12th Report of the Perinatal and Infant Mortality Committee of Western Australia

Deaths 2002-04

Department of Health

Foreword:

Chairman's report

It is with pleasure that I submit, on behalf of the Committee, the 12th Perinatal and Infant Mortality Report of investigations of deaths in the years 2002–04.

This is the second Report since the Committee was re-established in October 2001. The Committee reviews cases of perinatal and infant death with each case discussed in a de-identified format. The criteria for review were widened for this triennium to include cases of 26 weeks gestational age or more, in comparison with the previous cut-off of 32 weeks gestation. After the Committee's deliberations, letters are sent to the medical practitioners involved in each case to inform the doctors of the decisions and to provide education. This information is confidential.

As shown in the Report, the perinatal and infant mortality rates in Western Australia continue to fall. There has also been a meaningful reduction in the proportion of cases in which the Committee could find evidence of preventable medical factors. In this triennium, 87% of investigated deaths had no identified preventable medical factor, compared with 69% in the 2000-01 period. The proportion of stillbirths classified as "unexplained" has also fallen in this triennium, reflecting a significant and documented improvement in investigation of such cases by practitioners.

Stillbirth rates however remain unchanged and the rate of preterm birth is rising. These data provide compelling evidence of the need for innovative research to discover the origins of these most serious complications of pregnancy. One area that warrants particular attention is the high rate of mortality associated with untoward aspects of maternal behaviour and lifestyle. While the rate of smoking appears to be decreasing, the Committee noted high rates of substance abuse, poor compliance with medical care, and continuation of higher mortality rates in Aboriginal people.

The Committee recommends a review of home births in Western Australia. When the data for the 2000-01 and 2002-04 periods were combined, the perinatal mortality rate for planned home births was three fold higher than the rate for term deliveries in planned hospital births, and this difference was statistically significant. These data however do not allow for definitive conclusions to be reached as the numbers are relatively small and the Committee addresses mortality alone. It is recommended that an independent review be conducted of planned home births, with the review including morbidity as well as mortality.

Finally, as Chairman I would like to thank Dr Catherine Douglass who has taken the lead role in assembling information and writing the Report, Elizabeth Nathan who has provided biostatistical support, Vivien Gee from the Health Information Centre, and Dr Margaret Stevens, Executive Director, Public Health, for their tireless and enthusiastic efforts that have ensured the Committee's work is effective. I would also like to thank the members of the Committee who contribute their time freely as volunteers.

The Report contains evidence that the education provided by the Committee is making a contribution to perinatal and infant health in Western Australia. Credit for this achievement goes not only to the Committee members, but also to the many medical practitioners, midwives, nurses and other health-care workers who are working so hard to make a difference.

I trust you will find the Report informative and useful.

Respectfully submitted

Professor John Newnham
Chair

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1 Executive summary

The Perinatal and Infant Mortality Committee of Western Australia[1] (PIMC; 'The Committee') is a statutory Committee under the *Health Act 1911*.

This is the 12th Report of the PIMC, containing data related to deaths in the years 2002 to 2004 inclusive. Historically death audits have formed an important role in public health. Valuable data are available here in Western Australia (WA) due to the special privileges and protection provided to the Committee through its statutory rights. There are recognized limitations to the scope of the Committee's role, as the legislation does not include the investigation of non-fatal adverse obstetric outcomes. The primary role of the Committee is *educational*.

The annual number of births in WA has been around 25,000 births in recent years, although there are indications that this is now increasing. There were 26,792 births in WA in 2005.[2] There were annual averages of 182 stillbirths (20 weeks gestation or 400g birthweight), 55 neonatal deaths (in the first 28 days of life), 237 perinatal deaths (stillbirths and neonatal deaths combined) and 87 infant deaths (deaths in the first year of life) per year in WA in 2002-04. Birth and death rates for Aboriginals are much higher than for the Caucasian population.

Perinatal and infant mortality rates have continued to decline, due to significant reductions in the neonatal and post-neonatal mortality rates, but there has not been a significant reduction in the stillbirth rate in the last two decades. The perinatal and infant mortality rates in the triennium 2002-04 were lower than those published in the 11th Report pertaining to deaths in 2000-01[3] and WA rates compare favourably with national figures in these indices.[4,5,6]

The Committee's 11th Report was based on investigations of a subset of perinatal and infant deaths of at least 32 weeks gestational age, selected according to criteria set by the Executive Director, Public Health (EDPH). This subset of deaths was considered unlikely to be representative of all deaths. From 2002 onwards, the EDPH directed the Committee to investigate a broader range of cases, being all deaths of 26 weeks or greater gestational age. Of the 167 investigated deaths in the years 2000 and 2001, 51 (31%) were found to have possible preventable medical factors, with 15 (9%) of these deaths considered potentially avoidable. Data for the years 2002-04 indicate a lower proportion of deaths with possible preventable medical factors, with 59 (13.3%) of the 445 investigated deaths in these years coded with possible preventable medical factors, and 18 (4.0%) of these considered potentially avoidable deaths. Thus 96% of investigated stillbirths and infant deaths in Western Australia in the triennium of 2002-04 were considered unavoidable in a medical context.

Maternal behavioural factors were of particular interest. Overall, the prevalence of smoking was 28.0% in mothers experiencing a stillbirth or infant death compared with 18.7% in the general population of mothers. The prevalence of smoking was 22.7% in mothers experiencing a stillbirth and 39.2% of those experiencing an infant death. In the subgroup of investigated deaths, 30% of mothers were smokers, and other aspects of parental lifestyle such as illicit substance use or poor compliance with medical care, were associated with 22% of deaths.

Population health benefits are associated with improved living conditions, good nutrition and avoidance of harmful substance use. These factors remain the challenges in working for improved outcomes for those living in disadvantaged social circumstances, particularly for many Aboriginal people.

The major categories of stillbirth were congenital abnormalities, prematurity due to spontaneous preterm births, and 'unexplained'. Improved efforts for primary prevention of fetal loss, particularly with peri-conceptional folic acid supplementation, and improved antenatal screening for abnormalities, remain areas where further reductions in stillbirth rates may be achieved. Finding ways to prevent preterm birth and unexplained antepartum death remain primary health goals.

Obesity and diabetes mellitus are major contemporary health problems. Their increasing prevalences may lead to an increase in perinatal deaths. Prevention approaches will include public health initiatives to reduce obesity and the provision of specialised care for morbidly obese and diabetic women.

Sudden infant death syndrome (SIDS) is still the leading single category of infant deaths. The incidence has declined in recent years with 'safer sleeping' education programs but 'at-risk' groups have not experienced the same risk reduction. Public education about smoking avoidance, breastfeeding, and safer sleeping practices needs to be directed at those most at risk.

Specific efforts are required to address the high perinatal and infant mortality rates in Aboriginal people. Targeted culturally relevant educational programs and dedicated Aboriginal antenatal clinics may be of benefit.

There was an improvement in the proportion of cases that had pathology investigations performed to assess cause of death in the cases in 2002-04 compared with those in 2000-01.

The work of this Committee is bound by the provisions of the *Health Act 1911*, which confine its work to the review of deaths. Practitioners are reminded of the importance of audit of broader perinatal outcomes, assessing patient satisfaction and morbidity factors, along with mortality outcomes.

Findings:	Key Points:	Recommendations:
Overview: In Western Australia (WA) in 2002-04 there were 74,449 livebirths and 806 perinatal and infant deaths (546 stillbirths, 166 neonatal deaths and 94 post-neonatal deaths). The stillbirth rate was 7.3 per 1,000 births. The neonatal mortality rate was 2.2 per 1,000 livebirths **The perinatal mortality rate was 9.5 per 1,000 births.** The post-neonatal mortality rate was 1.3 per 1,000 livebirths. **The infant mortality rate was 3.5 per 1,000 livebirths.**	In WA there have been reductions in the perinatal and infant mortality rates, but the stillbirth rate is virtually unchanged over the past two decades.	**Recommendation 1:** **Antenatal Education:** Antenatal public health programs should be a priority, addressing → smoking cessation → good nutrition/periconceptional folic acid supplementation → healthy weight → early pregnancy screening for congenital abnormalities → avoidance of alcohol and other harmful substances
Risk Factors for stillbirth and infant death: Rates of stillbirth and infant death were higher in those with markers for lower socioeconomic status. Stillbirth and infant mortality rates were significantly higher in mothers who smoked, with the greatest difference being in the post-neonatal mortality rate which was five-fold higher in smoking mothers. The prevalence of smoking in pregnancy has reduced from 21.3% of mothers who gave birth in 2000-01 to 18.7% of mothers who gave birth in 2002-04.	Lower socioeconomic status and smoking are important risk factors for stillbirth and infant death.	**Recommendation 2:** **Social Issues:** Support for those with social risk factors needs to be improved. 2.1 Increased support should be given to agencies working to assist families with social risk factors such as poor housing, domestic violence and alcohol and other substance use. 2.2 Outreach services are recommended to improve compliance with antenatal care for those with special needs.[ii] 2.3 Screening for depression and domestic violence is recommended as a routine in antenatal and postnatal assessments.
Aboriginality: Compared with rates in non-Aboriginal mothers, the stillbirth rate was double, the neonatal mortality rate almost four-fold higher, and the post-neonatal mortality rate five-fold higher in Aboriginal mothers.	Aboriginal people have considerably higher rates of stillbirth and infant death.	**Recommendation 3:** **Aboriginal care:** Innovative programs are required to address the high rates of Aboriginal mortality. 3.1 Culturally appropriate education programs targeting nutrition, diabetes and alcohol and other substance use problems are recommended.
Preterm: There were 6,290 preterm births, giving a preterm birth rate (<37 weeks) of 8.4%, compared with 8.2% in 2000-01 and 6.4% in 1990.	The incidence of preterm birth has increased.	

Findings:	Key Points:	Recommendations:
Cause of Death: The leading categories of stillbirth by Perinatal Society of Australia and New Zealand Perinatal Death Classification (PSANZ PDC) were congenital abnormality 26.6% (26% in 2000-01), unexplained antepartum death 18.3% (22% in 2000-01) and spontaneous preterm birth 15.6% (11% in 2000-01). The leading categories of neonatal death by PSANZ-PDC were prematurity 40.4% (37% in 2000-01), congenital abnormality 22.9% (28% in 2000-01) and perinatal infection 7.2% (11% in 2000-01). The leading categories of post-neonatal deaths by Perinatal Society of Australia and New Zealand Neonatal Death Classification (PSANZ NDC) were Sudden Infant Death Syndrome (SIDS) 23.4% (31% in 2000-01), congenital abnormalities 23.4% (19% in 2000-01) and "other" which includes injuries and indeterminate causes of death 27.7% (21% in 2000-01). **INVESTIGATED DEATHS:** The Committee investigated 445 of the 806 deaths (256 stillbirths, 98 neonatal and 91 post-neonatal deaths). **Preventable medical factors** 96% (427 of 445) of investigated deaths were considered unavoidable in a medical context (preventability score <4). 87% (386 of 445) of investigated deaths had no identified preventable medical factor (preventability score=1). This compares with investigated deaths in 2000-01 where 91% (152 of 167) were considered unavoidable (preventability score <4) and 69% (115 of 167) had no identified preventable medical factor (preventability score=1). There was a reduction in the proportion of cases with preventable medical factors in 2002-04 compared with those in 2000-01, however there were differences in the selection of cases for investigation over these two time periods.[i]	The leading categories of stillbirth were congenital abnormality, "unexplained" and spontaneous preterm birth. The rate of unexplained stillbirth has reduced. The leading causes of neonatal death were prematurity and congenital abnormality. The leading causes of post-neonatal death were SIDS, congenital abnormalities and "other" which includes injuries and indeterminate causes of death.	3.2 Outreach programs, such as home visits by Aboriginal health workers, are recommended. 3.3 Dedicated antenatal clinics for Aboriginal women may be of benefit and should be considered. **Recommendation 4:** **Statewide Obstetric Unit:** The established Statewide Obstetric Support Unit should be further expanded in its role to assist in the delivery of obstetric care in WA, including: 4.1 Workforce and infrastructure advice and planning. 4.2 Supporting skilled obstetric staff in rural areas. 4.3 Producing evidence-based practice protocols applicable to each area. **Recommendation 5:** **Professional Training:** Medical practitioners and midwives should have training and practice drills, particularly in the following areas: 5.1 Use and interpretation of electronic fetal heart rate monitoring in labour 5.2 Resuscitation of the newborn 5.3 Management of obstetric emergencies, particularly shoulder dystocia. **Recommendation 6:** **Clinical Guidelines:** On-line access to clinical guidelines should be available at the point of patient contact.[iii]

Findings:	Key Points:	Recommendations:
The 59 cases in 2002-04 where any **preventable medical factors** were identified comprised 27 stillbirths, 29 neonatal deaths and 3 post-neonatal deaths. The types of preventable medical factors were divided into 'systems factors' (15 cases), 'medical care factors' (50 cases) and 'both systems and medical care factors' (6 cases). The main **'systems factors'** identified were: Delays in management: 4 cases Delays in transfer to another unit: 2 cases Supervision of mother and baby (co-sleeping) in hospital: 4 cases The main **'medical care factors'** identified related to: Antenatal management: 21 cases Medical care of the neonate: 11 cases Intrapartum management: 10 cases Earlier referral indicated: 6 cases Identification of abnormal CTG traces: 5 cases CTG monitoring indicated: 4 cases Technical skills in resuscitation of newborn: 3 cases Technical obstetric skills: 2 cases **Deaths with 'preventable factors' by Cause of Death:** In the group of 27 stillbirths where any preventable medical factors were identified, the most frequent causes of death by PSANZ PDC were: Hypoxic peripartum insult: 6 cases Fetal growth restriction: 6 cases Maternal diabetes mellitus: 5 cases Maternal hypertension: 4 cases Specific perinatal conditions: 4 cases	**INVESTIGATED DEATHS:** The peer review process of the Perinatal and Infant Mortality Committee found that in the 2002-04 triennium 87% of deaths met the Committee's expectations of appropriate medical care, and 96% of deaths were considered unavoidable in a medical context. The proportion of investigated deaths with preventable medical factors was lower in 2002-04 compared with 2000-01. Key areas were identified where improved medical management may have improved outcome: • fetal growth restriction • labour • diabetes and hypertension in pregnancy • neonatal sepsis	**Recommendation 7:** **Diabetes in Pregnancy:** Routine management of patients with diabetes in pregnancy should involve: → education and dietary advice. → monitoring blood glucose levels to assess glycaemic control. → specialist consultation/ liaison for those patients with poor glycaemic control. → routine monitoring of fetal wellbeing, including ultrasound assessment for fetal macrosomia. **Recommendation 8:** **Obesity:** In obese women ultrasound examination is advised in the third trimester, to identify fetuses at increased risk due to macrosomia or fetal growth restriction. **Recommendation 9:** **Multiple Pregnancy:** Management of multiple pregnancy requires ascertainment of chorionicity at 12 weeks gestation and frequent ultrasound assessments of fetal growth, as per guidelines[iii]. **Recommendation 10:** **Maternal age:** In older mothers ultrasound examination is advised in the third trimester, in order to identify fetal growth restriction.

Findings:	Key Points:	Recommendations:
In the group of 29 neonatal deaths where any preventable medical factors were identified, the most frequent causes of death by PSANZ PDC were: Hypoxic peripartum insult: 9 cases Perinatal infection: 5 cases No obstetric antecedent: 5 cases **Maternal Behaviour:** Smoking was a significant risk factor, associated with 30.0% of investigated deaths in this triennium. Other aspects of maternal or family behaviour which may have contributed to the outcome of stillbirth or infant death, such as substance use and poor compliance with medical care, were associated with 98 (22%) of the 445 investigated deaths (42 stillbirths, 16 neonatal deaths and 40 post-neonatal deaths). In this group of 98 mothers, 61% were smokers (n=61), 46% were Aboriginal (n=45) and 44% lived in a rural area (n=43) In the subgroup of these mothers experiencing a post-neonatal death of their babies (n=40), 36 mothers had significant social problems or poor compliance with medical care (40% of the total of 91 investigated post-neonatal deaths). 21 mothers had alcohol or other substance use problems (23% of investigated post-neonatal deaths) and 10 babies suffered non-accidental injuries (11% of investigated post-neonatal deaths).	Smoking was associated with 30% of investigated deaths. Other maternal or family lifestyle factors such as substance abuse or poor compliance with medical care were documented in 22% of investigated deaths. In mothers experiencing a post-neonatal death of their baby in 2002-04, 40% had significant social problems. 10 babies died in the post-neonatal period in 2002-04 due to non-accidental injuries.	**Recommendation 11:** **Group B Streptococcus Guidelines:** 11.1 Guidelines for screening for Group B Streptococcus at 36 weeks gestation of pregnancy, and intrapartum antibiotic treatment for carriers are recommended.[iii] 11.2 Staff should be aware of guidelines to reduce the risk of neonatal sepsis.[iii] **Recommendation 12:** **Neonatal Management issues:** The newly established Neonatal Network is supported. The Neonatal Network should be adequately resourced and supported to coordinate statewide neonatal care and workforce. 12.1 A baby with poor Apgar scores (suspected birth asphyxia) should initially be managed in a level II or III special care nursery, particularly being aware of the problems of hypoglycaemia and metabolic acidosis. 12.2 Where there is neonatal shock (e.g. sepsis, birth trauma/ sub-galeal haemorrhage), staff should be aware of the baby's need for rapid intravenous volume replacement. 12.3 Infants with respiratory distress or other signs of sepsis should be treated promptly with antibiotics. **Recommendation 13:** **Transport Issues:** 13.1 Care should be taken to deliver babies likely to require special nursery care in an appropriately staffed and equipped hospital. 13.2 Referring staff are encouraged to anticipate transfer, phone early, and closely liaise with transport staff, to assist in prioritisation of transport needs.

Findings:	Key Points:	Recommendations:
Co-sleeping: 33 unexpected infant deaths (17.5% of the 189 investigated infant deaths) occurred in association with co-sleeping. 27 of these deaths occurred in combination with significant social problems or parental substance abuse. These deaths all occurred prior to 5 months of age. Twelve of the deaths occurred in babies that were preterm or less than 2.5 kg birthweight. The deaths were classified by PSANZ NDC: 13 of these deaths were classified as SIDS, 4 due to sepsis, 2 due to accidental asphyxiation and 14 other/undetermined.	Co-sleeping was associated with 17.5% of sudden unexpected infant deaths in 2002-04.	→ **Recommendation 14:** **Data collection:** Collection of additional information on midwifery notification forms is recommended. Questions about number of antenatal visits, maternal weight and alcohol use are suggested.
Home births: There were three term perinatal deaths in planned home births in WA in 2002-04. Data was combined for the years 2000-04 to allow valid statistical analysis. There were six perinatal deaths in the 846 planned home births in 2000-04. Four of these six cases had preventable medical factors. The perinatal mortality rate in this group was 6.7 per 1,000 births, compared with 2.1 per 1,000 births in term deliveries that were planned hospital births, which was a statistically significant difference.	There was a three-fold increased perinatal mortality rate in planned home births in WA in the years 2000-04.	→ **Recommendation 15:** **Sudden Infant Death Syndrome:** Increasing public knowledge about ways to reduce SIDS is advised. Special attention should be given to delivering information to families with risk factors, and institutions that provide infant care. In addition to the current education about safer sleeping practices, there should be messages about the increased risk of infant death related to: → co-sleeping in the presence of parental smoking/alcohol/drug use, and in small babies especially under the age of 4 months. → co-sleeping on a couch Parents should be advised that there is a decreased risk of SIDS where parents room-share with their baby in a separate cot for the first few months of life, compared with the baby sleeping in a separate room to its parents.
Investigations for Cause of Death: 25.8% of investigated deaths had insufficient pathology investigations performed into the cause of death. This represented a significant improvement since 2000-01 when over half the deaths investigated by the Committee had insufficient pathology tests performed.	Significantly more pathology investigations were performed to assess cause of death in the investigated deaths in 2002-04 compared with 2000-01	→ **Recommendation 16:** **Home births:** A review of home births in WA is recommended to assess essential health outcomes, including morbidity and mortality. **Recommendation 17:** **Cause of Death:** Thorough investigation to assess cause and contributing factors in stillbirths and infant deaths is recommended, with reference to investigations recommended in Appendix II.

[i] Note that the criteria for investigations changed. In 2000-01 the criteria for deaths requiring investigation were stillbirths and neonatal deaths greater than 32 weeks gestation with the exception of those known to be caused by lethal malformations or specific injuries, post-neonatal deaths due to infection, and other deaths at the discretion of the EDPH. In 2002-04 the criteria for deaths requiring investigation were deaths of 26 weeks or greater gestational age.

[ii] Outreach services, such as increasing specialist visits to rural areas/increasing use of teleconferencing /assisting patients with transport and accommodation issues to enable easier access to regional and metropolitan specialist services.

[iii] King Edward Memorial Hospital guidelines for obstetrics: http://kemh.health.wa.gov.au/development/manuals/sectionb/index.htm

King Edward Memorial Hospital guidelines for neonatology: http://kemh.health.wa.gov.au/services/nccu/guidelines/

2 Committee members

Permanent members

Professor John Newnham	Chair; Professor Obstetrics & Gynaecology, The University of Western Australia (October 2001 – present)
Professor Karen Simmer	Deputy Chair; Neonatal Paediatrician (October 2001 – present)
Professor Carol Bower	Epidemiologist (October 2001 – present)
Dr Noel French	Neonatal Paediatrician (October 2001 – present)
Dr Mary Sharp	Neonatal Paediatrician (April 2006 – present)
Dr Jennifer Sokol	Neonatal Paediatrician (October 2001 – March 2006)
Dr Andrew Wawryk	Paediatrician (October 2001 – present)
Vacancy	Australian Medical Association Representative

Provisional members

A/Professor Jan Dickinson	Maternal Fetal Medicine Specialist (October 2001 – April 2007)
Dr Annabelle Shannon	General Practitioner-Obstetrician (October 2004 – present)
Dr Jane Talbot	General Practitioner-Obstetrician (August 2004 – April 2007)
Ms Julie Watson	Clinical Midwife (October 2001 – October 2004)
Ms Raye McNally	Clinical Midwife (October 2004 – present)

Co-opted members

Dr Lindsay Adams	Neonatal Paediatrician (May 2005 – present)
Dr Adrian Charles	Perinatal Pathologist (October 2001 – present)
Dr Donald Clarke	Obstetrician (March 2003 – present)
Dr Everett (Pat) Magann	Obstetrician (October 2001 – March 2003)

Medical investigators

Dr Catherine Douglass (Buccilli)	General Practitioner (October 2001 – present)
Dr Antonia Lobo-Braganza	Obstetrician (October 2001 – July 2003)
Dr Patrick Pemberton	Neonatal Paediatrician (October 2001 – present)
Dr Erica Shellabear	Obstetrician (August 2003 – June 2006)

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Brigitte Glockner and team, King Edward Memorial Hospital Library

3 Methods

3.1 The Role of the PIMC

The PIMC exists as a statutory requirement of the *Health Act 1911*[1], under the direction of the EDPH. The membership of the Committee comprises a panel of experts, as prescribed by the *Health Act 1911*, with the Chair being the Professor of Obstetrics at The University of Western Australia. The EDPH appoints investigators to enquire into deaths and to present de-identified case summaries to the Committee at monthly meetings. Approximately twenty case summaries are presented at each meeting. The circumstances of each case are considered and constructive written feedback is provided exclusively to the medical practitioners who provided clinical care. Each case is assessed for cause of death, possible preventable factors and other issues of public health significance. The Committee examines cumulative data obtained from analysis of deaths, along with broader statewide perinatal data, to propose recommendations aimed at reducing perinatal and infant mortality rates.

