is a critical period where women are able to focus on their own health care and behaviour change is more sustainable than during other periods.¹² Antenatal care programs are holistic, they provide multiple pathways to improving maternal and infant health, include preventative and curative care and have more substantial effects than single level interventions. Controlled trials from the 1990s demonstrated that comprehensive antenatal care programs could substantially improve maternal anaemia and morbidities such as preeclampsia.^{13,14} However, there are no recent data and information on the effectiveness of these programs in disadvantaged populations in rural areas in Australia with high levels of substance abuse, domestic violence and malnutrition.¹¹ The neurodevelopmental damage from poor maternal nutrition and iron deficiency occurs early in life and must be prevented in utero and before infants reach 6 months of age.^{4,5} Yet surprisingly, there are also no prospective data about the effect of antenatal care programs on the health and nutritional status of mothers and breastfed infants in the post neonatal period and the first six months of life.⁴ Existing data are cross sectional or retrospective and confounded by socio-economic status and co-existing morbidities.

There are also little published data about anaemia levels in Aboriginal mothers and infants across Western Australia. Many primary health care providers send blood samples to WA laboratories for formal haemoglobin and iron levels during the first trimester of pregnancy. The finger prick Hemocue haemoglobinometer is used to screen for anaemia at other times. The Hemocue haemoglobinometer has moderate sensitivity and specificity but values depend on the technique of the provider and the Hemocue must be used according to manufacturers instructions.¹⁹ Primary care data are the most representative of population levels, however these data are incomplete and there is no formal mechanism for recording and reporting on anaemia levels in primary care clinics. The Midwives Notification System is also an ideal source of prospective antenatal data. The use of this system is increasing during the antenatal period and at delivery. This system is likely to be an important source of prospective anaemia data and other data in the future.

All mothers who deliver in hospital in WA have their haemoglobin levels measured at the time of delivery if they are considered to be at risk of anaemia. The WA hospital morbidity data set (HMDS) then codes all primary and secondary diagnoses (co morbidities). The table below displays the prevalence of Aboriginal and non Aboriginal women coded as having anaemia by region in the HMDS in WA from 2000 to 2013. Antenatal and postpartum haemorrhage are important risk factors for anaemia so data are also presented excluding women who had anaemia and haemorrhage.

The data in the table show that the rates of anaemia are much higher in Aboriginal mothers (12%) than non Aboriginal mothers (4%). The WHO reports that 0.2% of pregnant women in high income countries have haemoglobin levels < 70g/l (severe anaemia).²⁴ The data in our table are not comparable to these data because they are collected on women who are admitted to hospital and include women with medical conditions which make them more likely to have anaemia. However the comparison between Aboriginal and non Aboriginal mothers is striking and indicates the suboptimal nutritional status of many Aboriginal mothers and lack of access to culturally appropriate quality antenatal care. Rates appeared to be similar across regions and in urban compared to rural areas.

Important hospital treatment therapies include parenteral iron, blood transfusion to the mother and delayed clamping of the umbilical cord for the infant. However there are insufficient data from the HMDS to currently understand the prevalence of these practices in WA.

There has also been concern for many years about the quality of antenatal and postnatal care provided in urban and remote WA regions.¹² Many strategies have been developed to improve the quality of antenatal and postnatal care including standard treatment guidelines, key performance indicators and continuous quality improvement (CQI) cycles.^{15,16} The National Community Controlled Health Organisation (NACCHO), Kimberley Aboriginal Medical Services Council (KAMSC) and the Audit and Best Practice for Chronic Disease (ABCD) National Research Partnership have led much of this work in Aboriginal maternal and child health.^{16,17} There has been significant progress and improvement in the quality of care for single conditions (e.g rheumatic heart disease, diabetes, sexually transmitted infections [STIs]).^{17,15,18} However, there has been less progress in improving quality of care in complex programs such as antenatal care programs. Data from the Audit and Best Practice for Chronic Disease (ABCD) National Research Partnership network indicate that only 41% of mothers who received care from WA primary care clinics received nutrition education during the antenatal period, 58% of Aboriginal mothers were screened for anaemia, but only 50% received a follow up haemoglobin check.^{19,20}

Recognition of the importance of clinical governance in continuous quality improvement (CQI) initiatives is also increasing.^{16,21} Clinical governance is a systematic and integrated approach to ensuring health services focus on clinical knowledge, skills and quality health care and are accountable for health outcomes.¹⁶ Recent CQI systematic reviews concluded that CQI is most efficacious if it includes both clinical governance and peer led targeted support.^{16,22} They also concluded that the most effective models are delivered through a combination of strategies including: local priority setting, development of targeted tools, on the job education and training, targeted electronic primary care systems, review and reflection, feedback and problem solving.^{16,23} These strategies have been tested in urban settings and are considered to be most effective for complex interventions and programs.^{15,22} However, there have been no studies of effectiveness of peer led clinical governance with complex interventions in rural and disadvantaged communities who are likely to benefit most.