The Committee's role is educational, providing confidential written feedback to practitioners involved in individual cases, and to the medical profession and wider community through publishing reports such as this from time to time.

3.2 Reporting of Births and Deaths

It is a requirement of the *Health Act 1911*[1] that stillbirths and infant deaths are notified directly to the EDPH by attending medical practitioners. Information is also made available to the EDPH from midwifery notification forms and the Registrar General's Office (death certificates). The EPDH directs an appropriately qualified medical investigator to review the medical notes pertaining to a death. National Privacy Principles allow exemption for the disclosure of information when the disclosure is required or authorised by, or under the law.[7] Thus, medical notes pertaining to a death must be released to the appointed investigator when requested by the EDPH.

Midwives are required to report all births (including stillbirths) in WA to the Department of Health via the 'Notifications by Midwives Regulations' 1994.[8] To ensure completeness of records, notifications are cross-referenced with records from the Department of Justice Registry of Birth, Deaths and Marriages. Statistics regarding all livebirths, stillbirths and infant deaths are regularly published by the Health Information Centre (HIC).[2]

The definition used for stillbirth is 'a fetus that does not have a heart beat or any sign of life, which is 20 weeks or more in gestation or 400g or more in birthweight.' Other definitions are described in Appendix I.

3.3 Designation of Cases for Investigation by the PIMC in 2002-04

Of the reported deaths, the EDPH designates those deaths to be further investigated.

The EDPH set the criterion for the investigation of deaths in 2002-04 as:

'All stillbirths and deaths of infants of 26 weeks or greater gestational age.'

By contrast, for the years 2000-01 the criteria for deaths requiring investigation were stillbirths and neonatal deaths greater than 32 weeks gestation with the exception of those known to be caused by lethal malformations or specific injuries, post-neonatal deaths due to infection, and other deaths at the discretion of the EDPH.

Legal opinion regarding the requirement for investigation of deaths due to pregnancy termination was sought in 2004. It was deemed that it is not the role of the PIMC to investigate therapeutic post-20 weeks gestation pregnancy terminations that fall within the criterion for investigation, as there is a statutory Ministerial panel that approves such late terminations in the State of Western Australia.[9,10]

3.4 Case Investigation Methods

For those cases that met the criterion for investigation, letters were sent to the notifying medical practitioners to explain the investigation process and to obtain medical notes regarding cases. The notes were conveyed to the investigators who contacted any other relevant health providers and hospitals for further information. From the available notes, case summaries were prepared using a standard electronic format.

At the monthly PIMC meetings, cases were discussed and classified for:

1. aetiology of death, using PSANZ death classifications
2. preventability score
3. any maternal factors that may have contributed to poor outcome
4. thoroughness of investigative work-up into the cause of death
5. early prevention issues

An electronic dataset from case investigations was created and used to produce statistics for this Report. There were some differences between this dataset and HIC data that was obtained from Midwifery Notification Forms.

3.5 Cause of Death Classification

In analysis of deaths from the year 2000 onwards, the Committee applied the 'Perinatal Society of Australia and New Zealand Perinatal Death Classification' (PSANZ PDC) and the 'Perinatal Society of Australia and New Zealand Neonatal Death Classification' (PSANZ NDC).[11] Whilst it was designed for coding neonatal deaths, the Committee has found the PSANZ NDC useful to describe post-neonatal deaths as well. Investigated cases were classified at monthly PIMC meetings.

3.6 Preventability Scale

In analysis of deaths from the year 2000 onwards, the Committee used a 'Preventability Scale' to classify deaths with possible preventable factors (Table 1). This scale is used to assess aspects of medical and nursing care. It does not reflect aspects of patient lifestyle that may contribute to poor outcome.

The preventability of an adverse event is defined as 'an error in management due to failure to follow accepted practice at an individual or system level' and accepted practice is taken to be 'the current level of expected performance for the average practitioner or system that manages the patient.'[12]

Preventability scores '2' and '3' reflect 'low levels' of preventable medical factors in deaths that are considered unavoidable in a medical context. Preventability scores greater than or equal to '4' code for higher levels of medical preventability and are used to code potentially avoidable deaths.

Table 1: Preventability Scale	
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

In those cases where the preventability score was greater than or equal to '2', the preventable factors were coded further (see Table 2):

Table 2: Preventable Medical Factors	
Systems factors:	Significant delay in assessment or treatment Delay in transfer to other unit Staffing problem Equipment problem Follow-up of abnormal test result Significant delay in performance of clinical investigation Co-sleeping of mother and baby in hospital
Medical Care factors:	Management of antenatal problems (other than obstetric delivery skills) Medical care of baby (other than resuscitation of the newborn) Identification of abnormal fetal heart rate patterns on cardiotocographic (CTG) trace Fetal heart rate monitoring not performed when indicated Technical skills for obstetric delivery Technical skills for resuscitation of newborn Earlier referral indicated Intrapartum management decisions Postnatal depression not identified

3.7 Maternal Behavioural Factors

The Committee noted documented maternal or other family behaviour that may have contributed to poor outcome. Maternal smoking status was considered. In addition, other family lifestyle factors that may have contributed to deaths were coded as 'Maternal Behavioural Factors' (Table 3).

Table 3: Maternal Behavioural Factors
Poor compliance with recommended medical care
Domestic violence
Other serious social problem(s)
Serious maternal psychiatric disorder, other than substance use
Non-accidental injury (NAI)
Alcohol abuse
Marijuana use
Illicit intravenous drug use/other 'hard drugs' use

3.8 Adequacy of Investigation into Cause of Death

An investigator reviewed the pathology tests performed for investigated cases and graded them with reference to guidelines for pathology tests to assess cause of stillbirths and infant deaths (Appendix II, Section 7.2) and consideration of the circumstances of each case (Table 4).

Table 4: Investigations to Assess Cause of Death
1 = adequate investigations performed to investigate the cause of death
2 = some investigations performed, but absence of relevant pathology tests (partially investigated)
3 = few/no investigations to investigate the cause of death

Placental histopathology was generally considered necessary to adequately investigate the cause of stillbirths, with exceptions such as prenatally diagnosed trisomy 13. Whilst ideally thorough post-mortem examination is performed, this is frequently not done, in accordance with parental wishes, and was not considered essential to be scored as 'adequately investigated' in this context. In the assessment of cause of stillbirth, guidelines (Appendix II) also recommend amniocentesis and maternal toxicology tests, but these are still infrequently performed, and were not considered essential to code as 'adequately investigated' in this triennium.

For infant deaths, each case was considered on its own merits, according to the prior clinical history and investigations performed.

3.9 Autopsy Utility

Benefits of autopsy examination were considered in the investigated cases that underwent examination, and coded according to an 'autopsy utility scale'[13] (Table 5):

Table 5: Autopsy Utility: Categories of Concordance of Clinical and Pathological Diagnoses	
1 = confirm	The clinical and pathologic diagnoses were identical or similar enough as to not alter future counselling or recurrence risk.
2 = change	The clinical and pathologic diagnoses differed enough to alter future counselling and the recurrence risk, suggesting the autopsy provided clinically relevant information.
3 = add	The clinical diagnosis was not altered but additional unexpected findings such as anomalies that required counselling were noted on the perinatal autopsy, thus providing clinically relevant information.
4 = inconclusive	The perinatal autopsy demonstrated neither an obvious cause of death nor significant congenital malformations.

3.10 Early Prevention Factors

The Committee considered cases where 'early prevention' or early termination of pregnancy may have prevented death after twenty weeks gestation. Cases were coded for 'early prevention' factors where prenatal screening for fetal anomaly had not been performed or there had been some other problem with prenatal screening.

Deaths that occurred in pregnancies conceived with assisted fertility techniques were also recorded.

3.11 Statistical Methods

Frequency distributions were used to summarise categorical data. Mortality rates and relative risk ratios with their 95% confidence intervals were used to compare mortality by subgroups of data. Mantel-Haenszel, Chi-square tests and trend analysis were used to test for group differences. All hypothesis tests were two sided and p-values <0.05 were considered statistically significant. SPSS 15.0 (SPSS Inc, Chicago IL) and StatExact 5.0 (Cytel Software Corporation, Cambridge, MA) statistical software were used for data analysis.

4 Results

To facilitate greater understanding of the broader picture of perinatal and infant mortality in WA, statewide data[2] are presented here prior to detailing the selected population of cases investigated by the Committee.

4.1 Statewide Data, WA 2002-04

4.1.1 Perinatal and Infant Mortality Rates by Birth Weight, Gestational Age and Race, WA 2002-04

Statistics for livebirths, stillbirths and infant deaths by birth weights and gestational age are shown for the cohort 2002-04 in Tables 6 and 7.[2]

Stillbirth rates are quoted per 1,000 total births and neonatal deaths are quoted per 1,000 livebirths. Stillbirths and neonatal deaths combined are quoted as a perinatal mortality rate, per 1,000 total births. In a similar manner, neonatal and post-neonatal death figures are combined to give the infant mortality rate, which is quoted per 1,000 livebirths.

Note that rates published here, as supplied by the Health Information Centre (HIC) of the WA Department of Health[2] are higher than published Australian Bureau of Statistics (ABS) rates[5,6] from the Registrar General Offices in each state and territory. These HIC-WA data are produced annually and are provided to the National Perinatal Statistics Unit of the Australian Institute of Health and Welfare (AIHW).[14] These data are more comprehensive than ABS data, as in addition to notifications from the Registrar General's Office, they combine information from midwifery notification forms, notifications made to the EDPH, and the Coroner's office.

In the three-year period there were 74,449 livebirths, 546 stillbirths, 166 neonatal deaths and 94 post-neonatal deaths. Combining neonatal and post-neonatal deaths, the total number of infant deaths was 260.

The Committee was directed to investigate 256 stillbirths and 98 neonatal and 91 post-neonatal deaths, making a total of 445 investigated deaths.

Table 6: Birth & Death Statistics by Birthweight, WA 2002-04

Infant Weight (grams)	Total Births	Livebirths	Stillbirths		Neonatal Deaths		Perinatal Deaths†		Post-neonatal Deaths		Infant Deaths‡	
	N	N	N	Rate	N	Rate	N	Rate	N	Rate	N	Rate
<500	277	42	235	848.4	37	881.0	272	981.9	0	0.0	37	881.0
500-999	366	262	104	284.2	46	175.6	150	409.8	8	30.5	54	206.1
1000-1499	464	423	41	88.4	15	35.5	56	120.7	3	7.1	18	42.6
1500-1999	999	967	32	32.0	11	11.4	43	43.0	4	4.1	15	15.5
2000-2499	3094	3069	25	8.1	10	3.3	35	11.3	14	4.6	24	7.8
2500-2999	11698	11654	44	3.8	14	1.2	58	5.0	23	2.0	37	3.2
3000-3499	27533	27501	32	1.2	21	0.8	53	1.9	22	0.8	43	1.6
3500-3999	22436	22414	22	1.0	5	0.2	27	1.2	16	0.7	21	0.9
4000-4499	6966	6959	7	1.0	5	0.7	12	1.7	4	0.6	9	1.3
>=4500	1162	1158	4	3.4	2	1.7	6	5.2	0	0.0	2	1.7
Total	**74995**	**74449**	**546**	**7.3**	**166**	**2.2**	**712**	**9.5**	**94**	**1.3**	**260**	**3.5**

† Perinatal Mortality Rate (PMR) = $\frac{\text{Number of stillbirths + neonatal deaths in the cohort}}{\text{Number of stillbirths + livebirths in the cohort}}$ x 1000

‡ Infant Mortality Rate (IMR) = $\frac{\text{Number of neonatal deaths + post-neonatal deaths in the cohort}}{\text{Number of livebirths in the cohort}}$ x 1000

The stillbirth rate was 7.3 per 1,000 births (for birthweight >= 400g and/or over 20 weeks gestation), being 7.4 per 1,000 births for males and 7.2 per 1,000 births for females.

The neonatal mortality rate was 2.2 per 1,000 livebirths.

The perinatal mortality rate was 9.5 per 1,000 births (for birthweight >= 400g and/or over 20 weeks gestation).

The post-neonatal mortality rate was 1.3 per 1,000 livebirths.

The infant mortality rate was 3.5 per 1,000 livebirths, being 3.9 per 1,000 livebirths for males and 3.0 per 1,000 livebirths for females.

Compared to the years 2000-01, stillbirth rates were virtually static, being 7.4 in 2000-01 and 7.3 per 1,000 births in 2002-04, the perinatal mortality rate reduced from 10.2 to 9.5 per 1,000 total births, the neonatal mortality rate reduced from 2.8 to 2.2 per 1,000 livebirths and the infant mortality rate reduced from 4.5 to 3.5 per 1,000 livebirths over the two time periods.

There were 3.1% of livebirths (n=2,345) and 9.2% of stillbirths (n=50) from multiple pregnancies.

The preterm (<37 wks) birth rate was 8.4%, having increased from 8.2% in the years 2000-01 .

Preterm deliveries (<37 wks) accounted for 80.2% (n=438) of stillbirths and 71.1% (n=118) of neonatal deaths.

Very low birth weight babies (<1,000g) accounted for 62% (n=339) of the stillbirths and 35% (n=91) of the infant deaths.

There were 11.3% of Aboriginal babies of low birth weight (<2,500g), compared with 5.1% of non-Aboriginal babies, and 3.5% of Aboriginal babies were very low birth weight (<1,500g), compared with 1.3% of non-Aboriginal babies.

The perinatal mortality rate for infants >=1,500g birthweight was 3.2 per 1,000 births, and that for infants >=2,500g was 2.2 per 1,000 births.

There were 100 post-20 weeks gestation pregnancy terminations in the triennium 2002-04.[15]

Table 7: Birth & Death Statistics by Gestational Age, WA 2002-04

Gestational Age (weeks)	Total Births	Livebirths	Stillbirths		Neonatal Deaths		Perinatal Deaths		Post-neonatal Deaths		Infant Deaths	
	N	N	N	Rate	N	Rate	N	Rate	N	Rate	N	Rate
20-27	613	300	313	510.6	80	266.7	393	641.1	8	26.7	88	293.3
28-32	933	861	72	77.2	21	24.4	93	99.7	5	5.8	26	30.2
33-36	4744	4691	53	11.2	17	3.6	70	14.8	15	3.2	32	6.8
37-43	68705	68597	108	1.6	48	0.7	156	2.3	66	1.0	114	1.7
< 37	6290	5852	438	69.6	118	20.2	556	88.4	28	4.8	146	24.9

Table 8: Births & Deaths by Race, WA 2002-04

Ethnicity	Total Births	Livebirths	Stillbirths		Neonatal Deaths		Post-neonatal Deaths		PMR	p-value	IMR	p-value
		N	N	Rate	N	Rate	N	Rate				
Caucasian	62920	62510	410	6.5	115	1.8	62	1.0	8.3		2.8	
Aboriginal	4796	4727	69	14.4	35	7.4	25	5.3	21.7	<0.001	12.7	**<0.001**
Asian/Indian	4390	4365	25	5.7	6	1.4	1	0.2	7.1	0.381	1.6	0.140
Other	2889	2847	42	14.5	10	3.5	6	2.1	18.0	<0.001	5.6	**0.009**

Note: p-values represent differences in mortality rates between the Caucasian group and each ethnic group (statistically signficant difference p<0.05)

Of the total births, 83.9% of mothers were Caucasian, 6.4% were Aboriginal[i], 5.8% were Asian and 3.9% were of 'other' racial descent. The perinatal and infant mortality rates in Asian babies were lower than for Caucasian babies, but the differences were not statistically significant. There were significantly higher perinatal and infant mortality rates in babies born to mothers identified as Aboriginal and 'other' racial descent (Table 8).

The median birth weight for all stillborn babies by race was: Caucasian 585g; Aboriginal 690g; Asian 700g; and 'other' 510g.

The median birth weight for all babies that died (combined stillbirths and infant deaths) by race was: Caucasian 895g; Aboriginal 960g; Asian 582g; and 'other' 582g.

Compared with non-Aboriginal mothers, the stillbirth rate was double in Aboriginal mothers (14.4 versus 6.8 per 1,000 births), the neonatal death rate almost four-fold higher (7.4 versus 1.9 per 1,000 livebirths), and the post-neonatal rate five-fold higher (5.3 versus 1.0 per 1,000 livebirths)(Figure 2).

Fig 1: Number of Stillbirths, Perinatal, Neonatal, Post-neonatal and Infant Deaths by Aboriginality, WA 2002-04

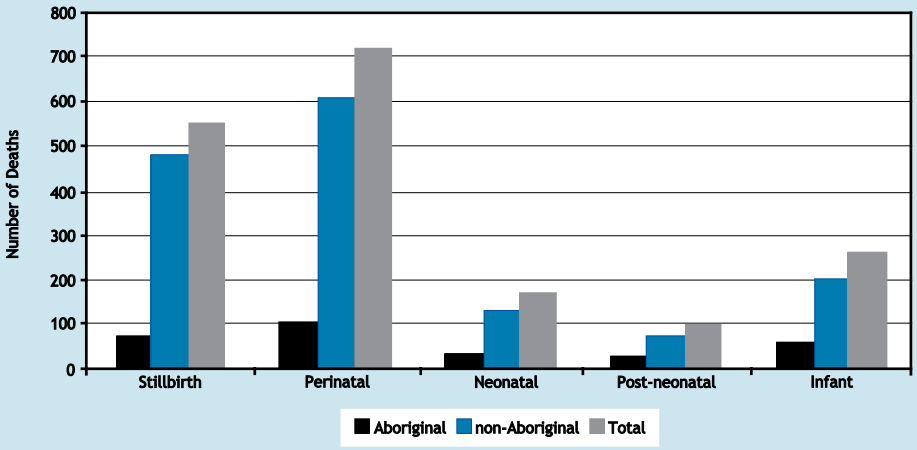
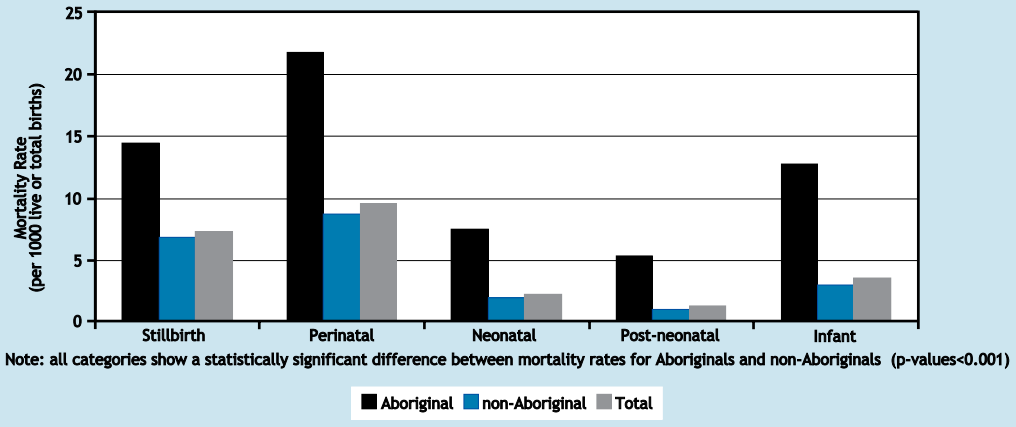


Fig 2: Rates for Stillbirths, Perinatal, Neonatal, Post-neonatal and Infant Mortality by Aboriginality, WA 2002-04



[i]Aboriginal is defined here as being of Aboriginal or Torres Strait Islander (TSI) racial descent.

4.1.2 Perinatal Deaths by Cause of Death and Aboriginality, WA 2002-04

Stillbirths were classified according to PSANZ PDC alone. Neonatal deaths were classified in two ways, using PSANZ PDC and PSANZ NDC. The PSANZ PDC classification system focuses on pregnancy related precedents to neonatal deaths, and differs to the PSANZ NDC that describes neonatal deaths according to the pathology in the neonate that led to death.

Tables 9a and 9b describe stillbirths and neonatal deaths by 'pregnancy related' causes of death, using PSANZ PDC, and Table 9c and Fig 3 show perinatal deaths by PSANZ PDC and Aboriginality.

Appendices III and IV (Sections 7.3 and 7.4) provide further details of numbers of cases in each of the sub-categories of PSANZ PDC and PSANZ NDC for 2002-04.

Table 9a: Number of Stillbirths, by Cause of Death (PSANZ PDC), WA 2002-04

PSANZ PDC	N	%
1. Congenital Abnormality	145	26.6
2. Perinatal Infection	23	4.2
3. Hypertension	38	7.0
4. Antepartum Haemorrhage	40	7.3
5.2. Diabetes	15	2.7
5.1 5.3-5.8. Maternal Conditions	5	0.9
6.1. Twin-twin	18	3.3
6.2. Fetomaternal Haemorrhage	9	1.6
6.3. Cord Abnormality	3	0.5
6.4. Uterine Abnormality	3	0.5
6.5. Birth Trauma	0	0.0
6.6. Trauma	3	0.5
6.7. Hydrops	3	0.5
6.8. Other Specific Perinatal Conditions	3	0.5
7. Hypoxic Peripartum Death	16	2.9
8. Fetal Growth Restriction	37	6.8
9. Spontaneous Preterm	85	15.6
10. Unexplained Antepartum Death	100	18.3
11. No Obstetric Antecedent	0	0.0
Total	**546**	**100.0**

Table 9b: Number of Neonatal Deaths by Cause of Death (PSANZ PDC), WA 2002-04

PSANZ PDC	N	%
1. Congenital Abnormality	38	22.9
2. Perinatal Infection	12	7.2
3. Hypertension	1	0.6
4. Antepartum Haemorrhage	6	3.6
5.2. Diabetes	0	0.0
5.1 5.3-5.8. Maternal Conditions	1	0.6
6.1. Twin-twin	5	3.0
6.2. Fetomaternal Haemorrhage	1	0.6
6.3. Cord Abnormality	0	0.0
6.4. Uterine Abnormality	3	1.8
6.5. Birth Trauma	1	0.6
6.6. Trauma	0	0.0
6.7. Hydrops	0	0.0
6.8. Other Specific Perinatal Conditions	1	0.6
7. Hypoxic Peripartum Death	15	9.0
8. Fetal Growth Restriction	5	3.0
9. Spontaneous Preterm	67	40.4
11. No Obstetric Antecedent	10	6.0
Total	**166**	**100.0**

The most common categories of stillbirth were congenital abnormalities (n=145; 26.6%), unexplained antepartum deaths (n=100; 18.3%) and prematurity due to spontaneous preterm delivery (n= 85; 15.6%). The corresponding proportions in the period 2000-2001 were congenital abnormalities (26%), unexplained (22%) and spontaneous preterm birth (11%).

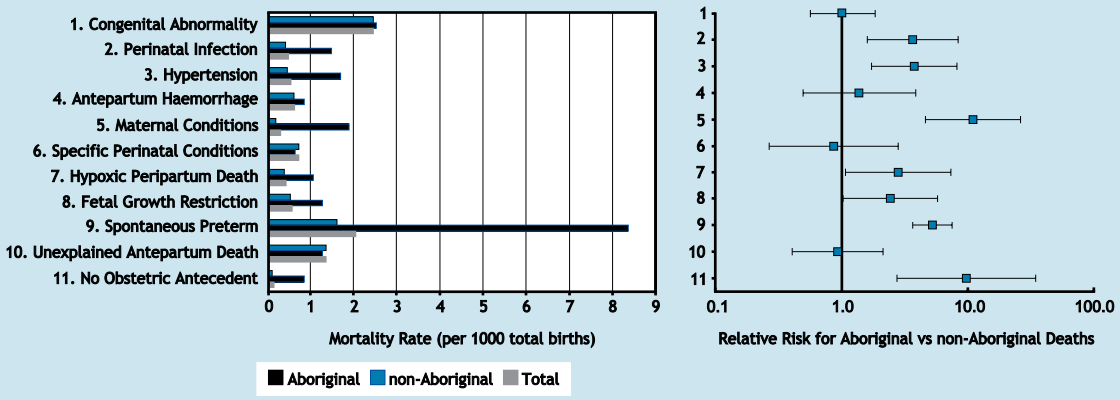
The leading causes of neonatal death by the PSANZ PDC were prematurity due to spontaneous preterm birth (n=67; 40.4%), congenital abnormality (n=38; 22.9%) and perinatal infection (n=12; 7.2%). In 2000-01, the proportions were prematurity (37%), congenital abnormality (28%) and perinatal infection (11%).

Table 9c: Number and Rate of Perinatal deaths by Cause of Death (PSANZ PDC) and Aboriginality, WA 2002-04

PSANZ-PDC	Aboriginality of Mother				Total		p-value
	non-Aboriginal		Aboriginal				
	N	Rate	N	Rate	N	Rate	
1. Congenital Abnormality	171	2.4	12	2.5	183	2.4	0.928
2. Perinatal Infection	28	0.4	7	1.5	35	0.5	**0.002**
3. Hypertension	31	0.4	8	1.7	39	0.5	**<0.001**
4. Antepartum Haemorrhage	42	0.6	4	0.8	46	0.6	0.525
5. Maternal Conditions	12	0.2	9	1.9	21	0.3	**<0.001**
6. Specific Perinatal Conditions	50	0.7	3	0.6	53	0.7	0.827
7. Hypoxic Peripartum Death	26	0.4	5	1.0	31	0.4	**0.034**
8. Fetal Growth Restriction	36	0.5	6	1.3	42	0.6	**0.043**
9. Spontaneous Preterm	112	1.6	40	8.3	152	2.0	**<0.001**
10. Unexplained Antepartum Death	94	1.3	6	1.3	100	1.3	0.872
11. No Obstetric Antecedent	6	0.1	4	0.8	10	0.1	**<0.001**
Total	**608**	**8.7**	**104**	**21.7**	**712**	**9.5**	**<0.001**

† Perinatal deaths comprise stillbirths plus neonatal deaths

Fig 3: Perinatal Mortality Rates by Cause of Death (PSANZ PDC) and Aboriginality, WA 2002-04



The leading causes of perinatal death were congenital abnormality (n=183; 25.7%) and prematurity due to spontaneous preterm birth (n=152; 21.3%).

The most common congenital abnormalities were chromosomal (n=41), central nervous system (n=38) and cardiovascular (n=33).

Perinatal infection was the primary cause of death in a small proportion of cases (n=35; 4.9%). Infections included Group B Streptococcal infection (n=9), E coli (n=1), Listeria monocytogenes (n=1), syphilis (n=1), “other” bacterial sepsis (n=10), viral infection (n=9) [cytomegalovirus (n=4), parvovirus (n=1), herpes simplex virus (n=2), rubella (n=1) and unspecified virus (n=1)], toxoplasmosis (n=1) and unspecified organism (n=3).

There were significantly higher perinatal mortality rates in Aboriginal births compared with non-Aboriginal births. In the Aboriginal group there were around ten-fold increased risks of perinatal death due to maternal conditions including diabetes mellitus (RR 11.00; 95% CI 4.63 -26.11) and of deaths without an obstetric antecedent (RR 9.77; 95% CI 2.76 - 34.62), five-fold increased risk of perinatal death due to prematurity (RR 5.26; 95% CI 3.66 - 7.56) and two to three-fold increased risks due to infection (RR 3.66; 95% CI 1.60 - 8.39), hypertension (RR 3.78; 95% CI 1.74 - 8.23), hypoxic peripartum insult (RR 2.82; 95% CI 1.08 - 7.34) and fetal growth restriction (RR 2.44; 95% CI 1.03 - 5.80).

4.1.3 Infant deaths by Cause of Death and Aboriginality, WA 2002-04

This section describes neonatal deaths and post-neonatal deaths according to the PSANZ NDC. As previously described, the PSANZ PDC classification system focuses on pregnancy related precedents to neonatal deaths, and differs to the PSANZ NDC that describes neonatal deaths according to the pathology in the neonate that led to death.

The PSANZ NDC was originally designed to describe neonatal deaths, but has been adopted by the Committee to describe post-neonatal deaths as well, also using the dual classification systems (PSANZ PDC and PSANZ NDC) for comparative purposes.

Tables 10a and 10b describe neonatal and post-neonatal deaths by cause of death, using PSANZ NDC, and Table 10c and Fig 4 show combined infant deaths by PSANZ NDC and Aboriginality. See Appendices III and IV (Section 7.3 and 7.4) for details of the numbers in each of the sub-categories of PSANZ NDC for 2002-04.

Table 10a: Number of Neonatal Deaths, by Cause of Death (PSANZ NDC), WA 2002-04

PSANZ NDC	N	%
1. Congenital Abnormality	37	22.3
2. Extreme Prematurity	42	25.3
3. Cardio-Respiratory Disorder	26	15.7
4. Infection	18	10.8
5. Neurological	24	14.5
6. Gastrointestinal Tract	5	3.0
7.1. SIDS	1	0.6
7.2-7.9. Other	13	7.8
Total	166	**100.0**

Table 10b: Number of Post-neonatal deaths by Cause of Death (PSANZ NDC), WA 2002-04

PSANZ NDC	N	%
1. Congenital Abnormality	22	23.4
2. Extreme Prematurity	3	3.2
3. Cardio-Respiratory Disorder	3	3.2
4. Infection	16	17.0
5. Neurological	1	1.1
6. Gastrointestinal Tract	1	1.1
7.1. SIDS	22	23.4
7.2-7.9. Other	26	27.7
Total	94	**100.0**

The leading causes of neonatal deaths by the neonatal classification system (PSANZ NDC) in the triennium 2002-04 were prematurity (n=42; 25.3% compared with 30% in 2000-01), congenital abnormalities (n=37; 22.3%, compared with 26% in 2000-01), cardiorespiratory disorders (n=26; 15.7% compared with 13% in 2000-01) and neurological disorders (n=24; 14.5%, compared with 13% in 2000-01) (Table 10a).

With the exception of congenital abnormalities, which contributed to just under one quarter of deaths in both age groups, the leading causes of post-neonatal deaths were quite different to those in the neonatal period (Table 10b). The leading category was the mixed group of “other” (n=26; 27.7%) which includes accidental asphyxia and injuries, followed by SIDS and congenital abnormalities (both categories n=22; 23.4%). For comparison, in 2000-01 the figures were SIDS 31%, congenital abnormalities 19% and “other” 21%.

There were 34 (13.1%) infant deaths due to infection, the involved organisms being bacterial (n=28), viral (n=3), fungal (n=1) and ‘other/unspecified’ (n=2).

Table 10c and Figure 4 show that there were significantly higher infant mortality rates due to prematurity (RR 7.4; 95% CI 3.98-13.75), infection (RR 6.16; 95% CI 2.94-12.88), SIDS (RR 9.50; 95% CI 4.11-21.95), and ‘undetermined/other causes’ (RR 6.57; 95% CI 3.33-12.98), in Aboriginal infants than in non-Aboriginal infants. The greatest disparity in risk was for SIDS.

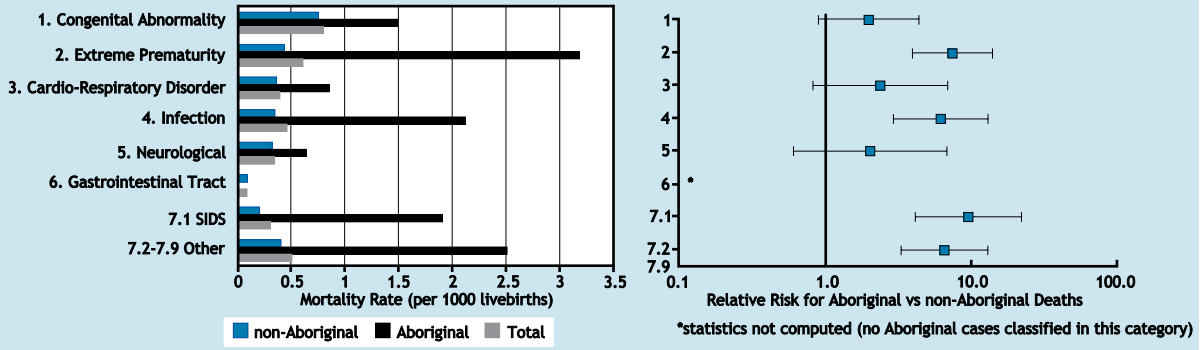
The findings in 2000-01 were similar, with Aboriginal infants having significantly increased risks of death due to infection, extreme prematurity and SIDS/other compared with non-Aboriginal infants. There was also a significantly increased risk of infant death due to congenital abnormalities in 2000-2001, whereas in 2002-04 the increased risk in this category did not reach statistical significance.

Table 10c: Number and Rate of Infant deaths by Cause of Death (PSANZ NDC) and Aboriginality, WA 2002-04

PSANZ NDC	Aboriginality of Mother				Total		p-value
	non-Aboriginal		Aboriginal				
	N	Rate	N	Rate	N	Rate	
1. Congenital Abnormality	52	0.7	7	1.5	59	0.8	0.088
2. Extreme Prematurity	30	0.4	15	3.2	45	0.6	**<0.001**
3. Cardio-Respiratory Disorder	25	0.4	4	0.8	29	0.4	0.111
4. Infection	24	0.3	10	2.1	34	0.5	**<0.001**
5. Neurological	22	0.3	3	0.6	25	0.3	0.256
6. Gastrointestinal Tract	6	0.1	0	0.0	6	0.1	*
7.1 SIDS	14	0.2	9	1.9	23	0.3	**<0.001**
7.2-7.9 Other	27	0.4	12	2.5	39	0.5	**<0.001**
Total	**200**	**2.9**	**60**	**12.7**	**260**	**3.5**	**<0.001**

*statistics not computed (no Aboriginal cases in this category)

Fig 4: Infant Mortality Rates by Cause of Death (PSANZ NDC) and Aboriginality, WA 2002-04



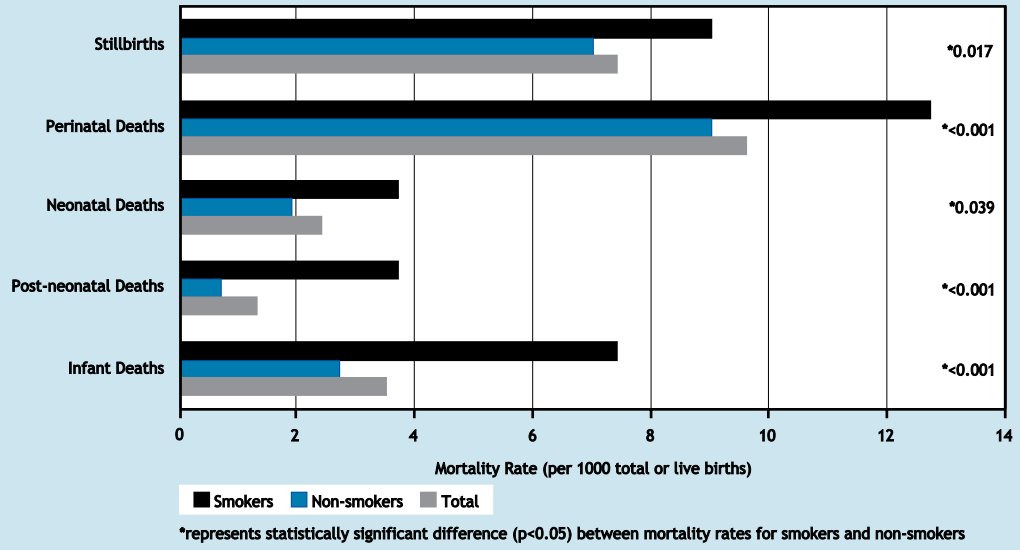
4.1.4 Stillbirths and Infant Deaths by Maternal Smoking Status, WA 2002-04

Smoking status was recorded on all midwifery notification forms (100% data collection) in the triennium 2002-04, compared with 99% in the years 2000-01. In the time period 2002-04, 18.7% of mothers (16.7% of non-Aboriginal women and 48.3% of Aboriginal women) giving birth were smokers, compared with 21.3% in 2000-01.

In 2002-04, 28.0% of mothers experiencing a stillbirth or infant loss were smokers, compared with 30.8% of mothers in 2000-01. The proportion of mothers who smoked was higher amongst those who experienced an infant death (39.2%) compared with those who experienced a stillbirth (22.7%).

Figure 5 illustrates the significantly increased risks of stillbirth and infant death related to maternal smoking in WA in 2002-04. The perinatal mortality rate was 12.7 in smoking mothers and 9.0 in non-smokers. The infant mortality rate was 7.4 in mothers who smoked compared with 2.7 in non-smoking mothers. The greatest disparity in rates was in the post-neonatal period, where the mortality rate was five-fold higher in infants of smoking mothers compared with infants of non-smoking mothers (IMR 3.7 compared with 0.7).

Fig 5: Rates of Stillbirths, Perinatal, Neonatal, Post-neonatal and Infant Mortality by Maternal Smoking Status, WA 2002-04



There were significantly more perinatal deaths due to fetal growth restriction, prematurity, spontaneous preterm labour and 'no obstetric antecedent' in births to smoking mothers compared to non-smoking mothers (Table 11a).

Table 11a: Number and Rate of Perinatal Deaths by Cause of Death (PSANZ PDC) and Maternal Smoking Status, WA 2002-04

PSANZ PDC	Smoking During Pregnancy				p-value
	No		Yes		
	N	Rate	N	Rate	
1. Congenital Abnormality	152	2.5	31	2.2	0.534
2. Perinatal Infection	24	0.4	11	0.8	0.059
3. Hypertension	32	0.5	7	0.5	0.900
4. Antepartum Haemorrhage	33	0.6	13	0.9	0.102
5. Maternal Conditions	14	0.2	7	0.5	0.201
6. Specific Perinatal Conditions	39	0.7	14	1.0	0.155
7. Hypoxic Peripartum Death	26	0.4	5	0.4	0.710
8. Fetal Growth Restriction	26	0.4	16	1.2	**0.002**
9. Spontaneous Preterm	109	1.8	43	3.1	**0.003**
10. Unexplained Antepartum Death	79	1.3	21	1.5	0.562
11. No Obstetric Antecedent	3	0.1	7	0.5	**<0.001**
Total	**537**	**9.0**	**175**	**12.7**	**<0.001**

Table 11b: Number and Rate of Infant Deaths by Cause of Death (PSANZ NDC) and Maternal Smoking Status

PSANZ PDC	Smoking During Pregnancy				p-value
	No		Yes		
	N	Rate	N	Rate	
1. Congenital Abnormality	46	0.8	13	0.9	0.513
2. Extreme Prematurity	28	0.5	17	1.2	**0.002**
3. Cardio-Respiratory Disorder	21	0.4	8	0.6	0.225
4. Infection	18	0.3	16	1.2	**<0.001**
5. Neurological	20	0.3	5	0.4	0.868
6. Gastrointestinal Tract	4	0.1	2	0.1	0.370
7.1 SIDS	6	0.1	17	1.2	**<0.001**
7.2-7.9 Other	15	0.3	24	1.8	**<0.001**
Total	**158**	**2.7**	**102**	**7.4**	**<0.001**

There were significantly higher infant mortality rates due to prematurity, infection and SIDS/ other in infants of smoking mothers, compared with infants of non-smoking mothers (Table 11b).

4.1.5 Mortality Rates by Maternal Age and Aboriginality, WA 2002-04

Table 12: Number and Rate of Stillbirths, Neonatal and Post-neonatal Deaths, by Maternal Age and Aboriginality, WA 2002-04

Maternal Age	Stillbirths				Neonatal Deaths				Post-neonatal Deaths			
	non-Aboriginal		Aboriginal		non-Aboriginal		Aboriginal		non-Aboriginal		Aboriginal	
	N	Rate	N	Rate	N	Rate	N	Rate	N	Rate	N	Rate
<=19	24	7.9	19	16.6	8	2.6	6	5.3	6	2.0	1	0.9
20-34	352	6.5	44	13.2	96	1.8	26	7.9	55	1.0	22	6.7
>=35	101	7.7	6	18.7	27	2.1	3	9.5	8	0.6	2	6.3
Total	**477**	**6.8**	**69**	**14.4**	**131**	**1.9**	**35**	**7.4**	**69**	**1.0**	**25**	**5.3**

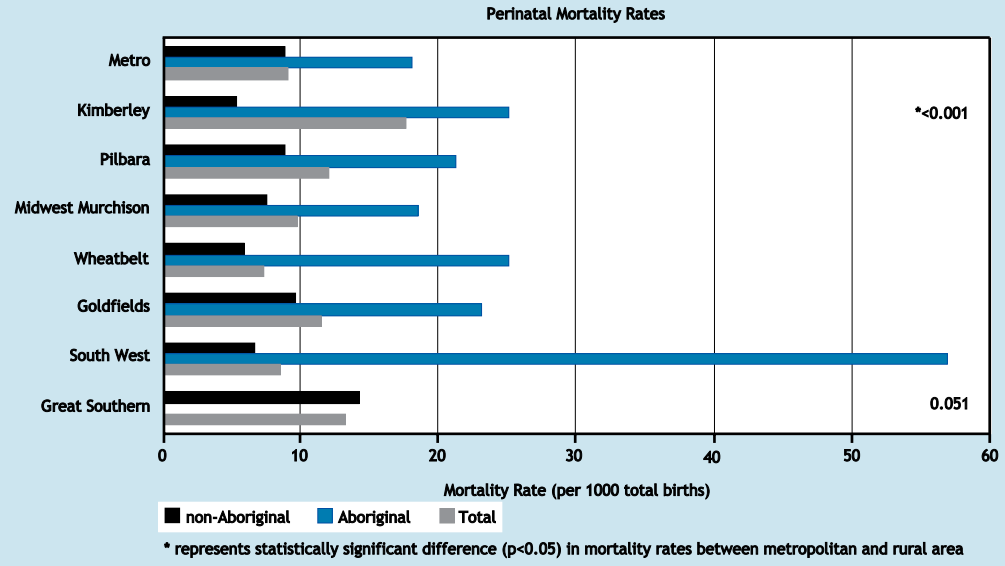
During the time period 2002-04, the mean maternal age for all mothers was 29.2 years, being 29.0 years in 2002 and 29.3 years in the years 2003 and 2004. The mean maternal age for non-Aboriginal mothers was 29.5 years and for Aboriginal mothers was 24.4 years.

In Table 12 the significant disparity in stillbirth and infant mortality rates between non-Aboriginal and Aboriginal births is again seen. There were slightly higher stillbirth and neonatal mortality rates in non-Aboriginal women at the extremes of reproductive life (under-20 years and over-34 years age groups), and higher stillbirth rates in Aboriginal women at the extremes of reproductive life. Smaller numbers of Aboriginal neonatal deaths and Aboriginal and non-Aboriginal post-neonatal deaths to mothers in the under-20 years and over-34 years age groups precluded conclusions about these groups.

4.1.6 Mortality Rates by Maternal Residence, WA 2002-04

Women living in the metropolitan area accounted for 74.2% of all births (n=55,656 metro births; n=74,995 total births).

Fig 6: Perinatal and Post-neonatal Mortality Rates by Maternal Residence, WA 2002-04



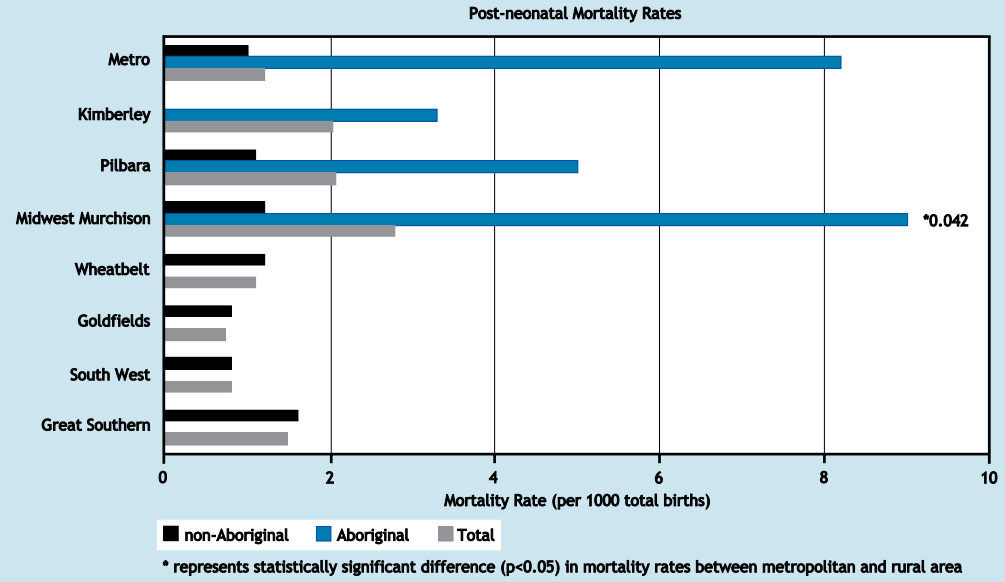


Figure 6 shows significant differences in mortality rates for different geographic locations within Western Australia. These figures are derived using maternal postcodes for residence, and do not always reflect where births occurred.

The perinatal mortality rates for women who resided in the Kimberley and the Great Southern were significantly higher than the metropolitan rate. These findings were different to those in 2000-01 when the perinatal mortality rates for the Goldfields, Mid-West & Gascoyne, Pilbara and Kimberley regions were all higher than the Metropolitan, Central Wheatbelt and Southern parts of the state. The perinatal mortality rate in the Great Southern changed significantly, being significantly lower than the Metropolitan rate in 2000-01, and significantly higher in 2002-04.