Summary

Rates of anaemia are much higher in WA Aboriginal women delivering in hospital than non Aboriginal women. These high rates are consistent across all regions in WA. No data are available on treatment types and therapies. Primary care data indicate that maternal anaemia is an important problem in primary care clinics in WA but more robust data are needed especially from primary care settings and through the Midwives Notification System . There are no robust data on rates of infant anaemia in WA. Most anaemia is caused by iron deficiency in WA. Iron deficiency anaemia can be prevented by improving nutrition, reducing infectious disease and improved quality of primary care services including clinical governance and culturally appropriate care.

Recommendations

More robust anaemia data are needed especially from primary care settings and through the Midwives Notification System. Antenatal programs should have a greater focus on improving nutrition, reducing infectious disease and improved quality of primary care services including clinical governance and culturally appropriate care.

References

1. Russell LM. Reports indicate that changes are needed to close the gap for Indigenous health. *The Medical Journal of Australia*. Dec 16 2013;199(11):737-738.
2. Eades SJ, Stanley FJ. Improving the health of First Nations children in Australia. *The Medical Journal of Australia*. Jul 8 2013;199(1):12-13.
3. Gracey M, King M. Indigenous health part 1: determinants and disease patterns. *Lancet*. Jul 4 2009;374(9683):65-75.
4. Grantham-McGregor S. Does Iron-Deficiency Anemia Affect Child Development? *Pediatrics* 2003;. 2003;112:978.
5. Grantham-McGregor S, Cheung YB, Cueto S, et al. Developmental potential in the first 5 years for children in developing countries. *Lancet*. Jan 6 2007;369(9555):60-70.
6. Allen LH. Anemia and iron deficiency: effects on pregnancy outcome. *The American Journal of Clinical Nutrition*. May 2000;71(5 Suppl):1280S-1284S.
7. Hill Z, Kirkwood B, Edmond K. Family and community practices that promote child survival, growth and development: A review of the evidence. World Health Organization (Geneva) 2004; ISBN 92 4 159150 1:1-133.
8. Kramer MS, Kakuma R. Optimal duration of exclusive breastfeeding. *The Cochrane Database of Systematic Reviews*. 2012;8:CD003517.
9. Haider BA, Olofin I, Wang M, et al. Anaemia, prenatal iron use, and risk of adverse pregnancy outcomes: systematic review and meta-analysis. *BMJ*. 2013;346:f3443.
10. Bar-Zeev S BL, Kruske S, Kildea S. Factors affecting the quality of antenatal care provided to remote dwelling Aboriginal women in northern Australia. *Midwifery*. 2013;2013(Jun 25):S0266-6138(0213)00127-00127.
11. Walker R, Reibel T. Audit of Antenatal Services for Aboriginal Women in Western Australia PSANZ 2009, A Top End Experience: Better Birthing, Better Babies; 19-22 April 2009, 2009; Darwin, Northern Territory.
12. Ronsmans C, Oona Meave Renee C, McDermott J, Koblinsky M. Questioning the indicators of need for obstetric care. *World Health Organization. Bulletin of the World Health Organization*. 2002;80(4):317-324.