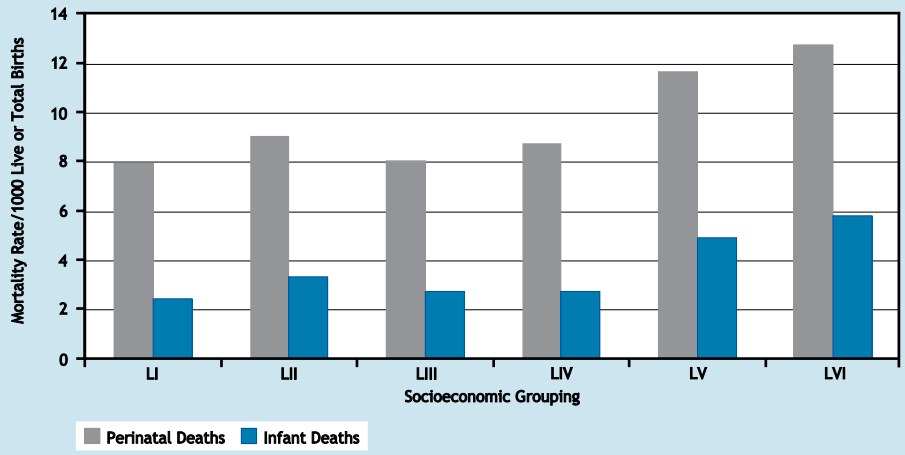
In 2002-04 the only locality where the post-neonatal mortality rate was significantly higher than the Metropolitan rate was in births to women who lived in the Midwest-Murchison area. This differed to findings in 2000-01 when there were higher rates in the Goldfields, Mid-West & Gascoyne and Kimberley regions.

Racial differences are also shown in Figure 6. Perinatal and infant mortality rates were very high in the Aboriginal population, but the small proportion of Aboriginal mothers (6.4%) compared with non-Aboriginal mothers mean that the total numbers of deaths are small, and there were no post-neonatal Aboriginal deaths in some areas in the years 2002-04.

4.1.7 Mortality Rates and Socioeconomic Factors, WA 2002-04

Figure 7 shows further assessment of socioeconomic distributions of births and deaths, using maternal postcode as a marker for socioeconomic status. The Socio-economic Indexes for Areas (SEIFA) published by the ABS[16] for each Census Collection District in WA was used to allocate each postcode to a Socioeconomic Level. The postcodes are grouped so that Level I represents 'least disadvantage' and Level VI represents 'greatest disadvantage'.

Fig 7: Perinatal & Infant Mortality Rates by Socioeconomic Status, WA 2002-04



In general, both the perinatal and the infant mortality rate increased as the socioeconomic disadvantage increased.

4.1.8 Preterm deliveries by Neonatal Nursery Facility, WA 2002-04

Table 13: Number of Preterm Births by Hospital Establishment, WA 2002-04.

	KEMH		Other Metro	Rural	Total
	N	% of total	N	N	N
<28 weeks	521	85.0%	49	43	613
<30 weeks	713	85.4%	69	53	835
<32 weeks	1054	87.2%	87	68	1209
<34 weeks	1600	82.2%	252	95	1947
<1000g	542	84.3%	57	44	643
< 1500g	933	84.3%	104	70	1107

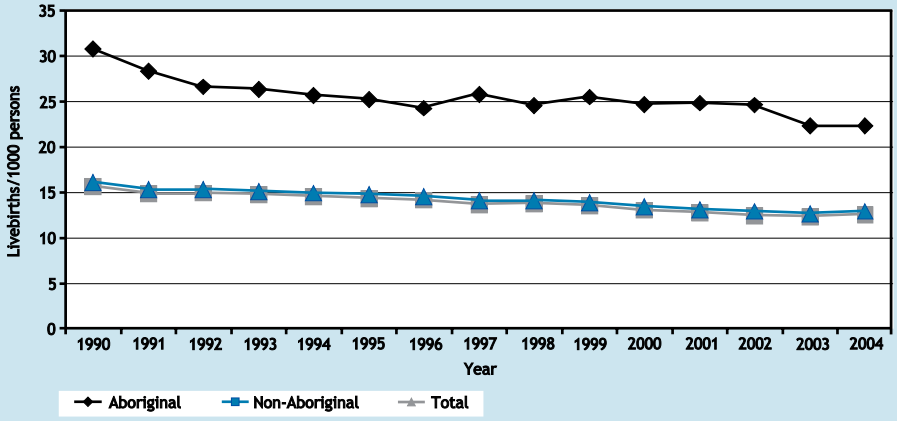
Table 13 shows the number of preterm births that occurred in the state's only tertiary obstetric hospital, King Edward Memorial Hospital (KEMH), other metropolitan hospitals and rural hospitals. The major proportion of preterm deliveries occurred at KEMH, with 85% of babies of less than 28 weeks gestational age and 84% of babies less than 1,000g birthweight being delivered at this hospital. These proportions were similar to those in 2000-01.

4.1.9 Trends in Birth Rates and Mortality Rates, WA 1990-2004

Figures 8-15 show trends in births, stillbirths, and infant deaths from 1990-2004.[2]

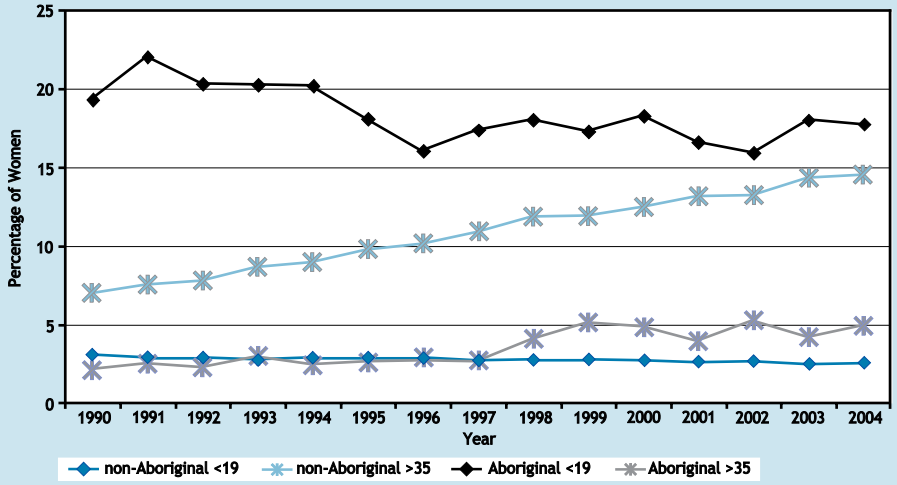
Both Aboriginal and non-Aboriginal birth rates have decreased in this 15-year period (Figure 8).

Fig 8: Trends in Birth Rates by Aboriginality, WA 1990-2004



In the 15 years 1990-2004 an increasing proportion of mothers have been aged over 35 years, and this has been most marked for the non-Aboriginal population (Figure 9). The proportion of non-Aboriginal teenage mothers has been similar over this time period, and there has been a small increase in the proportion of Aboriginal teenage mothers.

Fig 9: Trends in Proportion of Mothers at Extremes of Reproductive Age, by Aboriginality, WA 1990-2004



Perinatal mortality rates have continued to decline gradually. This reduction has been statistically significant over the last 14 yrs ($p=0.010$), due to a large reduction in the neonatal mortality rate ($p<0.001$), but there has not been a statistically significant reduction in the stillbirth rate over this time ($p=0.672$) (Figure 10).

Fig 10: Trends in Perinatal Mortality Rates, WA 1990-2004

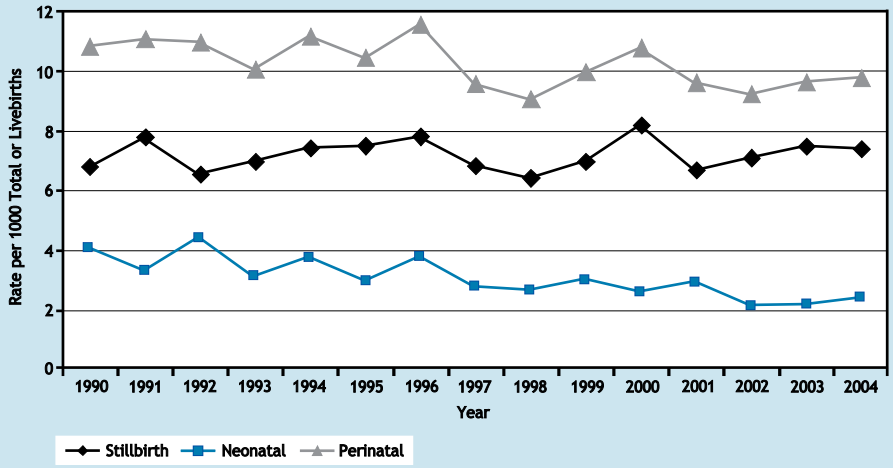
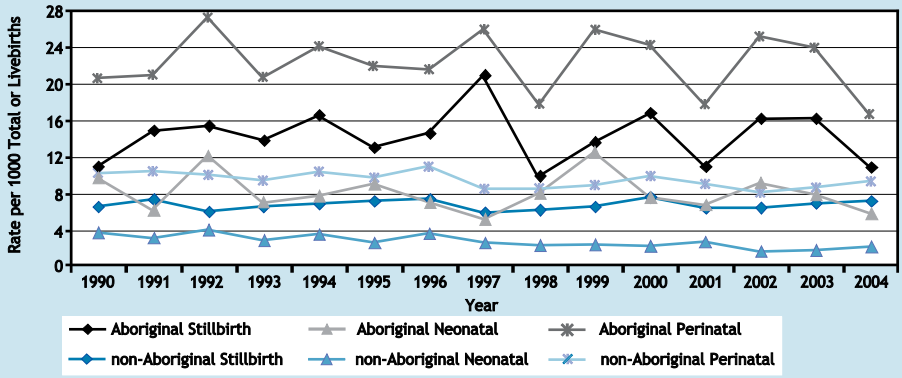
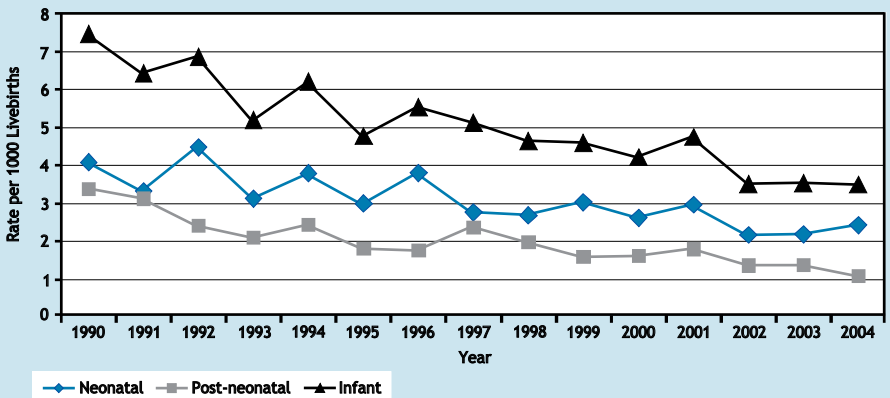


Fig 11: Trends in Perinatal Mortality Rates by Aboriginality, WA 1990-2004



There has been little change in the perinatal mortality rates in both Aboriginal and non-Aboriginal people over the past 15years (Figure 11). By contrast, neonatal, post-neonatal and overall infant mortality rates in non-Aboriginal and Aboriginal people have all significantly reduced (Figures 12 and 13).

Fig 12: Trends in Infant Mortality Rates, WA 1990-2004



Note: mortality rates for neonatal, post-neonatal and infant deaths have significantly reduced over time (p-values <0.001)

Fig 13: Trends in Infant Mortality Rates, by Aboriginality, WA 1990-2004

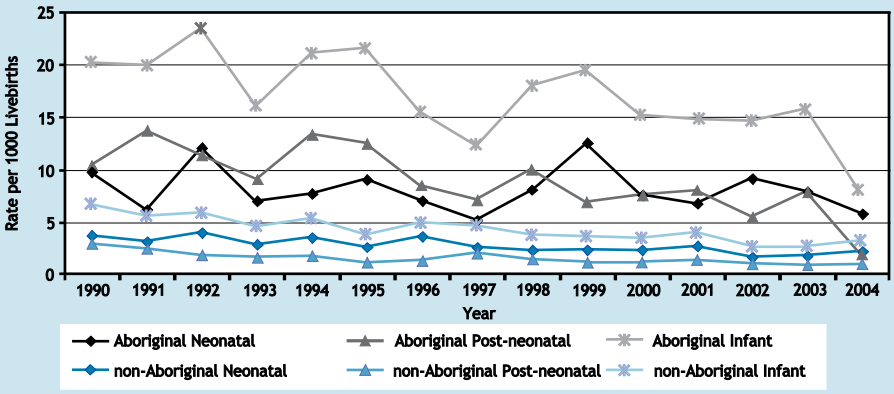
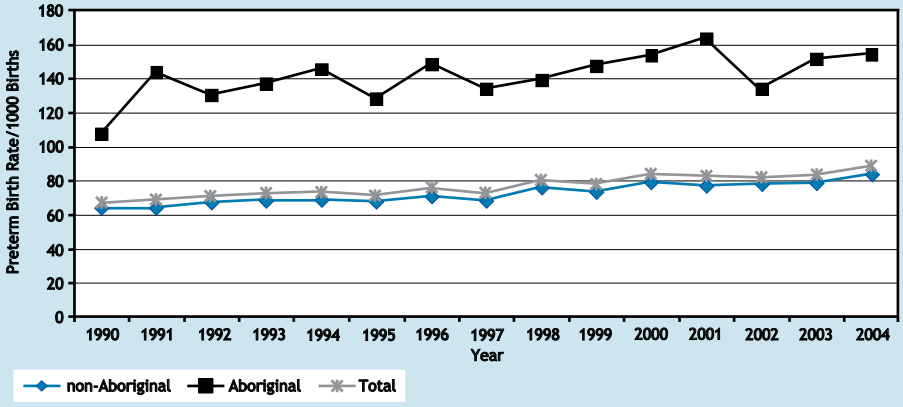


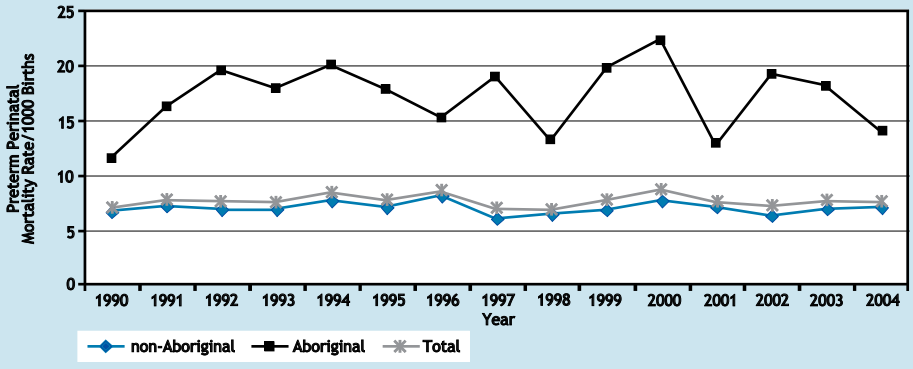
Fig 14: Trends in Preterm Birth Rates, by Aboriginality, WA 1990-2004



Note: Aboriginal and non-Aboriginal preterm birth rates have significantly increased over time (p=0.009 and p<0.001 respectively)

Aboriginal mothers had higher rates of preterm births than non-Aboriginal mothers. In addition, Aboriginal and non-Aboriginal preterm birth rates have both increased significantly over the period 1990-2004, as shown in Figure 14. Aboriginal preterm births increased by an average of 1.9 preterm births/1,000 births per year (1990-2004) and non-Aboriginal preterm births increased by an average of 1.3 preterm births/1,000 births per year; these differences are statistically significant (p=0.009 and p<0.001 respectively).

Fig 15: Trends in Preterm Perinatal Mortality Rates, WA 1990-2004



Note: Aboriginal and non-Aboriginal preterm perinatal mortality rates have not significantly changed over time (p=0.786 and p=0.755 respectively)

Whilst preterm birth rates have increased, preterm perinatal mortality rates in both Aboriginal and non-Aboriginal women have not significantly changed over this time period (p=0.786 and p=0.755 respectively), as shown in Figure 15.

4.2 Cases Investigated by the PIMC, WA 2002-04

4.2.1 Investigated Deaths with Preventable Medical Factors - Overview, WA 2002-04

The Committee was directed to investigate 445 of the total 806 deaths in the triennium 2002-04, comprising those stillbirths and infant deaths post 26 weeks gestational age, and excluding known terminations. The Committee investigated 256 of the 546 stillbirths, 98 of 166 the neonatal deaths, and 91 of the 94 post-neonatal deaths. There were 372 deaths in non-Aboriginal mothers and 73 of the deaths were in Aboriginal mothers. There were six investigated deaths (five stillbirths and one neonatal death) that were found to have been late terminations of pregnancy for severe congenital abnormalities. There were a further twelve post-26 week gestation pregnancy terminations in this triennium that were not referred for investigation.

There were eight investigated cases (3 stillbirths, 1 neonatal and 4 post-neonatal deaths) in births of less than 26 weeks gestation.

As a result of the investigations, there were minor corrections made to the HIC dataset obtained from midwifery notification forms, such as corrections of gestational age.

The Committee scored the cases by a 6 point 'preventability score'[12], where 1 = virtually no evidence for preventability and 6 = virtually certain evidence for preventability (Table 14). Cases with scores >=4 were considered potentially avoidable deaths. Cases with scores of 2 or 3 had one or more preventable medical factors but were thought unlikely to have been avoidable deaths.

Table 14: Preventability Scores and Type of death, Investigated Cases, WA 2002-04

Preventability Score	Stillbirths	Neonatal Deaths	Post-neonatal Deaths	Total
1	224	68	88	380
2	15	16	2	33
3	5	3	0	8
4	5	5	1	11
5	2	3	0	5
6	0	2	0	2
Total	**251**	**97**	**91**	**439**

Total is 439 investigated cases, due to the exclusion of six cases of pregnancy termination.

Of the 445 cases investigated, the Committee coded 59 cases (27 stillbirths, 29 neonatal deaths and 3 post-neonatal deaths) as having any (even slight-to-modest) evidence of preventability (preventability score >=2), and 18 cases as likely to have been avoidable (preventability score >=4).

Comment:

The peer review process of this Perinatal and Infant Mortality Committee showed that in the triennium 2002-04, 87% of deaths met the Committee's expectations of appropriate medical care, and 96% of deaths were considered unavoidable in a medical context.

Table 15 describes the types of preventable medical factors that were identified in the 59 cases with some evidence of preventability, categorised broadly as 'systems' or 'medical care' factors. There were 15 cases with any 'systems' factor identified and 50 cases with any 'medical care' factor identified. Cases may have been coded with more than one type of preventable factor. Six cases had both 'systems' and 'medical care' factors identified.

Table 15: Preventable 'Systems' and 'Medical Care' Factors, Investigated Cases, WA 2002-04

	Number of Cases
Systems factors:	**15**
Significant delay in assessment or treatment	4
Delay in transfer to other unit	2
Staffing problem	1
Equipment problem	1
Follow-up of abnormal test result	1
Significant delay in performance of clinical investigation	1
Co-sleeping of mother and baby in hospital	4
Medical Care factors:	**50**
Management of antenatal problems (other than obstetric delivery skills)	21
Medical care of baby (other than resuscitation of the newborn)	11
Identification of abnormal fetal heart rate patterns on CTG trace	5
Fetal heart rate monitoring not performed when indicated	4
Technical skills for obstetric delivery	2
Technical skills for resuscitation of newborn	3
Earlier referral indicated	6
Intrapartum management decisions	10
Postnatal depression not identified	1

*Note: cases may be coded more than once.

4.2.2 Investigated Deaths with Preventable Medical Factors – Systems factors, WA 2002-04

"Systems problems" are not always ascertainable from the medical notes. For example there is no documentation regarding staff work rosters. It is recognized that the detection of systems factors is underestimated by the methodology used in this work.

Examples of identified systems factors:

* *A term baby born in a rural area following prolonged rupture of membranes developed early respiratory distress. Antibiotic therapy was administered, and Western Australian Neonatal Transport Service (WANTS) evacuation was arranged a short time later. Another priority case for Royal Flying Doctor Service (RFDS) led to a delay of several hours before the arrival of WANTS. Despite intensive resuscitation attempts the baby died in the first day of life. Earlier specialised help may have improved the outcome. Earlier communication with WANTS may have led to more rapid evacuation.*
* *An early neonatal death occurred in a preterm, growth restricted baby delivered by an elective Caesarean section in a small hospital. The baby's condition deteriorated, requiring full resuscitation and transfer to a level III unit, with resultant delays in appropriate high-intensity care.*

Comments:

(see Recommendation 13):

- **Care should be taken to deliver babies likely to require special nursery care in an appropriately staffed and equipped hospital.**
- **Referring staff are encouraged to anticipate transfer, phone early, and closely liaise with transport staff, to assist in prioritisation of transport needs.**

4.2.3 Investigated Deaths with Preventable Medical Factors - Medical Care Factors, WA 2002-04

The vast majority of deaths were found to be unavoidable in a medical context.

There were 21 cases (15 Caucasian, six Aboriginal women) identified with preventable medical factors related to antenatal management. In eight of these 21 cases there were maternal behavioural factors (other than smoking) that may also have been contributory.

There were 10 cases (eight Caucasian, two Aboriginal women) where, in retrospect, better decisions may have been made in the management of labour. Improved CTG application and interpretation may have assisted in three of these cases.

There were four cases where the addition of intrapartum CTG monitoring, in keeping with The Royal Australian and New Zealand College of Obstetricians and Gynaecologists (RANZCOG) guidelines[17] may have improved the outcome.

In five cases attending practitioners or midwives did not identify important CTG features. In one of these cases the doctor had requested that the trace be faxed to him. This was not done, and resulted in a late detection of an abnormal fetal heart rate pattern.

There were 11 cases (nine Caucasian, two Aboriginal women) with preventable medical factors related to the medical care of an infant, with two of these cases also coded for maternal behavioural factors (other than smoking).

There were six cases where earlier referral may have altered the outcome.

4.2.4 Investigated Intrapartum Deaths with Preventable Medical Factors, WA 2002-04

In the investigated cases for the 2002-04 triennium, there were 30 intrapartum stillbirths. Of these, 23 had no preventable factors identified in the medical care received. Seven cases had preventability scores of >=2, and three of these had preventability scores >=4.

Table 16 describes some issues identified by the investigations that arose in the management of women in labour.

Table 16: Preventable factors in Intrapartum Management, Investigated Cases, WA 2002-04

- A delay in treatment occurred due to a communication breakdown when a doctor was on leave and hospital staff were unaware of this.
- Intermittent rather than continuous fetal heart rate monitoring following induction of labour with prostaglandins was associated with a delay in the recognition of fetal distress in two cases.
- Intermittent rather than continuous fetal heart rate monitoring was performed in a patient on treatment for hypertension. There was fetal tachycardia followed by an abrupt loss of the fetal heartbeat, without earlier recognition of significant fetal compromise.
- There were problems in the recognition of sinister patterns of fetal heart rate traces.
- There was delay in delivery by Caesarean section in the presence of significant fetal distress in two cases.
- Prolonged maternal hypotension following the insertion of an epidural may have compromised the fetus.
- There was rapid fetal demise in the presence of maternal fever and variable decelerations on CTG monitoring, highlighting the danger of fetal sepsis particularly in labour.
- Variable adherence to routine protocols, such as checking maternal blood pressure after epidural, and routine CTG monitoring following vaginal administration of prostaglandin gel were noted.

Comments:

- **Clear communication between staff members is a high priority.**
- **Improved knowledge of CTG monitoring techniques and interpretation is recommended.**
- **Sepsis may lead to very rapid fetal compromise.**

Sections 4.2.1 - 4.2.3 considered types of preventable medical factors according to systems factors and medical care factors, and section 4.2.4 considered modifiable factors in intrapartum deaths. Section 4.2.5 presents preventable medical factors in another manner, according to cause of death, to help identify specific areas where future educational attention may be of most benefit.

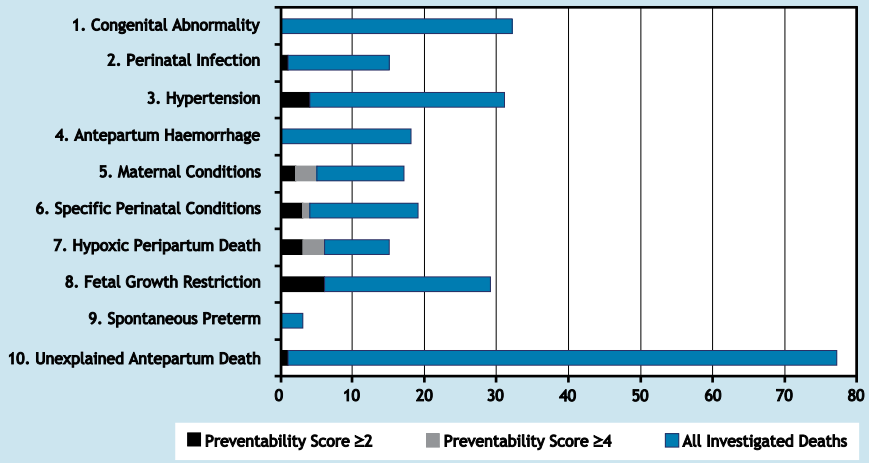
4.2.5 Investigated Stillbirths by Cause of Death (PSANZ PDC) and Preventability Score, WA 2002-04

Table 17a and Figure 16a show the investigated stillbirths (n=256) by cause of death, and the proportion of cases with any preventable medical factors (n=27; 10.5%).

Table 17a: Number of Stillbirths by Cause of Death (PSANZ PDC), Preventability Score and Aboriginality, Investigated Cases, WA 2002-04

PSANZ PDC	Total		Preventability Score			Aboriginality of Mother			
			>=4	>=2		non-Aboriginal		Aboriginal	
	N	%	N	N	%	N	%	N	%
1. Congenital Abnormality	32	12.5	0	0	0.0	32	14.5	0	0.0
2. Perinatal Infection	15	5.9	0	1	6.7	10	4.5	5	14.3
3. Hypertension	31	12.1	0	4	12.9	23	10.4	8	22.9
4. Antepartum Haemorrhage	18	7.0	0	0	0.0	17	7.7	1	2.9
5. Maternal Conditions	17	6.6	3	5	29.4	9	4.1	8	22.9
6. Specific Perinatal Conditions	19	7.4	1	4	21.1	17	7.7	2	5.7
7. Hypoxic Peripartum Death	15	5.9	3	6	40.0	13	5.9	2	5.7
8. Fetal Growth Restriction	29	11.3	0	6	20.7	25	11.3	4	11.4
9. Spontaneous Preterm	3	1.2	0	0	0.0	2	0.9	1	2.9
10. Unexplained Antepartum Death	77	30.1	0	1	1.3	73	33.0	4	11.4
11. No Obstetric Antecedent	0	0.0	0	0	0.0	0	0.0	0	0.0
Total	256	100.0	7	27	10.5	221	100.0	35	100.0

Fig 16a: Number of Stillbirths by Cause of Death (PSANZ PDC) and Preventability Score, Investigated Cases, WA 2002-04



The cause of death categories with the highest proportion of stillbirths with preventable medical factors (preventability score >=2) were peripartum hypoxia (six of 15 stillbirths; 40.0%), maternal conditions (five of 17 stillbirths; 29.4%), specific perinatal conditions (four of 19 stillbirths; 21.1%) and fetal growth restriction (six of 29 stillbirths; 20.7%).

Each PSANZ PDC category is considered in detail, from that associated with the highest number of deaths to that with the lowest.

There were 77 cases (30.1%) classified as unexplained antepartum stillbirths.

One of these stillbirths had a preventability score >=2.

There were 32 stillbirths (12.5%) attributed to congenital abnormalities. None of these had a preventability score >=2.

There were 31 stillbirths (12.1%) in mothers with hypertension.

Four of these had a preventability score >=2.

Examples of cases with low-level preventability scores:

* *A woman with pre-eclampsia in the third trimester was treated with antihypertensive medication. A decision to induce labour was changed due to an unstable lie and fetal death occurred at 38 weeks.*
* *A young multiparous woman with a history of previous severe early-onset growth restriction presented in the third trimester with reduced fetal movements and borderline hypertension. A CTG was non-reactive but non sinister. She was advised to complete a kick chart, and sent home. She presented two days later with fulminant pre-eclampsia and a fetal death.*
* *A high-risk woman with past severe pre-eclampsia had a midwifery outpatient check in the third trimester. There was normotensive proteinuria with no record of fundal height. She subsequently presented with a fetal death attributed to growth restriction.*

There were a further six cases coded with no medical preventability where stillbirth occurred in patients on methyldopa treatment for hypertension.

There were 29 stillbirths (11.3%) in growth restricted babies. Six of these had preventability scores of 2 or 3.

There were 19 stillbirths (7.4%) related to specific perinatal conditions.

Four of these had preventability scores >=2.

Example:

* *A young Aboriginal woman with a twin pregnancy had documented discordant growth, without specialist referral. Twin 2 died at 36 weeks, weighing 1.4kg.*

Comments:

(see Recommendation 9):

- **Guidelines for the management of twin pregnancies are available:**
  King Edward Memorial Hospital (KEMH) guidelines for obstetrics: http://kemh.health.wa.gov.au/development/manuals/sectionb/index.htm
- **Chorionicity should be determined at 12 weeks gestation by ultrasound.**
- **Careful monitoring of fetal well-being is required in twin pregnancies.**
- **Early ultrasound assessment should identify twin pregnancies at increased risk of twin to twin transfusion syndrome. Those with monochorionic twin pregnancies should have ultrasound surveillance for fetal growth at 18, 24, 27, 30, 33 and 36 weeks gestation. Those with dichorionic pregnancies should have ultrasound monitoring at 18, 26, 30, 33 and 36 weeks gestation.**
- **Discordant growth in twins is an indication for specialist referral.**

There were 18 deaths (7.0%) related to antepartum haemorrhage.

None of these stillbirths had preventable medical factors identified.

There were 17 deaths (6.6%) related to maternal conditions.

Five of these had preventability scores >=2, and were all associated with maternal diabetes mellitus.

Examples: Diabetes mellitus:

* *A young Aboriginal woman with poorly controlled diabetes and binge alcohol drinking had no treatment and no monitoring of fetal wellbeing. Fetal death occurred at 38 weeks.*
* *An Aboriginal woman with severe gestational diabetes had no specialist consultation although insulin therapy was commenced at 37 weeks. There was no monitoring to assess fetal wellbeing. Fetal death occurred at 38 weeks.*
* *An obese woman with gestational diabetes was not advised to commence blood glucose monitoring until near term. There was third trimester ultrasound evidence of macrosomia, but no monitoring of fetal wellbeing, and fetal death occurred at 39 weeks.*

Comments:

(see Recommendation 7):

Routine management of patients with diabetes in pregnancy should involve:

- **education and dietary advice.**
- **monitoring blood glucose levels to assess glycaemic control.**
- **specialist consultation/ liaison for those patients with poor glycaemic control, with earlier rather than later initiation of insulin and perhaps oral hypoglycaemic agents.**
- **routine monitoring of fetal wellbeing, such as ultrasound assessment for fetal macrosomia.**

There were 15 stillbirths (5.9%) with hypoxic peripartum insult.

Six of these had preventability scores >=2.

These were documented intrapartum deaths (see section 4.2.8).

There were 15 stillbirths (5.9%) due to infection. One of these cases had a preventability score of 2.

There were 3 deaths due to spontaneous preterm birth. None of these cases had any identified preventable medical factors.

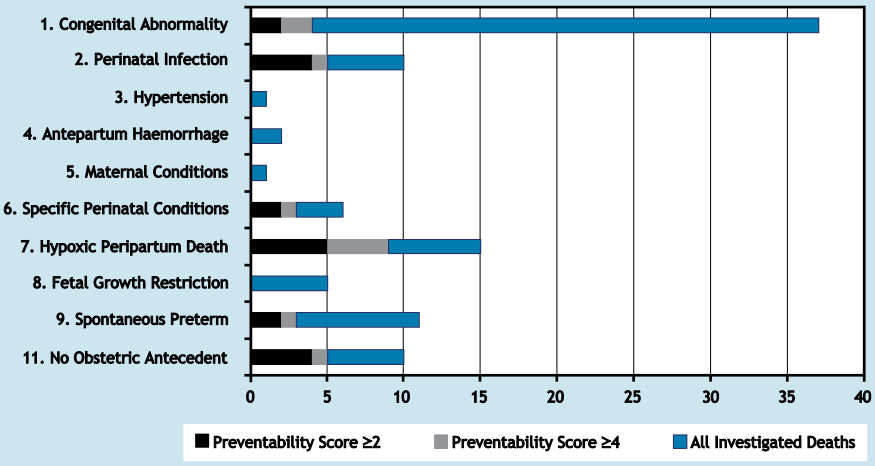
4.2.6 Investigated Neonatal Deaths by Cause of Death (PSANZ PDC) and Preventability Score, WA 2002-04

Table 17b and Figure 16b show investigated neonatal deaths (n=98) by cause of death, and the proportion of cases with any preventable medical factors (n=29; 29.6%).

Table 17b: Number of Neonatal Deaths by Cause of Death (PSANZ PDC), Preventability Score and Aboriginality, Investigated Cases, WA 2002-04

PSANZ PDC	Total		Preventability Score			Aboriginality of Mother			
			>=4	>=2		non-Aboriginal		Aboriginal	
	N	%	N	N	%	N	%	N	%
1. Congenital Abnormality	37	38.1	2	4	10.8	33	39.3	4	28.6
2. Perinatal Infection	10	10.3	1	5	50.0	9	10.7	1	7.1
3. Hypertension	1	1.0	0	0	0.0	1	1.2	0	0.0
4. Antepartum Haemorrhage	2	2.1	0	0	0.0	2	2.4	0	0.0
5. Maternal Conditions	1	1.0	0	0	0.0	1	1.2	0	0.0
6. Specific Perinatal Conditions	6	6.2	1	3	50.0	6	7.1	0	0.0
7. Hypoxic Peripartum Death	15	15.5	4	9	60.0	12	14.3	3	21.4
8. Fetal Growth Restriction	5	5.2	0	0	0.0	5	6.0	0	0.0
9. Spontaneous Preterm	11	11.3	1	3	27.3	9	10.7	2	14.3
10. No Obstetric Antecedent	10	10.3	1	5	50.0	6	7.1	4	28.6
Total	**98**	**100.0**	**10**	**29**	**29.6**	**84**	**100.0**	**14**	**100.0**

Fig 16b: Number of Neonatal Deaths by Cause of Death (PSANZ PDC) and Preventability Score, Investigated Cases, WA 2002-04



The cause of death categories with the highest proportion of deaths with preventable medical factors (preventability score >=2) were hypoxic peripartum deaths (nine of 15 neonatal deaths, 60%), perinatal infection (five of ten neonatal deaths, 50%), specific perinatal conditions (three of six neonatal deaths, 50%) and deaths with no obstetric antecedent (five of ten neonatal deaths, 50%), such as postnatally acquired infection.

Each PSANZ PDC category is considered in detail, from that associated with the highest number of deaths to that with the lowest:

There were 37 deaths (38%) attributed to congenital abnormalities, and four of these cases had preventability scores >=2.

There were seven deaths in patients who underwent surgery for congenital cardiac disease. Six of these cases were given preventability scores = 1, and a single case was scored as having slight to modest preventability (preventability score = 2). The Committee commented that it did not have the expertise to properly assess preventability in this highly specialized area and noted that regular internal audit takes place in this area of paediatric surgery.

There were 15 deaths (15.5%) from hypoxic peripartum insult and nine of these cases had preventability scores >=2.

Example:

An early neonatal death followed a significant delay in the decision to perform a Caesarean section in the presence of significant intrapartum fetal compromise (bradycardia, meconium amniotic fluid, adverse CTG changes) and failure to progress.

Comments:

In the presence of sinister CTG signs or other signs of fetal distress, fetal well-being should be assessed by fetal scalp pH monitoring or delivery should be expedited.

Example: Trauma from a difficult instrumental delivery:

An unexpectedly large baby was delivered with difficulty by forceps, following multiple failed attempts with a vacuum extractor. The baby had low Apgar scores and became profoundly shocked with a subgaleal haemorrhage, dying in the neonatal period.

Comments:

(see Recommendation 12)

- **Consider Caesarean section rather than persisting with difficult instrumental vaginal deliveries.**
- **Significant blood loss can occur from birth trauma (e.g. sub-galeal haemorrhage) requiring rapid treatment with volume administration and sometimes blood transfusion.**

There were 11 deaths (11.3%) due to prematurity (spontaneous preterm birth).

Three of these had identified preventable medical factors.

There were 10 deaths (10.3%) from perinatal infection. Five of these had preventability scores >=2.

Examples:

* *A term Aboriginal baby was born in the presence of thick meconium amniotic fluid, and had a respiratory rate of over 70 breaths per minute from birth. Swabs were taken but antibiotics were not given. Ongoing tachypnoea was documented, with apparent lack of recognition of concerning signs of neonatal respiratory distress. When severe deterioration occurred several hours later, medical help was arranged. There was a delay of many hours between the onset of signs of neonatal respiratory distress and treatment, consultation and transfer.*
* *There was a long delay in the recognition of respiratory distress and administration of antibiotics in another newborn, who died with overwhelming group B streptococcus infection at 12 hours of age.*

Comments:

(see Recommendations 11 and 13)

- **Routine antenatal screening for Group B Streptococcus is advised at 36 weeks gestation of pregnancy, with intrapartum antibiotic therapy for carriers. Staff should be aware of guidelines to reduce the risk of neonatal sepsis.**

  King Edward Memorial Hospital guidelines for obstetrics: http://kemh.health.wa.gov.au/development/manuals/sectionb/index.htm

  King Edward Memorial Hospital guidelines for neonatology: http://kemh.health.wa.gov.au/services/nccu/guidelines/
- **Rapid identification and treatment of infants with respiratory distress is a priority.**
- **Where a baby may require transfer, early consultation with Western Australian Neonatal Transport Service (WANTS) is advised.**
- **Nursing staff caring for sick neonates are encouraged to liaise with specialist neonatal nurses.**
- **Early administration of antibiotics is advised for neonates at increased risk of sepsis.**

There were 10 neonatal deaths without an obstetric antecedent (10.3%) and five of these deaths had preventability scores >=2.

Examples:

There were three similar cases of term Aboriginal neonates who died in hospital whilst co-sleeping with their mothers following breastfeeding. All three were significantly growth restricted babies, below 2.5kg in birthweight. Two of the mothers were known to drink alcohol excessively and the third mother was known to use solvents and other substances. In one of these cases the mother was not rousable when the baby was found deceased. In another case the baby was cold when found. There was a question as to the adequacy of supervision in hospital in these cases.

Comments:

(see Recommendation 15)

Co-sleeping is a risk factor for sudden infant death, especially in:

- **infants of smoking mothers**
- **preterm or low birth weight babies**
- **babies under the age of 4 months**
- **impaired maternal conscious state**

There were six deaths (6.2%) related to specific perinatal conditions such as fetomaternal haemorrhage and iatrogenic complications (amniocentesis).

Three of these deaths had preventability scores >=2.

4.2.7 Investigated Neonatal Deaths by Cause of Death (PSANZ NDC) and Preventability Score, WA 2002-04

This section again examines neonatal deaths, but using the different classification system, PSANZ NDC.

The categories with the highest proportion of deaths with preventable medical factors (preventability score >=2) were eleven of 21 (52.4%) deaths due to neurological conditions, six of twelve (50%) deaths due to SIDS/other and five of eleven (45%) deaths due to infection (Table 18a).

Table 18a: Number of Neonatal Deaths by Cause of Death (PSANZ NDC), Preventability Score and Aboriginality, Investigated Cases, WA 2002-04

PSANZ NDC	Total		Preventability Score			Aboriginality of Mother			
			>=4	>=2		non-Aboriginal		Aboriginal	
	N	%	N	N	%	N	%	N	%
1. Congenital Abnormality	36	36.7	2	3	8.3	31	36.9	5	35.7
2. Extreme Prematurity	2	2.0	0	0	0.0	2	2.4	0	0.0
3. Cardio-Respiratory Disorder	12	12.2	3	4	33.3	10	11.9	2	14.3
4. Infection	11	11.2	1	5	45.5	10	11.9	1	7.1
5. Neurological	21	21.4	3	11	52.4	19	22.6	2	14.3
6. Gastrointestinal Tract	4	4.1	0	0	0.0	4	4.8	0	0.0
7. SIDS & Other	12	12.2	1	6	50.0	8	9.5	4	28.6
Total	**98**	**100.0**	**10**	**29**	**29.6**	**84**	**100.0**	**14**	**100.0**

4.2.8 Investigated Post-Neonatal Deaths by Cause of Death (PSANZ NDC) and Preventability Score, WA 2002-04

Table 18b: Number of Post-neonatal Deaths by Cause of Death (PSANZ NDC), Preventability Score and Aboriginality, Investigated Cases, WA 2002-04

PSANZ NDC	Total		Preventability Score			Aboriginality of Mother			
			>=4	>=2		non-Aboriginal		Aboriginal	
	N	%	N	N	%	N	%	N	%
1. Congenital Abnormality	22	24.2	0	0	0.0	20	29.9	2	8.3
2. Extreme Prematurity	2	2.2	0	0	0.0	2	3.0	0	0.0
3. Cardio-Respiratory Disorder	3	3.3	0	0	0.0	2	3.0	1	4.2
4. Infection	15	16.5	0	0	0.0	10	14.9	5	20.8
5. Neurological	1	1.1	0	1	100.0	1	1.5	0	0.0
6. Gastrointestinal Tract	0	0.0	0	0	0.0	0	0.0	0	0.0
7. SIDS & Other	48	52.7	1	2	4.2	32	47.8	16	66.7
Total	**91**	**100.0**	**1**	**3**	**3.3**	**67**	**100.0**	**24**	**100.0**

Of the 91 investigated post-neonatal deaths, three (3.3%) had preventability scores >=2.

There were 48 deaths (51%) due to 'other' causes, with 23 of these being SIDS. There were 22 deaths (24.2%) in babies with significant congenital abnormalities, and 15 deaths (16.5%) due to infection.

The post-neonatal deaths with preventable medical factors were categorised hypoxic ischaemic encephalopathy (n=1), possible SIDS (n=1), and non accidental injury (n=1).

Example: non-accidental injury:

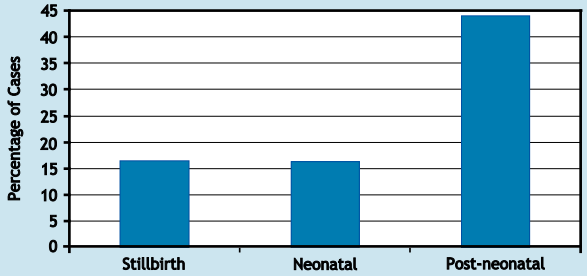
A woman with severe social disruption and illicit substance use was known to the Department of Community Development ('welfare'). A medical practitioner had noted a bruise on the baby on one occasion. The baby died at a few months of age, with multiple fractures, new and old injuries, and brain haemorrhages.

4.2.9 Maternal Behaviour and Lifestyle Factors, WA 2002-04

Statewide data for 2002-04 (section 4.1.4) indicated that 22.7% of mothers experiencing a stillbirth and 39.2% of all mothers experiencing an infant death were smokers (smoking prevalence 28.0% all deaths). Similar proportions were seen in the subgroup of investigated cases (2002-04) where 23.0% of mothers experiencing a stillbirth and 28.4% of mothers experiencing an infant death were smokers (24.5% for neonatal deaths and 54.9% for post-neonatal deaths). The overall prevalence of maternal smoking in investigated deaths was 30.0%.

In addition to smoking, aspects of maternal or other family lifestyle that may have contributed to poor outcomes, such as alcohol or other substance use, were assessed in the investigated deaths. Such 'maternal behavioural factors' were identified in 98 (22%) of the 445 investigated deaths (42 stillbirths, 16 neonatal deaths and 40 post-neonatal deaths). The proportions of cases with maternal behaviour factors, by type of death (stillbirth, neonatal and post-neonatal death) are shown in Figure 17, being most significant in post-neonatal deaths.

Fig 17: Proportion of Cases with Maternal Behavioural Factors, by Type of death, Investigated Cases, WA 2002-04



Comments:

Maternal smoking was a significant risk factor for stillbirth or infant death, being associated with 30% of investigated deaths.

Other aspects of maternal or family behaviour that may have contributed to the outcome of stillbirth or infant death - such as substance use and poor compliance with medical care - were associated with 22% of the investigated deaths.

Table 19 provides details of the cases with 'maternal behavioural factors' (n=98 mothers). There were significant correlations between those with 'maternal behavioural factors' and with smoking and living in a rural area. In the group of mothers with 'maternal behavioural factors' 60 (61%) were also smokers and 57 (58%) lived in the metropolitan area, compared with the group of all mothers who gave birth in 2002-04, which comprised 18.7% smokers and 74.2% who lived in the metropolitan area. Of the 98 women with 'maternal behavioural factors', 45 (46%) were of Aboriginal race.

Table 19: Investigated Cases with Maternal Behavioural Factors: Associated Factors, WA 2002-04

	All Deaths (N=98)		Stillbirths (N=42)		Neonatal Deaths (N=16)		Post-neonatal Deaths (N=40)	
	N	%	N	%	N	%	N	%
Maternal characteristics								
Smoker	60	61.2	19	45.2	11	68.8	30	75.0
Maternal age (years)								
<= 19	11	11.2	5	11.9	2	12.5	4	10.0
20-34	77	78.6	32	76.2	11	68.8	34	85.0
>= 35	10	10.2	5	11.9	3	18.8	2	5.0
Metropolitan postcode	57	58.2	25	59.5	7	43.8	25	62.5
Assessment								
Preventability score >= 2	16	16.3	8	19.0	6	37.5	2	5.0
Preventability score >= 4	7	7.1	4	9.5	2	12.5	1	2.5
Autopsy performed	74	75.5	24	57.1	15	93.8	35	87.5

Table 20 gives details of the types of behaviour that may have contributed to an adverse outcome. Alcohol abuse was listed only where the notes recorded excessive alcohol consumption. In this group of 98 mothers, there was documentation that 61 mothers were poorly compliant with medical care, 80 mothers were poorly compliant with care or had some other serious social problem, 53 mothers had “any substance abuse” (21 women drank alcohol excessively, 18 women used marijuana and 22 women used “hard drugs”), 15 women experienced domestic violence and eight women had a psychiatric disorder.

Of the total group of 445 investigated deaths, 14% of mothers were poorly compliant with medical care, 18% were poorly compliant with care or had some other serious social problem and 12% of mothers had “any substance abuse”.

There were 35 investigated stillbirths in Aboriginal women and almost half of these (n=18 cases) had infrequent antenatal attendance or poor compliance with recommended antenatal care. There were 84 investigated stillbirths in non-Aboriginal women, and 13 of these women had infrequent antenatal attendance or poor compliance with recommended antenatal care.