13. Dowswell T, Carroli G, Duley L, et al. Alternative versus standard packages of antenatal care for low-risk pregnancy. *The Cochrane Database of Systematic Reviews*. 2010(10):CD000934.
14. Villar J, Ba'aqeel H, Piaggio G, et al. WHO antenatal care randomised trial for the evaluation of a new model of routine antenatal care. *Lancet*. May 19 2001;357(9268):1551-1564.
15. Gardner KL, Dowden M, Togni S, Bailie R. Understanding uptake of continuous quality improvement in Indigenous primary health care: lessons from a multi-site case study of the Audit and Best Practice for Chronic Disease project. *Implementation Science*. 2010;5(1):21-21.
16. Phillips C, Pearce C, Hall S, et al. Can clinical governance deliver quality improvement in Australian general practice and primary care? A systematic review of the evidence. *Medical Journal of Australia*. 2010;193 number 10(15 November 2010):602.
17. Bailie RS, Si D, O'Donoghue L, Dowden M. Indigenous health: effective and sustainable health services through continuous quality improvement. *Medical Journal of Australia*. 2007;186(10):525-527.
18. Gardner K, Yen L, Banfield M, Gillespie J, McRae I, Wells R. From coordinated care trials to medicare locals: what difference does changing the policy driver from efficiency to quality make for coordinating care? *International Journal for Quality in Health Care : journal of the International Society for Quality in Health Care / ISQua*. Feb 2013;25(1):50-57.
19. Rumbold A, Bailie R, Si D, et al. Delivery of maternal health care in Indigenous primary care services: baseline data for an ongoing quality improvement initiative. *BMC Pregnancy and Childbirth*. 2011;11(1):16.
20. Steenkamp M RA, Kildea S, Bar-Zeev SJ, Kruske S, Dunbar T, Barclay L. Measuring what matters in delivering services to remote-dwelling Indigenous mothers and infants in the Northern Territory, Australia. *Aust J Rural Health*. 2012 2012;Aug;20(4):228-37.
21. Campbell S, Braspenning J, Hutchinson A, Marshall MN. Research methods used in developing and applying quality indicators in primary care. *British Medical Journal*. 2003;326(7393):816-819.
22. Ivers N, Jamtvedt G, Flottorp S, et al. Audit and feedback: effects on professional practice and healthcare outcomes. *The Cochrane database of systematic reviews*. 2012;6:CD000259.
23. Nicholson C, Jackson C, Marley J. A governance model for integrated primary/secondary care for the health-reforming first world - results of a systematic review. *BMC health services research*. Dec 20 2013;13(1):528.
24. Stevens GA. Global, regional, and national trends in haemoglobin concentration and prevalence of total and severe anaemia in children and pregnant and non-pregnant women for 1995–2011: a systematic analysis of population-representative data. *Lancet* 2013.

Table 1: Anaemia in Aboriginal and Non-Aboriginal women who delivered in hospital, by region, 2000-2013

Region	No of women who delivered in hospital		No of women who delivered in hospital and were diagnosed with anaemia in pregnancy		Rates of anaemia in pregnancy per 100 deliveries 95%CI		Rates of anaemia in pregnancy without antepartum or postpartum haemorrhage 95%CI*			
	Non-Aboriginal	Aboriginal	Non-Aboriginal	Aboriginal	Non-Aboriginal	Aboriginal	Non-Aboriginal	Aboriginal		
Goldfields	11506	1880	204	125	1.8 (1.5- 2.0)	6.6 (5.5-7.8)	81	63	0.7(0.6-0.9)	3.4(2.5-4.2)
Great Southern	9087	715	464	89	5.1 (4.7-5.6)	12.4 (10.0-14.9)	203	50	2.2(1.9-2.5)	7.0(5.1-8.9)
Kimberley	3499	5885	166	834	4.7 (4.0- 5.4)	14.2 (13.3-15.1)	72	397	2.1(1.6-2.5)	7.4)
Midwest	9760	2863	314	332	3.2 (2.9- 3.6)	11.6 (10.4-12.8)	149	160	1.5(1.3-1.8)	5.6(4.7-6.4)
North Metro	151942	4212	6663	609	4.4 (4.3-4.5)	14.5 (13.4-15.5)	2895	252	1.9(1.8-2.0)	6.0(5.3-6.7)
Pilbara	8307	2479	332	237	4.0 (3.6- 4.4)	9.6 (8.4-10.7)	98	87	1.2(0.9-1.4)	3.5(2.8-4.2)
South Metro	135929	4995	5104	644	3.8 (3.7-3.9)	12.9 (12.0-13.8)	2028	244	1.5(1.4-1.6)	4.9(4.3-5.5)
South West	25264	975	827	99	3.3 (3.1-3.5)	10.2 (8.3-12.0)	315	33	1.2(1.1-1.4)	3.4(2.2-4.5)
Wheatbelt	12270	1178	457	148	3.7 (3.4- 4.1)	12.6 (10.7-14.5)	206	50	1.7(1.5-1.9)	4.2(3.1-5.4)
Total	368184*	25218*	14567	3120	4.0 (3.9-4.0)	12.4 (12.0-12.8)	6057	1336	1.6(1.6-1.7)	5.3(5.0-5.6)

Note: *Includes 656 deliveries for which it was not possible to assign a health region as the mother's usual residence was outside of WA or the residential address was not recorded.



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