There were 91 post-neonatal deaths investigated by the PIMC. Of these, 40 had maternal behavioural factors identified, comprising 36 mothers with significant social problems or poor compliance with medical care (40% of all 91 investigated post-neonatal deaths), 21 mothers with “any substance abuse” problems (23% of 91 investigated post-neonatal deaths) and ten babies who suffered non-accidental injuries (11% of 91 investigated post-neonatal deaths).

Table 20: Number of Deaths in which Maternal Behavioural Factors were apparent, by Aboriginality, Investigated Cases, WA 2002-04

	All Deaths		Stillbirths						Neonatal Deaths						Post-neonatal Deaths					
	N=98		non-Aboriginal N=20		Aboriginal N=22		Total N=42		non-Aboriginal N=11		Aboriginal N=5		Total N=16		non-Aboriginal N=22		Aboriginal N=18		Total N=40	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Poor compliance	61	62.2	13	65.0	18	81.8	31	73.8	7	63.6	2	40.0	9	56.3	7	31.8	14	77.8	21	52.5
Domestic violence	15	15.3	3	15.0	0	0.0	3	7.1	1	9.1	0	0.0	1	6.3	5	22.7	6	33.3	11	27.5
Other social problems	20	20.4	1	5.0	2	9.1	3	7.1	2	18.2	0	0.0	2	12.5	9	40.9	6	33.3	15	37.5
Maternal psychiatric problem	8	8.2	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	7	31.8	1	5.6	8	20.0
Non accidental injury of infant	10	10.2	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	5	22.7	5	27.8	10	25.0
Social problems or poor compliance	80	81.6	15	75.0	18	81.8	33	78.6	9	81.8	2	40.0	11	68.8	19	86.4	17	94.4	36	90.0
Alcohol abuse	21	21.4	1	5.0	6	27.3	7	16.7	0	0.0	3	60.0	3	18.8	2	9.1	9	50.0	11	27.5
Marijuana use	18	18.4	5	25.0	6	27.3	11	26.2	1	9.1	0	0.0	1	6.3	4	18.2	2	11.1	6	15.0
Hard drugs	22	22.4	7	35.0	2	9.1	9	21.4	3	27.3	1	20.0	4	25.0	7	31.8	2	11.1	9	22.5
Any substance abuse	53	54.1	12	60.0	12	54.5	24	57.1	4	36.4	4	80.0	8	50.0	11	50.0	10	55.6	21	52.5

Note: cases may be coded more than once

4.2.10 Infant Deaths which occurred whilst Co-Sleeping, Investigated Cases, WA 2002-04

Table 21: Number of Infant deaths which occurred whilst Co-Sleeping, by Aboriginality, Investigated Cases, WA 2002-04

Co-sleeping and any Associated Factors:	Total		Neonatal Deaths				Post-neonatal Deaths			
			non-Aboriginal		Aboriginal		non-Aboriginal		Aboriginal	
	N=33		N=4		N=4		N=12		N=13	
	N	%	N	%	N	%	N	%	N	%
No documented social problems	6	18.2	1	25.0	1	25.0	2	16.7	2	15.4
Social problems other than substance abuse	20	60.6	2	50.0	0	0.0	8	66.7	10	76.9
Substance abuse	17	51.5	2	50.0	3	75.0	6	50.0	6	46.2
Substance abuse or other social problems	27	81.8	3	75.0	3	75.0	10	83.3	11	84.6
Smoking mother	28	84.8	3	75.0	4	100.0	11	91.7	10	76.9
Birthweight <2.5kg	10	30.3	1	25.0	2	50.0	4	33.3	3	23.1
Death <12 weeks age	25	75.8	4	100.0	4	100.0	9	75.0	8	61.5

There were 33 unexpected infant deaths that occurred in association with infant/parent co-sleeping (17.5% of the 189 investigated infant deaths).

All of the 33 babies died prior to 4.5 months of age, with 25 deaths being prior to 12 weeks of age and eight deaths in babies between the ages of 12 weeks and 4.5 months.

Ten of the deaths were in babies that were less than 2.5kg birthweight, with six of these being preterm and four being small for gestational age. There were two further deaths in preterm babies that were more than 2.5kg birth weight. (Total deaths in preterm babies: n=8; total deaths either preterm or small for gestational age: n=12).

The majority of these deaths (n=28) were in the infants of smoking mothers.

Of the 33 infant deaths associated with co-sleeping, one half occurred in non-Aboriginal infants (n=16) and one half in Aboriginal infants (n=17).

Of the 33 infant deaths, 27 occurred in combination with significant social problems or parental substance abuse, and six deaths occurred in the absence of any documented maternal/family behavioural factor.

Six of the unexpected infant deaths associated with co-sleeping occurred whilst sleeping on a couch.

Four neonatal deaths occurred whilst mothers and babies were co-sleeping in hospital. All four babies were less than 2.5kg in birthweight. Three of these cases were previously described in section 4.2.6, and involved growth restricted term Aboriginal neonates, and the fourth case was the death of a preterm Caucasian baby.

The deaths were classified for cause of death (PSANZ NDC): SIDS (n=13), sepsis (n=4), accidental asphyxiation (n=2) and 'other/undetermined' (n=14). It may be noted that the 13 SIDS deaths that occurred whilst co-sleeping represented over half of the total SIDS deaths in the triennium (n=23; 57%).

4.2.11 Data Collection Maternal Factors, WA 2002-04

There is no routine collection of data on the number of antenatal appointments women attend in WA. Improved data collection regarding antenatal attendance may allow for a more accurate assessment of the relationship between antenatal attendances, compliance with medical advice and pregnancy outcomes.

There is no routine collection of data about alcohol and drug use in pregnancy. In the investigated stillbirths in WA 2002-04 there was no information about alcohol use in 69 (27%) of mothers and no information about other substance use in 120 (47%) of mothers.

Table 22 shows that in those who had a stillbirth, maternal height was recorded in 212 (82.8%) women, maternal weight in 154 (60.2%) women and both height and weight were recorded in 135 (52.7%) women. Maternal height is requested on midwifery notification forms, but maternal weight is not collected. In the population of all mothers giving birth in the years 2002-04, maternal height was recorded on the midwifery notification forms in 81.2% of records. It was not possible to make meaningful analyses of relationships between body mass index and pregnancy outcomes due to missing height and weight data in a high proportion of mothers.

Table 22: Maternal Height and Weight Records, Investigated Perinatal Deaths, WA 2002-04

Data Collection	Perinatal Deaths (N=354)		Stillbirths (N=256)		Neonatal Deaths (N=98)	
	N	%	N	%	N	%
Height recorded	289	81.6	212	82.8	77	78.6
Weight recorded	165	46.6	154	60.2	11	11.2
Both height and weight recorded	145	41.0	135	52.7	10	10.2

4.2.12 Perinatal Mortality Risk by Gestational Age, Investigated Cases, WA 2002-04

Table 23 provides information about the rates of stillbirth and the subgroups of unexplained stillbirths, neonatal deaths, and hypoxic peripartum deaths, at different gestational ages using HIC data (including livebirths) to enable calculations of risk.[2] Stillbirth rates were most closely related to the degree of prematurity, whereas the peak mortality rate of unexplained stillbirths was in the gestational age group of 28-34 weeks. The perinatal mortality rate due to peripartum hypoxia was highest in two gestational age groups (28-34 weeks and in >42 weeks) although the absolute numbers were low.

Table 23: Perinatal Mortality Risk by Gestational Age, Investigated Perinatal Deaths, WA 2002-04

Gestational Age (weeks)	Total Births	Livebirths	Stillbirths (all causes)		Unexplained Antepartum Deaths		Neonatal Deaths (all causes)		Perinatal Deaths due to Hypoxic Peripartum Death	
	N	N	N	Rate	N	Rate	N	Rate	N	Rate
20-27	613	300	32	52.2	6	9.8	12	40.0	0	0.0
28-34	2115	2018	97	45.9	25	11.8	31	15.4	3	1.4
35	1191	1179	12	10.1	4	3.4	4	3.4	1	0.8
36	2371	2355	16	6.7	4	1.7	2	0.8	0	0.0
37	5360	5334	26	4.9	9	1.7	11	2.1	1	0.2
38	16728	16707	21	1.3	8	0.5	6	0.4	1	0.1
39	14963	14941	22	1.5	7	0.5	10	0.7	4	0.3
40	23370	23342	28	1.2	12	0.5	17	0.7	11	0.5
41	7660	7650	10	1.3	1	0.1	4	0.5	8	1.0
42-43	622	620	2	3.2	0	0.0	0	0.0	2	3.2

4.2.13 Home Births, Investigated Cases, WA 2002-04

In the triennium 2002-04 there were three term gestation perinatal deaths amongst planned home births. The home births were pre-booked with attendant midwifery antenatal and peripartum care. One of the three deaths was coded with an element of medical preventability, where improved antenatal assessment and management may have improved the outcome (preventability score of 3). In a second case the parents refused recommended medical care after advice that there were signs of fetal compromise. The third case was a sudden unexplained stillbirth without investigations to assess the cause of death.

In summary, one of the three cases had 'medical' preventability, another had 'maternal factors' present, and the third had neither medical nor maternal preventability factors evident, but did not have post-mortem investigations.

4.2.14 Home Births, Investigated Cases, WA 2000-04

Data were pooled with those from the Committee's 11th Report for the years 2000-01, to allow for a valid statistical analysis. There were a total of six unexpected *term* perinatal deaths amongst planned home births recorded in the five years Jan 2000 – Dec 04. The six deaths occurred between 38 and 41 weeks gestational age, and involved singleton pregnancies with no overt congenital abnormalities. Two deaths were antepartum and four were the result of an intrapartum complication (two stillbirths and two early neonatal deaths). Three of the deaths occurred at home and three occurred in hospital. One of the six babies delivered at home, and five delivered in hospital. Four of the six cases had low-level medical preventability scores (2 or 3) and two cases had no evidence of preventability.

The term perinatal mortality rate was 6.7 per 1,000 total births, compared with a term perinatal mortality rate of 2.1 per 1,000 total births in the planned hospital births in the same period, which was a statistically significant difference (Fisher Exact p=0.013).

In the 5-year period, the average number of annual planned home births was 169, with the average number that delivered at home being 138 per year. The percentage of planned homebirths that delivered at home was 82%. Of the 700 births that occurred at home, 697 were spontaneous vertex deliveries, one was a twin-birth, one vaginal birth by breech presentation, one vaginal birth recorded as 'brow' presentation, and one was an unspecified 'other presentation' delivery.

Trend data show that the proportion of planned home births has remained fairly stable at between 0.4 – 0.7% of all births over the past 15 years.[2]

Table 24: Number of Planned and Actual Home Births, WA 2000-2004

Year	Planned homebirths	Actual homebirths	Planned Hospital Births
2000	160	122	24,570
2001	182	144	24,286
2002	153	121	23,787
2003	186	163	23,641
2004	165	150	24,429
Total	**846**	**700**	**120,776**

4.2.15 Pathology Investigations into Cause of Death, Investigated Cases, WA 2002-04

In 2002-04, 303 of the 445 investigated deaths (68%) underwent post-mortem examination, comprising 69.5% of stillbirths, 60.2% of neonatal deaths and 73.3% of post-neonatal deaths.

Table 25 shows the benefits conferred by post-mortem examination, using an 'autopsy utility scale';[13] these findings are similar to those reported in 2000-01.[3]

Table 25: Autopsy Utility for Perinatal and Infant Deaths, Investigated Cases, WA 2002-04

Autopsy Utility	Stillbirths N=178		Neonatal Deaths N=59		Post-neonatal Deaths N=66		Total N=303	
	N	%	N	%	N	%	N	%
Confirm	46	25.8	24	40.7	6	9.1	76	25.1
Change	34	19.1	11	18.6	12	18.2	57	18.8
Add	39	21.9	12	20.3	12	18.2	63	20.8
Inconclusive	59	33.1	12	20.3	36	54.5	107	35.3

Cases were individually assessed according to the adequacy of the pathology investigations performed to investigate the cause of death (Table 26). Of the 445 cases investigated, 330 (74.2%) were considered adequately investigated, 81 (18.2%) cases were partially investigated and 34 (7.6%) had very little or no investigations into the cause of death. In all, 25.8% of cases had insufficient pathological investigation of the cause of death. This represented a significant improvement from the data published in the PIMC 11th Report of deaths in 2000-01, when 53% of deaths had insufficient pathological investigations performed to determine the cause of death.[3]

Table 26: Pathology Investigations to Assess Cause of Stillbirths and Infant Deaths, Investigated Cases, WA 2002-04

Investigative Work Up	Stillbirths N=256		Unexplained Stillbirths N=77		Infant Deaths N=189		Total Deaths N=445	
	N	%	N	%	N	%	N	%
Adequate	156	60.9	44	57.1	174	92.1	330	74.2
Some investigations	67	26.2	17	22.1	14	7.4	81	18.2
Few investigations	33	12.9	16	20.8	1	0.5	34	7.6

A minority of cases had a full range of investigations as recommended in Appendix II (Section 7.2), including amniocentesis, Kleihauer-Betke test prior to induction of labour, and maternal drug screen for illicit substances.

Of the 77 unexplained antepartum stillbirths, 44 (57%) had adequate investigations performed, 17 had some tests performed but lacked important investigations such as placental histopathology, and 16 cases (20.8%) had few or no investigations into the cause of death. Of these 77 unexplained antepartum stillbirths, 31.2% had a Kleihauer-Betke test, 39% had maternal cultures taken, 24.7% had fetal/placental cultures taken and 71.4% had an autopsy performed. Pathology assessment of cases was more thorough in 2002-04 than in 2000-01 when 20% of 'unexplained antepartum' stillbirths had a Kleihauer-Betke test, 48% had cultures taken and 60% had an autopsy.

4.2.16 Early Prevention Factors, Investigated Cases, WA 2002-04

Table 27 shows that 39 of the investigated cases (8.8% of the total 445 investigated stillbirths and infant deaths) were identified in which 'early prevention' or early termination of pregnancy may have prevented death after twenty weeks gestation, or in which the pregnancy was conceived by assisted fertility techniques including in vitro fertilisation (IVF), intracytoplastic sperm injection (ICSI) and clomid treatment.

Table 27: Investigated Cases with 'Early Prevention' Factors, WA 2002-04	
Screening Factors:	
Patient presented too late for screening	9 cases
Declined screening or follow-up amniocentesis	4 cases
Declined termination of pregnancy	2 cases
Screening not done - unknown if not offered or if declined	10 cases
Miscommunication in prenatal counselling	1 case
False negative screening test	5 cases
Total cases screening factors	**31 cases**
Assisted Fertility techniques:	
ICSI twin pregnancy	3 cases
IVF singleton pregnancy (not ICSI)	1 case
Clomid pregnancy - diabetes related	2 cases
Clomid pregnancy - multiple birth	1 case
Total cases assisted fertility	**7 cases**
Vaccine preventable diseases: Congenital Rubella syndrome	1 case
Total	**n=39 cases**

There were nine cases with lethal congenital abnormalities in which patients presented too late for screening. There were four deaths due to lethal congenital abnormalities where patients declined to have prenatal screening and two cases where patients declined an offer of termination of pregnancy in the presence of trisomy 13 or 18. Another patient had a high-risk first trimester screening result but declined the offer of amniocentesis.

There were ten deaths of babies with lethal congenital abnormalities where it was unknown whether or not early pregnancy screening was offered. The notes did not document if screening had been offered, suggesting that in at least some of these cases the option had not been discussed. Three of these cases had abnormalities detected by 'late' (post-20 weeks) anatomy scans where it was unclear as to why the ultrasound scans had been performed late.

There were six cases of lethal congenital abnormalities in which false negative results were obtained on routine screening tests.

In one case there was miscommunication in the prenatal counselling of a patient known to be at increased risk of having a baby with a neural tube defect, where the patient thought first trimester screening was sufficient, and an anatomy scan was not performed, resulting in a late diagnosis of hydrocephalus.

There were three deaths in pregnancies conceived through clomid therapy. Two of these deaths were likely to have been due to diabetes in the mother, and the third was a neonatal death due to prematurity in a quadruplet. There were three deaths identified in twin pregnancies conceived through the IVF technique of ICSI. One was due to twin-twin transfusion syndrome (TTTS), one related to discordant growth in the presence of a congenital abnormality, and the third due to preterm birth. The antenatal notes did not provide details as to how many embryos were transferred to the mother in these cases.

There was one neonatal death due to congenital rubella syndrome where the mother contracted the illness early in first trimester.

It is unlikely that this summary includes all cases with 'early prevention' factors. For example, there may have been other deaths related to multiple births where the antenatal notes did not specify that the pregnancy was a result of an assisted fertility technique.

5 Commentary

5.1 The Role of the PIMC in WA

The role of the PIMC is to make recommendations to practitioners and the health system to reduce perinatal and infant mortality. This task involves analyses of individual cases and consideration of statistical data. It also requires consideration of available services and extrapolations to predict population requirements in the future.

5.2 Perinatal and Infant Mortality: How WA Compares with National Rates

The annual number of births in WA has been around 25,000 in recent years, although there are indications that this is now increasing. There were 26,792 births in WA in 2005[2]. There were annual averages of 182 stillbirths (20 weeks gestation or 400g birthweight), 55 neonatal deaths (in the first 28 days of life), 237 perinatal deaths (stillbirths and neonatal deaths combined) and 87 infant deaths (deaths in the first year of life) per year in WA in 2002-04. Birth and death rates for Aboriginals are much higher than those for the Caucasian population.

Perinatal mortality rates have continued to decline gradually, due to a significant reduction in the neonatal mortality rate, but there has not been a significant reduction in the stillbirth rate in recent decades. Infant mortality rates also continue to decline gradually. The perinatal and infant mortality rates in the triennium 2002-04 were lower than those published in the 11th Report pertaining to deaths in 2000-01. Table 28 shows that the stillbirth rate in WA compares favourably with national mortality rates, and that the neonatal mortality rate was amongst the lowest of the states and territories in Australia in 2004. This table is from National Perinatal Data Collection (NPDC) and uses ABS data and stillbirth definitions (see Appendix I for definitions).

Table 28: Stillbirths, Neonatal and Perinatal Deaths by State and Territory, 2004

	NSW	Vic	Qld	WA	SA	Tas	ACT[a]	NT	Australia
	Number								
Live births[b]	85,065	63,082	50,563	25,340	17,408	5,483	4,893	3,452	255,586
Fetal deaths	561	618	347	188	113	37	33	22	1,919
Neonatal deaths[c]	212	207	198	61	51	12	23	19	783
Perinatal deaths	*773*	*825*	*545*	*249*	*164*	*49*	*56*	*41*	*2,702*
Total births	**65,626**	**63,700**	**50,910**	**25,528**	**17,521**	**5,520**	**4,926**	**3,474**	**257,205**
	Rate per 1000 births[d]								
Fetal deaths	6.6	9.7	6.8	7.4	6.4	6.7	6.7	6.3	7.5
Neonatal deaths[c]	2.5	3.3	3.9	2.4	2.9	2.2	4.7	5.5	3.1
Perinatal deaths	*9.0*	*13.0*	*10.7*	*9.8*	*9.4*	*6.9*	*11.4*	*11.8*	*10.5*

(a) 16.3% of women who gave birth in the ACT were non-ACT residents. Care must be taken when interpreting rates. For example, for ACT residents who gave birth in the ACT, there were 6.1 fetal deaths per 1,000 births, 44 neonatal deaths per 1,000 live births and 10.4 perinatal deaths per 1,000 births.
(b) Includes neonatal deaths.
(c) Except in WA and NT, these may exclude neonatal deaths within 28 days of birth for babies transferred to another hospital or readmitted to hospital and those dying at home.
(d) Fetal and perinatal death rates were calculated using all births (live and stillbirths). Neonatal death rates were calculated using all live births.

Sources: AIHW[4] and ABS[5]

Table 29 shows that infant mortality rates in WA have been amongst the lowest in Australia in recent years.

Table 29: Infant Deaths by State and Territory, Australia 1984-2004

Years	NSW	Vic	Qld	WA	SA	Tas	ACT	NT	Australia[b]
	rate	rate	rate	rate	rate	rate	rate	rate	rate
1984	9.2	8.8	9.0	7.6	10.7	11.8	13.8	10.0	9.2
1989	8.7	6.5	8.5	7.4	7.8	10.6	14.5	6.5	8.0
1994	6.3	5.1	6.2	4.7	5.6	7.5	11.3	4.7	5.9
1999	5.8	5.6	5.7	4.3	4.7	7.6	11.7	5.6	5.7
2000	5.2	4.5	6.2	4.6	4.3	5.8	11.7	4.2	5.2
2001	5.3	4.8	5.9	4.6	5.1	6.2	10.7	3.0	5.3
2002	4.6	5.0	5.8	5.1	4.3	6.2	11.3	3.4	5.0
2003	4.6	5.1	4.8	3.7	4.1	7.0	8.4	5.8	4.8
2004	4.6	4.5	5.2	3.2	3.9	3.6	10.7	6.9	4.7

(a) Infant deaths per 1,000 live births.
(b) Includes other Territories.

Source: ABS Deaths 2004[6]

5.3 Statewide Issues, WA

Priorities in Maternity and Infant Health Services in WA

There have been great advances in the health of mothers and babies, but there are a number of important challenges in the provision of health services in the state at present, which are briefly mentioned here. These include workforce shortages, a high Caesarean section rate, and changing demographic features of mothers. In addition, a constant challenge is to improve health outcomes for those living in deprived social circumstances.

The state of WA has expansive distances. It is important to consider how hospital services, available staff and transfer services in metropolitan, rural and remote areas are inter-related and how changes may impact on available health services and outcomes.

Workforce factors

A focal issue in the delivery of maternity and infant health services is the current workforce. There is a recognised workforce shortage of obstetricians, GP-obstetricians, salaried medical officers with obstetric and neonatal skills, midwives and neonatal nurses across the state, particularly in rural areas.[18,19]

WA data [Royal Australasian and New Zealand College of Obstetrics and Gynaecology (RANZCOG) 2006] show a very small proportion of specialists in rural areas (Table 30).[19]

Table 30: Proportion of Specialist Obstetricians working in Rural Areas, by State or Territory in Australia, 2001

State or Territory	Total RANZCOG Fellows	Rural Fellows: % of State Fellows	% Births to women resident outside major metropolitan centre
Canberra	21	0	<1%
SA	102	4%	21%
Victoria	314	15%	21%
WA	99	8%	29%
NSW	377	18%	20%
NT	8	50%	52%
Queensland	202	26%	36%
Tasmania	24	20%	30%

Sources: ABS Births 2002. Cat No. 3301.0: 40-41 and RANZCOG data July 2006; With thanks to Dr Diane Mohen[19].

The Royal Australian College of Physicians has also indicated that, at least in the immediate future, there will be shortages in all disciplines of the health workforce, and that the need for neonatal paediatricians has increased, despite the fall in perinatal mortality.[20]

Workforce shortages and loss of local services can impact on communities in many ways. There may be social inconvenience and financial impact on families, loss of continuity of care, and an increased burden of transporting patients who cannot be cared for locally. Loss of facilities may also lead to loss of experienced staff, further limiting emergency obstetric and neonatal services.[21] An example of this de-skilling has recently been seen in WA with the RFDS being called to attend low-risk mothers in spontaneous term labour, due to no local facilities.[22]

There are ideals about maternal choice in birthing options,[18,23] although in practical terms many women do not have the choice to deliver near their homes.

Patient transfer services

It is noteworthy that around 85% of births of very low birth weight babies occurred in the state's only tertiary hospital, KEMH, throughout the years 2000-04. This is the result of a policy to transfer women early in preterm labour, and is to be commended.

The workload of WANTS has increased. In the year July 2001-June 2002, WANTS had a total of 743 transfers,[ii] with 507 primary transfers , including 73 retrievals from rural areas and 236 'reverse transfers'.[iii] The numbers have steadily increased and in 2006 there were a total of 1,074 transfers, comprising 664 primary transfers (n=150; 22% from rural areas) and 410 'reverse transfers'.

Table 31 illustrates that the number of WANTS transfers using RFDS have also increased significantly. Reasons for the increased transfer numbers are likely to be multi-factorial.

Table 31: WANTS/RFDS Transfers in 2001 and 2006, WA

Transfers using WANTS by source region, 2001 and 2006		
Region	**Year 2001**	**Year 2006**
Central	0	2
Goldfields	16	26
Great Southern	14	24
Interstate	1	0
Kimberley	16	17
Midwest	8	15
Perth Metro	0	1
Pilbara	11	10
South West	16	34
Total	**82**	**129**

Source: RFDS[22]

[ii] Primary transfer refers to the transport of a patient from a lower to a higher level health facility, when the patient requires more intensive treatment or equipment than that which is available locally.

[iii] Reverse transfer refers to the transport of a patient from a higher to a lower level health facility or to home, in convalescence.

Statewide Obstetric Unit

There is an important review of maternity services being undertaken at present, to address current and future health service requirements, workforce requirements, and transfer services.[18]

Recommendation 4:

Statewide Obstetric Unit:

The established Statewide Obstetric Support Unit (SOSU) should be further expanded in its role to assist in the delivery of obstetric care in WA, including:

- workforce and infrastructure advice and planning.
- supporting skilled obstetric staff in rural areas.
- producing evidence-based practice protocols applicable to each area.

Provision of perinatal services would ideally be coordinated in a statewide approach, with recognition of multiple factors including workforce issues, demographic changes, and considering and balancing the need for smaller and larger hospital services. Expansion of the activities of the established Statewide Obstetric Support Unit (SOSU), along with the newly established neonatal network, may help to address these important issues. WANTS provides a highly valuable service in providing consultant advice, and in transporting sick infants to appropriate special nurseries.[24] The importance of WANTS and other transport services should be recognized and supported.

Comments:

(see Recommendation 12):

Neonatal Network:

- **The newly established Neonatal Network is supported.**
- **The Neonatal Network should be adequately resourced and supported to coordinate statewide neonatal care and workforce.**

Increasing Caesarean section rates

In 2004 Western Australia had the highest Caesarean section rate in Australia.[2] Caesarean section rates continue to rise rapidly, for many reasons. Women are choosing to start their families later in life, with known higher risks of complications in older mothers, particularly older primigravid women.[25] There is concern about the increasing number of women with uterine scars, and the increasing number having multiple repeat Caesarean sections. There may be an associated loss of practical skills in the performance of instrumental vaginal deliveries. Caesarean sections require an increased hospital stay, and significantly impact on services. The 'appropriate Caesarean section rate' is a contentious question. The rising Caesarean section rate is an important issue to be considered, particularly by the RANZCOG, SOSU, and hospital service providers.

Other issues

Other important issues to consider in perinatal service planning include providing ready access to health services especially for those of lower socioeconomic status and rural and Aboriginal families, the rising epidemics of obesity and diabetes mellitus, and the aging population of mothers.

5.4 Investigators' Comments: Case Investigations WA 2002-04

The primary educational role of the Committee is emphasised. The resumption of activity of the PIMC in late 2001 was initially met with some resistance by a small proportion of the medical community. There was concern about issues of privacy and confidentiality. These areas were addressed by the EDPH, and legal advice confirmed that the provision of medical records was required by law (*the Health Act 1911*) and was in keeping with the National Privacy Principles, which allow exemption for the disclosure of information when the disclosure is required by law. With the passage of time there has been heightened awareness of the role of the PIMC such that doctors approached for case histories are now generally aware of the process and provide information readily. Compliance with the PIMC requirements, as set out in the *Health Act 1911*, was much easier to achieve in 2002-04 than previously.

There was an improvement in the quality of note-keeping and significant improvements in the performance of investigations to enquire into causes of death.

The Investigators considered that there was a generally high standard of medical care provided to pregnant women and neonates, with management decisions reflecting efforts to practise evidence-based medicine. The standard of antenatal care was generally good, with close adherence to recommendations for routine antenatal screening tests, advice about folic acid supplementation, diabetes screening and administration of prophylactic anti D in women with Rhesus negative blood group. Assessing the level of care for infants was sometimes difficult, due to difficulties in tracing notes where multiple care providers were involved.

The Investigators noted that medical and nursing practitioners were sometimes quite emotionally traumatised by involvement with a stillborn baby or infant death. They reassured the health professional that the information obtained is confidential, known only to the authorised Investigator, Chairman of the PIMC, and the EDPH, and that the information is presented to the Committee in a de-identified format. Feedback from the Committee is communicated only to the attending doctors and to the EDPH.

De-briefing may be helpful following a traumatic event, and practitioners may consider attending professional counselling. For example 'Colleague of First Contact' is a service available through the Australian Medical Association (AMA).[26] There is also professional advice and support available through King Edward Memorial Hospital (KEMH) Perinatal Loss Service, Department of Psychological Medicine, and at Princess Margaret Hospital for children (PMH).[27]

5.5 Reducing Perinatal and Infant Deaths in WA

The leading causes of stillbirths and infant deaths were congenital abnormalities, preterm births and SIDS. A brief overview is presented here.

5.5.1 Congenital abnormalities

Congenital abnormalities are a significant public health issue, being associated with pregnancy terminations, stillbirths and infant deaths, and survivors with severe disabilities.

Congenital abnormalities were the leading cause of stillbirths and infant deaths in WA in the years 2002-04. In this triennium there were 205 stillbirths and infant deaths due to congenital abnormalities, with 42 of these due to central nervous system abnormalities.[15] According to the WA Abortion Notification System, 447 (1.9%) of the 23,997 reported abortions in these years were for suspected or identified congenital abnormalities[15]. These data show that over 99.5% of abortions were undertaken prior to 20 weeks gestation. Late abortions (>=20 weeks gestation) must be approved by a medical panel appointed by the Minister for Health[9]. There were 100 late abortions in WA in 2002-04.

Primary health initiatives that make an impact on the number of babies with congenital abnormalities include good maternal nutrition, periconceptional folic acid supplementation and avoidance of harmful substances in early pregnancy. It is recommended (Recommendation 1) that educational efforts inform the public of important pre-conception information, including information about the increased risk of congenital abnormalities with increasing maternal age and the decreased risk of central nervous system congenital abnormalities with periconceptional folic acid supplementation. There is evidence that fortifying foods with folic acid can significantly reduce the incidence of neural tube defects, thus reducing the number of babies affected by this condition and reducing the number of pregnancy terminations. There is also evidence that mandatory fortification with folic acid is superior to voluntary fortification.[28,29,30]

There were 31 cases where 'screening factors' were identified in the investigated deaths WA 2002-04, where deaths may have been prevented after 20 weeks gestation. Guidelines about prenatal screening tests and interpretation of results are available: http://kemh.health.wa.gov.au/health/fetal_monitoring/

Recommendation 1:

Antenatal Education:

Antenatal public health programs should be a priority, addressing:

- smoking cessation
- good nutrition/periconceptional folic acid supplementation
- healthy weight
- early pregnancy screening for congenital abnormalities
- avoidance of alcohol and other harmful substances

5.5.2 Preterm Birth

Preterm birth (delivery <37 weeks gestation) is a major challenge, being a leading cause of perinatal death, as well as a major risk factor for disability.[31,32] In WA 2002-04, it was the second highest cause of perinatal death. Aboriginal and non-Aboriginal preterm birth rates have significantly increased over the 15 years 1990-2004 in WA ($p=0.009$ and $p<0.001$ respectively). National figures show that 7.4% of births occurred preterm in 2004, with trend data showing that the prevalence is increasing.[4] A similar increase in the prevalence of preterm birth has been seen in most countries in recent decades.

Useful predictive tests to identify women who are at risk of preterm delivery are ultrasound assessment of cervical length and fetal fibronectin. These tests have high negative predictive values, but poor positive predictive values.[33-36]

Negative results in these tests may help prevent unnecessary transfer from a rural setting to a regional or tertiary centre, and assist in decisions regarding administration of corticosteroids. For example, a woman with symptoms of preterm labour but intact membranes may not require transfer where there is a negative fetal fibronectin test and long closed cervix, as she is most likely not in preterm labour.[35] However, where there remains significant clinical concern about a risk of preterm delivery in an area without neonatal facilities, in utero transfer remains the preferred management option. There is still some question as to whether clinicians will alter their management based on fibronectin results[37]. Preliminary WA data have shown a small but significant reduction in rural transfers for threatened preterm labour since the introduction of fetal fibronectin testing.[38]

Current guidelines for the management of preterm labour are available on-line:
http://kemh.health.wa.gov.au/development/manuals/sectionb/index.htm
A single course of antenatal corticosteroids is recommended in women with threatened preterm labour between 24 and 34 weeks gestation.

The results of current trials in WA studying interventions aimed at preventing preterm birth may provide information on better prevention and treatment strategies.

5.5.3 Unexplained antepartum death

The reduction in perinatal mortality in Australia in recent decades has been almost entirely due to a reduction in neonatal mortality rates. The two leading 'causes' of stillbirth are congenital abnormalities and 'unexplained', which helps to explain the relatively static numbers. If research can begin to find aetiological factors in the 'unexplained' group, possible reductions may be achieved in the future. Thorough post-mortem examination and pathological investigations are recommended following all stillbirths. Satisfactory inquiry into deaths will result in fewer 'unexplored' cases, which would otherwise be categorized in the 'unexplained' group. In addition, improved classification systems assist in identifying sub-groups which may improve our understanding and lead to causes being illuminated. For example, whilst the aetiologies of fetal growth restriction are multi-factorial and ill-understood, it is a better descriptor than simply 'unexplained'. The prevalence of fetal growth restriction was not obvious with older classification systems, such as the Wigglesworth classification, because these deaths were in the group of 'unexplained' stillbirth, but the designation of this category of stillbirth in newer classification systems, such as PSANZ classification and "Relevant Condition at Death" (ReCoDe) classification, allows appreciation of its importance.[40]

A review of the literature identifies the most prevalent risk factors for stillbirth as pre-pregnancy obesity, lower socioeconomic status and advanced maternal age.[41,42,47] Unexplained stillbirths and deaths related to fetal growth restriction are the two categories that contribute most to late fetal losses. Late pregnancy (especially >39 weeks gestation) is associated with an increasing risk of stillbirth[41,43,44,45] and clinicians should have a low threshold to arranging ultrasound evaluation of fetal growth and wellbeing where there is any clinical concern.[46] Stillbirth is commonly associated with intrauterine growth restriction, which is often not identified until after birth.[47,48] With trends of increasing maternal age and obesity, it may be beneficial for more women to have late gestational ultrasounds to assess fetal well-being, with particular attention to fetal abdominal circumference, amniotic fluid volume and Doppler studies, although this may lead to an increase in interventions. The Committee suggests the use of a routine ultrasound examination in third trimester for obese mothers and older mothers, especially those who smoke or have other risk factors.

Recommendation 8:

Obesity:

In obese women ultrasound assessment of fetal growth is advised in the third trimester, to identify macrosomic fetuses and growth restricted fetuses.

Recommendation 10:

Maternal age:

In older mothers, ultrasound examination is advised in the third trimester, in order to identify fetal growth restriction.

5.5.4 SIDS

Reduction in the mortality from SIDS has been a considerable public health achievement, based on an education campaign about avoiding the known risk factors of prone sleeping position, smoking and excessive bedding. However, there continue to be deaths due to SIDS with known avoidable risk factors, particularly in the high-risk groups of infants of smokers, Aboriginals and infants from lower socioeconomic backgrounds.

The proportion of SIDS cases with certain risk factors has changed. For example in the past 20 years in the UK the proportion of deaths with the risk factors of maternal smoking, deprived socioeconomic background, co-sleeping (especially on a couch) and preterm birth are now significantly higher than in the past.[49]

Maternal smoking, a major risk factor, was associated with 74% (17 of 23 cases) of SIDS cases in WA 2002-04.

Co-sleeping

The issue of co-sleeping has emerged as a more important factor than previously recognized. Over the past 20 years, the proportion of children who died from SIDS whilst co-sleeping with their parents has risen from 12% to 50% in the UK ($p<0.0001$) but the actual number of SIDS deaths in the parental bed has halved ($p=0.01$).[49] Similarly in WA there has been a reduction in total deaths, and just over half of the SIDS deaths in 2002-04 were in association with co-sleeping.

There is debate about the merits and dangers of infant parent bed-sharing.[50] Evidence shows an increased risk of sudden infant death in infants bed-sharing with mothers who are smokers, particularly in infants under the age of four months, and in 'vulnerable infants' born preterm or low birth weight.[51-56] There is evidence that sleeping on a sofa is of particularly high risk.[51,56]

Studies of the risk of parental bed-sharing on SIDS in the absence of known risk factors such as smoking and preterm birth, have had variable results. Some sub-group data analyses have shown little (around two-fold) or no extra risk of SIDS,[51-54,57,58] while others have shown a much greater association, such as one robust study which showed an eight-fold increased risk in non-smoking mothers who co-slept with infants less than 11 weeks of age.[56]

The risk of sudden unexpected infant death associated with co-sleeping is likely to be underestimated because studies of SIDS and co-sleeping exclude deaths due to 'accidental asphyxiation' and other SIDS-like deaths with 'indeterminate causes' that do not quite fit the definition of SIDS. WA 2002-04 data showed a total of 33 cases of unexpected infant death in association with co-sleeping, with less than half of these attributed to SIDS (n=13; 39%).

Considering current evidence, it is reasonable to recommend that parents avoid co-sleeping when the mother smoked in pregnancy, when either parent has an impaired conscious state, with infants under the age of four months, and with infants born preterm or of low birth weight. Co-sleeping on a couch should be avoided at all times. There is evidence that room sharing in a separate cot (rather bed sharing) with an adult is protective and should be encouraged in the first few months of life.[54,55]

The Coroner in WA[59] recommends that bed sharing be avoided:

- when the parent is a smoker, under the influence of alcohol/sedation or excessively tired
- with other children/pets on the bed
- on a sofa/waterbed, beanbag or sagging mattress/adult bed

Definitions of SIDS:

It is worth commenting on changes in the definition of SIDS. Until recently many deaths such as accidental asphyxia by overlaying have not been classified as SIDS, and a number of deaths have been classified as 'unascertainable'. Many of these would fulfil the most recently accepted criteria for SIDS, as agreed at an international meeting in San Diego in 2004: SIDS is 'the sudden unexpected death of an infant under one year of age, with onset of the fatal episode apparently occurring during sleep, that remains unexplained after a thorough investigation, including performance of a complete autopsy and a review of the circumstances of the death and the clinical history.' This may result in an apparent increase in SIDS deaths from around 2005 onwards.

Aboriginal Infants

WA data have shown a much higher risk of death due to SIDS in Aboriginal compared with non-Aboriginal infants, as shown in Fig 4 for 2002-04, with a relative risk of 9.50 (95% CI 4.11-21.95). Considering trend data in WA from 1980-2001, the rate of death due to SIDS was thought to have decreased significantly in both populations, with the difference in the decline being significantly greater in the non-Aboriginal population, however closer analysis of data including the group of 'unascertainable deaths' as well as 'SIDS' cases showed that the decrease in deaths in Aboriginal infants was not significant.[61] That is, the reduction in sudden unexpected infant deaths seen in non-Aboriginal infants in WA has not been experienced in the Aboriginal population. Methods to address this are being explored.

A project funded through 'SIDS and Kids WA' and the Department of Health, WA on *Safe Sleeping in Aboriginal Communities* has included focus groups with Aboriginal women led by Aboriginal women.[62] The project has developed information materials for Noongar people, and has recently conducted focus groups with Kimberley Aboriginal groups and interested parties. The consultation process identified Aboriginal cultural and practical issues that differed markedly from Southern Aboriginal communities, especially in respect to safe sleeping practices. In general there was a lack of awareness about SIDS risk factors such as prone sleeping and providing a smoke-free environment for babies. Kimberley communities viewed safe sleeping as a protective practice in respect to sexual abuse. Co-sleeping was reported as a cultural 'norm' and facilitated breastfeeding.

There are many factors to consider in the best approach towards addressing risk factors for SIDS, with 'awareness of family, social and ethnic context'.[63] Cultural and practical factors must be understood and highlighted. The option of a separate cot for a baby may not be an option in some families, and more important 'safety' issues may surround the areas of bonding, breastfeeding, thermoregulation and protection from domestic violence. Rather than a 'never co-sleep' message, the best compromise may be to stress priority public health issues: dissuading mothers from smoking, drinking alcohol and using other harmful substances whilst pregnant and caring for small children and avoidance of the prone sleeping position for infants. The Ministerial Advisory Council on the Prevention of Deaths in Children and Young People is also looking at this issue.

Public education:

Dissemination of information is required to those most at risk and to staff involved in child-care.[64] Useful educational pamphlets for parents and health professionals about the risks of co-sleeping (particularly in the presence of maternal intoxication) were included in the PIMC's 11th Report.[3] Further Health Department policy is being developed in this area, with special reference to cultural issues.[65]

Recommendation 15:

Sudden Infant Death Syndrome:

Increasing public knowledge about ways to reduce SIDS is advised. Special attention should be given to delivering information to families with risk factors, and institutions that provide infant care. In addition to the current education about safer sleeping practices, there should be messages about the increased risk of infant death related to:

- co-sleeping in the presence of parental smoking/alcohol/drug use, and in small babies especially under the age of 4 months.
- co-sleeping on a couch.

Parents should be advised that there is a decreased risk of SIDS where parents room-share with their baby in a separate cot for the first few months of life, compared with the baby sleeping in a separate room to its parents.

5.5.5 Preventable Deaths, WA 2002-04

The data relating to the Committee's 11th Report contained investigations of a specially selected subset of deaths of at least 32 weeks gestational age, chosen at the discretion of the EDPH. These data were thought to represent a higher proportion of potentially avoidable deaths, and were considered unlikely to be representative of all deaths. From 2002 onwards the EDPH directed the Committee to investigate a broader range of cases, being all deaths from 26 weeks or greater gestational age, with the exception of known terminations. Of the 167 investigated deaths in the years 2000-01, 51 (31%) were found to have possible preventable medical factors, with 15 (9%) of these deaths considered potentially avoidable. Data for the years 2002-04 indicate a lower proportion of deaths with possible preventable factors, with 59 (13.3%) of 445 investigated deaths in these years coded with possible preventable medical factors, and 18 (4.0%) of these considered potentially avoidable deaths.

Comments:

The peer review process of this Perinatal and Infant Mortality Committee showed that in the triennium 2002-04 87% of deaths met the Committee's expectations of appropriate medical care, and 96% of deaths were considered unavoidable in a medical context.

The main areas where preventable medical factors were identified were in the areas of: management of labour, fetal growth

Skills, Knowledge and Training

Specific recommendations that flowed from the case reviews are now discussed.

Hypertension and diabetes are two of the most common medical conditions to complicate pregnancy (7-10% and 3-5% respectively) but optimal management has been shown to reduce the risk of pregnancy loss considerably.[46] These were areas of concern in the past that are now generally well managed. There were a small number of deaths due to hypertension and diabetes mellitus identified by the Committee in 2002-04 where improved medical management was indicated. However, the main areas where the Committee considered that medical management may have been better were in the management of labour, identification of fetal growth restriction, management of peripartum sepsis and the sick neonate.

Ready access to on-line guidelines, at the point of patient contact, is important to ensure up-to-date management decisions.[39,66] KEMH guidelines on the internet were previously accessible only by password, but the password feature was recently removed to allow universal access, making it easier to obtain current medical management advice.

The Committee discussed the need for adequate training and retention of technical skills for doctors and midwives. New techniques may be beneficial in this respect. For example, improvements in technical ability to manage emergencies such as shoulder dystocia have been shown with simulation training with manikins.[67]

Clear communication and good teamwork with other staff is highly important, particularly in emergency situations.

Recommendation 5:

Professional Training:

Medical practitioners and midwives should have training and practice drills, particularly in the following areas:

- Use and interpretation of electronic fetal heart rate monitoring in labour
- Resuscitation of the newborn
- Management of obstetric emergencies, particularly shoulder dystocia.

Recommendation 6:

Clinical Guidelines:

On-line access to clinical guidelines should be available at the point of patient contact.

Obstetric care:

Hypoxic peripartum deaths

Whilst hypoxic peripartum deaths represented 8.5% of the investigated perinatal deaths in WA 2002-04 (15 stillbirths and 15 neonatal deaths), almost half of these (14 deaths) had preventable medical factors.

The correct use and interpretation of electronic fetal heart rate monitoring may have assisted in nine cases. The Committee suggests the need for improved training of staff in monitoring of fetal wellbeing in labour.[17]

Diabetes

Five deaths with preventable medical factors in the triennium 2002-04 were attributed to diabetes. A detailed update of management of diabetes in pregnancy is included in Section 6.2 Educational Papers.

Almost half of the Aboriginal women experiencing stillbirths had infrequent antenatal attendance or poor compliance with recommended antenatal care. Aboriginal women with diabetes may have had improved outcomes if they had access to specialised diabetes clinics. Some of these women had poor compliance due to social or transport issues, and some were not referred to specialised care. The patient assisted transport scheme (PATS) provides financial support for women referred to specialist care away from home, but there continue to be barriers to women attending specialist services, particularly where they have other dependants, and limited accommodation options in specialist centres. For example sometimes there is hostel accommodation available for the patient, but not the rest of her family. These may be significant disincentives to travel to appointments.

Improving access to specialised diabetes services may be achieved through increasing the number of such clinics, utilising telephone support from the clinics, and increasing domiciliary services (outreach from the tertiary and regional centres, to remote areas). In particular, culturally appropriate outreach services, with multidisciplinary teams including Aboriginal health workers may improve compliance.

It is often necessary for local general practitioners and midwives to be involved in the management of high-risk patients in rural areas, particularly when patients are reluctant to travel to metropolitan or regional specialised clinics. Where this occurs, frequent liaison with specialists is recommended. Patients are also encouraged to access telephone advice for monitoring and adjustments of treatments, such as insulin doses.

Recommendation 7:

Diabetes in Pregnancy:

Routine management of patients with diabetes in pregnancy should involve:

- education and dietary advice.
- monitoring blood glucose levels to assess glycaemic control.
- specialist consultation/ liaison for those patients with poor glycaemic control.
- routine monitoring of fetal wellbeing, including ultrasound assessment for fetal macrosomia.

Pre-eclampsia

Four of the 30 stillbirths associated with hypertension had preventable medical factors. Antihypertensive medication should be used with prudence in pregnancy. Treatment may mask the progression of pre-eclampsia, and timely delivery should be carefully considered in the presence of this disease.

Antenatal low-dose aspirin therapy has been shown to reduce the risk of recurrent pre-eclampsia, birth prior to 34 weeks gestation and perinatal death in high risk women, and its use is recommended, along with consultant management.[68]

Twins

Early ultrasound assessment should identify twin pregnancies at increased risk of twin to twin transfusion syndrome. It is suggested that those with monochorionic twin pregnancies should have ultrasound surveillance for fetal growth at 18, 24, 27, 30, 33 and 36 weeks gestation. Those with dichorionic pregnancies should have ultrasound monitoring at 18, 26, 30, 33 and 36 weeks gestation.[39] Further discussion of twins is in Section 6.3 of this report.

There were six deaths in pregnancies conceived through assisted fertility techniques, with four of these involving multiple pregnancies. Careful monitoring and application of assisted fertility techniques is advised, to reduce the incidence of multiple pregnancy.

Recommendation 9:

Multiple Pregnancy:

Management of multiple pregnancy requires ascertainment of chorionicity at 12 weeks gestation and frequent ultrasound assessments of fetal growth, as per guidelines:

King Edward Memorial Hospital guidelines for obstetrics: http://kemh.health.wa.gov.au/development/manuals/sectionb/index.htm

Neonatal Care

A significant proportion of newborns are given some type of resuscitation. Of babies born in WA in 2004, 41.8% had some form of resuscitation (mainly oropharyngeal and nasal suction and free-flow oxygen); 7.2% required more active resuscitation with bag and mask ventilation or endotracheal intubation.[2]

Guidelines about resuscitation have largely been based on precedent, and may be altered with new research, for example some evidence challenging the belief that oxygen is superior to air for resuscitation.[69,70] This has to led to KEMH and PMH adopting the use of oxygen blenders and recommending initial settings of 30% oxygen in the resuscitation of the newborn, pending further evidence being available. These neonatal care guidelines are available on-line. KEMH and PMH follow the American Academy of Paediatrics and American Heart Association algorithm for resuscitation, which is taught through the Neonatal Resuscitation Program (NRP) in WA.[72]

The endotracheal route of administration of drugs is thought to be useful where intravenous access is not yet established, but there is less data about administration of drugs given this way.[73] Umbilical venous access can usually be secured readily in newborns. Naloxone should not be given in the absence of likely maternal opiate depression.

Medical and midwifery staff may benefit from regular 'drills' in technical skills for resuscitation of the newborn. The use of training programs with manikins may be helpful.[74]

Useful advice about the care of sick neonate and transport issues, with attention to practical advice, is available in the WANTS Medical Manual,[24] with summary guidelines 'Stabilisation and Transfer of the Sick Neonate' available in the 11th PIMC Report.[3]

Australian data have identified that equipment varies between institutions, and this variation reflects lack of clinical evidence that results in uncertainty in decision making.[75] Equipment problems and/or familiarity with the available resuscitation equipment may have been unidentified systems issues in the WA 2002-04 cases where there were difficulties with resuscitation of the newborn. The methods used by the Committee make it difficult to detect such problems, as they are usually not documented.

Particular Committee comments that arose from the case reviews of the deaths in WA 2002-04 included:

a) Close observation should be made of a newborn with low Apgar scores and suspected birth asphyxia. This is best done in a neonatal intensive care unit or at least a level II nursery.

b) In the presence of unexpected difficulty in ventilating a baby, one should consider the presence of pneumothorax or diaphragmatic hernia.

c) The importance of volume expansion is stressed, particularly in the circumstance where it is suspected that an infant has lost blood volume.

d) Infants expected to deliver prior to 34 weeks gestation should be referred to KEMH, the state's tertiary perinatal centre.

Recommendation 12:

Neonatal Management issues:

The newly established Neonatal Network is supported.

The Neonatal Network should be adequately resourced and supported to coordinate statewide neonatal care and workforce.

12.1 A baby with poor Apgar scores (suspected birth asphyxia) should initially be managed in a level II or III special care nursery, particularly being aware of the problems of hypoglycaemia and metabolic acidosis.

12.2 Where there is neonatal shock (e.g. sepsis, birth trauma/ sub-galeal haemorrhage), staff should be aware of the baby's need for rapid intravenous volume replacement.

12.3 Infants with respiratory distress or other signs of sepsis should be treated promptly with antibiotics.

Recommendation 13:

Transport Issues:

13.1 Care should be taken to deliver babies likely to require special nursery care in an appropriately staffed and equipped hospital.

13.2 Referring staff are encouraged to anticipate transfer, phone early, and closely liaise with transport staff, to assist in prioritisation of transport needs.

Group B Streptococcal Sepsis

The Committee advises that practitioners should have a high index of suspicion of sepsis in 'unwell' neonates and following high-risk labours, and antibiotics should be administered quickly where there is potential bacterial sepsis. Any respiratory distress in a newborn should be treated swiftly and the baby should be transferred to a special care nursery.

Recommendation 11:

Group B Streptococcus Guidelines:

- Guidelines for screening for Group B Streptococcus at 36 weeks gestation of pregnancy, and intrapartum antibiotic treatment for carriers is recommended:

  King Edward Memorial Hospital guidelines for obstetrics: http://kemh.health.wa.gov.au/development/manuals/sectionb/index.htm
- Staff should be aware of guidelines to reduce the risk of neonatal sepsis:

  PMH and KEMH Clinical Guidelines for Neonates: http://kemh.health.wa.gov.au/development/manuals/sectionb/11/7278.pdf

Medical Errors

There are considerable difficulties in identifying and assessing medical errors, near-misses and other adverse events that may affect patient outcome.[77] The PIMC does not assess broader issues of morbidity, nor errors that do not result in deaths. Health care providers are encouraged to assess their outcomes, including assessments of errors or near-errors, to work towards better systems.

5.5.6 Maternal Behavioural Factors

With reductions in deaths associated with medical factors, parental behavioural factors are increasingly the focus of the PIMC.

Compliance

Infrequent antenatal attendance is associated with an increased risk of term stillbirth, after correcting for socioeconomic status.[41] Poor maternal compliance was a factor in 14% of investigated deaths in WA 2002-04. In particular, a significant proportion of Aboriginal mothers experiencing a perinatal or infant death had poor compliance with antenatal care. There are many reasons for poor attendance. Attendance is more likely at culturally acceptable and easily accessed clinics. For example, a community-based model of care specifically for Aboriginal mothers in Queensland showed significantly improved attendance for antenatal care, and whilst it did not show a significant reduction in the prevalence of low birthweight or perinatal mortality, it did show reduced rates of preterm birth. Consideration should be given to increasing the number of dedicated antenatal clinics for Aboriginal women.

There is no routine collection of information about number of antenatal attendances. Adding a question about antenatal attendance to midwifery notification forms may lead to a better understanding of compliance factors.

Substance Use

Smoking and substance use are important modifiable risk factors. Smoking rates are declining, but still relatively high amongst those of lower socioeconomic status. There are problems in data collection about illicit substance use in pregnancy, and the extent of the problem is not well understood, but may be increasing. The number of patients using illicit substances at the time of postnatal discharge from KEMH has increased steadily from 38 women in the six month period July-December 2004 to 88 women in the six month period July-December 2006, and suggests that there may be an increase in the prevalence of women with serious drug use problems in pregnancy.[79]

Recommendation 14:

Data collection:

Collection of additional information on midwifery notification forms is recommended. Questions about number of antenatal visits, maternal weight and alcohol use are suggested.

Practitioners are urged to enquire into and provide counselling about smoking, alcohol and other substance use in pregnancy. The use of multidisciplinary specialised chemical dependency clinics are recommended for mothers with addiction/substance use problems, as these are a particularly high risk and challenging group.

There is an increased risk of neonatal mortality associated with women using opiates in pregnancy. In particular, a meta-analysis has shown that a combination of heroin and methadone use during pregnancy, compared to those stabilised on methadone, is associated with a higher risk, thought likely to be due to the chaotic and high-risk lifestyle associated with illicit heroin use, and not solely to the use of the opiates. It is recommended that women who use illicit heroin during pregnancy receive special attention over and above that provided to women stabilised on methadone.[80]

The postnatal follow-up of mothers using illicit substances is particularly important, with involvement of social workers and other welfare agencies strongly recommended. The Committee has limited data about the current state of follow-up of such high-risk women, and this is an area where potential benefits may be seen.

There are a number of services that provide assistance to mothers and families. These include child health nurses, general practitioners, psychiatric services, Department of Community Development, Department of Child Protection and non-Governmental agencies. There are also dedicated services that provide counselling, support and outreach services to women who are pregnant and/or parenting and have problematic alcohol and/or other substance use, such as the Pregnancy and Parenting Substance Use Program (PEPISU).[81]

Violence

Domestic violence was a documented problem in fifteen women who experienced a stillbirth or infant death in WA in 2002-04. It is difficult to know the prevalence of domestic violence in the community.

There were 946 hospital admissions due to intimate partner violence recorded in WA in the period July 2002 - December 2003, in people aged 15 years and over. The rate was 40.9 per 100,000 population and 85% of victims were female.[82] The rate for Aboriginal people (n=677) was 83 times greater than for non-Aboriginal people (n=284). Rural residents accounted for 71% of hospitalisations for the care of victims of domestic violence, however rural residents represented 24% of the population in WA during the study period.[82]

Advocacy has been shown to reduce re-abuse, and there is evidence that counselling and safety planning are beneficial.[83] KEMH now screens all pregnant women for domestic violence at the routine booking-in visit. Information and resources for this area are available through Domestic Violence Advocacy Support Central ('dvas central')[84] which is a partnership of organisations including Legal Aid, WA Police Service and other Governmental organisations, and Yorgum Aboriginal Counselling Service.

Child Abuse

Ten infant deaths in WA 2002-04 were due to non-accidental injury. The incidence of child abuse is significant in Australia, more prevalent in Aboriginal communities, and thought to be under-estimated. The Australian Institute of Health and Welfare (AIHW) has collected the national child protection data since the early 1990's. The data cover child protection notifications, investigations and substantiations (formerly referred to as child abuse and neglect), children on 'care and protection orders', those in out-of-home care and those receiving intensive family support services. There are significant differences in child protection processes between states, so published figures must be interpreted with caution, but they do show that a significant number of children are subject to abuse or neglect, with the risk in Aboriginal children being considerably higher than in non-Aboriginal children.[85,86] In 2003–04 the rate of children enrolled in the child protection system in Aboriginal families in WA was around 8 times higher than in non-Aboriginal families. Children at increased risk of child abuse include those living in poor housing conditions, of low socioeconomic status, and from single parent or blended families.[85]

The Royal Australasian College of Paediatricians has a discussion paper about the complex issue of child abuse and considering the problem in its broader social context.[87] The College suggests that when a child is at risk of or is being abused, action must be taken quickly and intensively. It recommends a consistent systems approach, early intervention programs and that social policies be reviewed to improve outcomes for children, such as in the justice system. It states that paediatricians should play a key role in child protection, and acknowledges the importance of involved professionals and agencies working in partnership for the benefit of children. There is comment on the need to improve data collection and review, and for training for those involved in this work.

Summary: social risk factors

A large number of organisations provide support to those with social risk factors. The Committee suggests that such organisations be further assisted in their endeavours. New initiatives are also sought.

A review of the Governmental Departments of Community Development and Child Protection is in process.

The use of specialised services may improve compliance and outcomes, such as:

- Dedicated antenatal clinics for Aboriginal women
- Specialist diabetes services for pregnant women with diabetes mellitus
- Alcohol/drug dependency services for pregnant women with addiction
- Psychiatric services for women with mental health problems in pregnancy and the puerperium
- Dedicated antenatal and postnatal services for adolescent mothers.

Recommendation 2:

Social Issues:

Support for those with social risk factors needs to be improved.

2.1 Increased support should be given to agencies working to assist families with social risk factors such as poor housing, domestic violence and alcohol and other substance use.

2.2 Outreach services are recommended to improve compliance with antenatal care for those with special needs.

2.3 Screening for depression and domestic violence is recommended as a routine in antenatal and postnatal assessments.

5.5.7 Aboriginal Health

Medical and social advances have seen striking reductions in stillbirth and infant mortality rates over time, particularly in first world countries. The results shown in this report highlight that the remaining challenges in reducing mortality rates lie largely in the public health domain - environmental factors such as socio-economic conditions and lifestyle factors. Aboriginal people have mortality rates similar to some third world countries.

'Many Aboriginal and Torres Strait Islander peoples, especially those living in remote communities, do not have adequate quality housing, reliable supplies of water and electricity or adequate sewerage and drainage systems…'

World Health Organization (WHO) data show that Australia has a higher infant mortality rate than many other Western countries.[89]

Aboriginal babies have increased risks of low birth weight and preterm birth, as shown in the WA data 2002-04. Low birthweight in Aboriginal infants is of particular concern, and known to be a predictor of poor health and disability.[90,91]

Low birth weight and fetal growth restriction also have future implications of increased risk of diabetes, cardiovascular disease and obesity in adult life.[92] There are issues such as living in remote areas, with reduced access to health services, disadvantaged living conditions and increased exposure to infection.

'Pregnancy and early childhood experiences impact on a child's lifelong capacity for learning and development, their physical and mental health and wellbeing and their opportunities for educational, social and economic attainment.

An important factor impacting on the early years of many Indigenous children is the issue of geographic remoteness and associated issues such as access to basic and specialist health infrastructure, and essential services such as potable water and safe rubbish and sewerage disposal. This is particularly relevant for discrete Indigenous communities where the condition of basic essential services can lead to environmental conditions impacting on health in ways not experienced by their mainstream or urban counterparts. For many this results in increased rates of infectious disease. In some very remote communities, the early diagnosis and treatment of childhood illnesses may be compromised by the condition of roads and the availability of transport to appropriate health services, among other things. Preventable diseases and illnesses may then require services such as the Royal Flying Doctor Service, to access the necessary treatment.'[90]

The diversity of Aboriginal people must be kept in mind. There are significant differences in different groups of people, including cultural practices and language.[93] The need to be aware of this has been highlighted by the recent work in public health education regarding safer sleeping practices for babies (see Section 5.5.4).

New ways are sought to improve the health and welfare of Aboriginal people. There is some evidence that antenatal clinics dedicated to improving the health of Aboriginal women can improve outcomes.[78] An example of another method that may prove beneficial is the 'Schools Based Healthy Eating Program'[94]:

The 'Schools Based Healthy Eating Program' is similar to projects trialled in Indigenous communities which have resulted in significant improvements in birthweight, decreases in hospitalisation for nutritional or gastroenteritis conditions, increases in regular school attendance, decreases in truancy, and improvements in mental health outcomes.

This strategy comprises:

- *the provision of a properly nutritious breakfast and lunch for children attending school;*
- *education sessions for mothers and pregnant women regarding nutrition and child development, including a focus on 'weaning' foods;*
- *the setting up of a grandmother/mothers' group to oversee the program and to coordinate the delivery of informal training to community members in healthy shopping, cooking skills and related areas;*
- *a program of regular visits to the local health clinics for children aged 0-12 years; and*
- *a partnership with local stores to promote supply and access to foods with high nutritional value.*

Important public health messages, such as the risks of smoking, importance of good nutrition and infant safety issues, may best be addressed in educational programs at school, arming young girls with more knowledge and skills prior to motherhood.

The WHO advocates health promotion that aims to enable people to increase control over and to improve their health. This includes creating a supportive environment, providing access to information, building healthy public policy, developing life skills, strengthening community action and increasing opportunities for making healthy choices (WHO 1986).[95]

Recommendation 3:

Aboriginal care:

Innovative programs are required to address the high rates of Aboriginal mortality.

- Culturally appropriate education programs targeting nutrition, diabetes and alcohol and other substance use problems are recommended.
- Outreach programs, such home visits by Aboriginal health workers, are recommended.
- Dedicated antenatal clinics for Aboriginal women may be of benefit and should be considered.

5.5.8 Home Births

Data from the National Perinatal Statistics Unit show that in Australia in 2004, there were 589 planned home births (0.2% of all women who gave birth), and the highest proportion of home births by state or territory occurred in WA. Of babies born at home in Australia in 2004, all were liveborn and the mean birthweight was 3,698 grams. The proportion of liveborn babies of low birthweight born at home was 1.5%, and the proportion of preterm births was 0.3%.[14] This data suggests that the vast majority of planned home births occur in low risk women in Australia. In the five years 2000-04, there was a significantly increased risk of perinatal mortality in babies of term gestation amongst planned home births in WA.

A small but significant number of women choose a planned home birth. Ideally that choice would be 'informed choice'. The current risks and benefits of home birth in Australia are not well understood, due to low numbers and lack of recent research. However, there was an increased risk of perinatal mortality in planned home births compared with planned hospital births in a large Australian study of home births (1985–1990, n=7,002 planned home births; 1.4% low birth weight) where analysis of births in the four years 1985-1988 for which the most comprehensive data were available showed that in babies of at least 2500g birthweight there was a perinatal mortality rate of 5.7 deaths per 1000 births in planned home births compared with 3.6 deaths per 1,000 planned hospital births (RR 1.6; 95% CI 1.1-2.4).[96] Intrapartum death not associated with congenital malformation or extreme immaturity was three times as frequent in planned home births than it was nationwide (RR 3.0; 95% C1 1.9-4.8). There was a fivefold increased standardised perinatal mortality risk in a South Australian study from 1976 to 1987 (standardised perinatal mortality ratio = 507; 95% CI 253-908).[97] The same study showed an intrapartum asphyxial death rate of 3.8 per 1000 births compared with a South Australian rate of 0.5 per 1,000 births in 1986-87. One small WA study (1983-1986, n=165 planned home births) had good outcomes. Another WA study (1981-1987, n=976 planned home births) showed a trend towards an increased perinatal mortality that was not statistically significant.[98] All of these studies showed a decreased incidence of obstetric intervention. Women requesting a planned home birth may be resistant to transfer to hospital and to obstetric intervention when clinically indicated.[99]

A recent large prospective study of planned home births in low risk women in the US was published in 2005 (n=5,418 planned homebirths).[100] This showed 'similar perinatal mortality risks to hospital births' (1.7 deaths per 1,000 planned home births), with reduced intervention rates and no maternal deaths. In this study comparison was made with perinatal mortality

rates in all singleton vertex births at 37 weeks or more gestation in the US in the same year, as reported by the National Centre for Health Statistics,[101] which the authors stated 'acted as a proxy for a comparable low risk group' although this would have included high and low risk pregnancies. There were measured (and probably other unmeasurable) differences between the groups of mothers that planned a home birth and those who planned a hospital birth. The authors considered this, and looked at a sub-group of mothers from California for whom more data were available.[102] Perinatal mortality in this group was 2.4 per 1,000 for planned home births, and for the planned hospital births was 1.9 per 1,000. The authors made statistical adjustments for differences in risk profiles and considered that the risk was slightly lower for intended home births, however some deaths were excluded from the analysis that may lead to questions about the interpretation of the data.

Advocates of home births have often quoted 'safety data' from international studies, but it is difficult to extrapolate from international data to the situation in Australia where there are differences in many respects, including training and experience of midwives, and geography. The difficulty of emergency transport services to offer safe retrievals in WA is a major consideration. Whilst there have not been any maternal deaths in planned home births in WA in recent years, there may be concern about the potential risk of maternal death, particularly due to postpartum haemorrhage in the home setting. There was a significantly increased risk of third stage complications in planned home births in WA 1981-1987.[98]

The information presented from the WA 2000-04 analysis shows that the choice of home birth would appear to have put 'low risk' women into a 'higher risk' category of perinatal death, although possible demographic differences in the group of women who chose home birth compared to those women who chose a hospital birth have not been examined. In addition, there is no information available to the Committee regarding morbidity outcomes for women who had a home birth. A formal review of home birth outcomes in WA may answer some of these questions.

Recommendation 16:

Home births:

A review of home births in WA is recommended to assess essential health outcomes, including morbidity and mortality.

5.6 Investigations into Cause of Death, Investigated Cases, WA 2002-04

In this triennium, the Investigators noted an increased number of pathology investigations performed to assess causal factors in stillbirths. This improvement coincides with renewed educational activity of the PIMC since 2001.

Post-mortem Examination

WA has relatively high rates of post-mortem examination of stillborn babies and infant deaths (68% in WA 2002-04) and these rates are gradually increasing, which is against the trend seen in many other places. To compare, in 2004 in NSW post-mortem examinations were carried out for 33% of stillborn infants and 23.7% of neonatal deaths.[103] It is a difficult time for parents and the importance of 'excellent communication skills' in explanation of the benefits of autopsy, and in obtaining consent for the procedure is acknowledged.[104] Practitioners are advised to liaise with the perinatal pathology centre of KEMH in obtaining information, brochures, and assistance in advising families about autopsy. Perinatal loss information is available on-line.[105]

Recommendation 17:

Cause of Death:

Thorough investigation to assess cause and contributing factors in stillbirths and infant deaths is recommended, with reference to investigations recommended in Appendix II.

5.7 Parental Support, Investigated Cases, WA 2002-04

Case notes generally documented a very high level of care and compassion offered to grieving families. Parental distress may be exacerbated by lack of explanation as to the cause of their child's death, and efforts should be made to thoroughly investigate deaths. Stillbirths labelled as 'unexplained' continue to perplex health professionals and patients. 'SIDS and Kids'[106] provide excellent support services for families who have lost an infant or child. There are also services offered through KEMH and PMH.[27]

5.8 Closing Remarks, PIMC, WA 2002-04

The work of the PIMC is an ongoing process, auditing stillbirths and infant deaths. Practitioners are reminded of the importance of auditing their broader health outcomes, including measures of morbidity.

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6 Educational & discussion papers

6.1 Epidural Analgesia in Labour - Safety and Monitoring

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Introduction

The number of births in Australia in 2003 was over 256,000 and the Caesarean section rate was almost 29% (AIHW, 2006). Over 90% of those having an operative delivery received a central neuraxial (epidural, spinal or combined spinal-epidural) block and a third of those having a vaginal delivery, including 50% of those in their first labour, use epidural pain relief.

This article addresses aspects of safety and monitoring relevant to epidural pain relief for labour and delivery. It is important to recognise that a 'labour epidural' is not a generic intervention and that a multiplicity of techniques is now used (Paech, 2003). Since the mid-1990s identification of, and drug administration into, the subarachnoid (also referred to as the spinal or intrathecal) space, prior to epidural catheterisation, has become an alternative method to the conventional 'labour epidural'. This 'combined spinal-epidural' (or 'CSE') technique has a number of different characteristics and implications when compared with a traditional 'epidural'. Furthermore, effective epidural pain relief can be achieved with different drug combinations, most commonly local anaesthetic with an opioid, and with different drugs from within the class, administered in a range of concentrations and doses. These analgesic solutions may be delivered by different means (most commonly by medical or midwifery administered intermittent boluses, but also by continuous infusion or patient-controlled administration and more recently by automated boluses and other computer-integrated variants). These variables have commonalities, but also specific and different implications with respect to maternal and fetal surveillance and care. All maternity units offering anaesthesia-based pain services should have monitoring policies and protocols based on general principles (ANZCA professional standards publications, 2006) and local practices that deal with the complexities of a 'labour epidural'.

Physiological implications of the "labour epidural"

Many types of drugs have central neuraxial and spinal cord analgesic properties and are safe to administer via this route. For example, epidural clonidine (an alpha$_2$-adrenergic agonist) and neostigmine (an anticholinesterase drug) are effective in early labour and are occasionally used as adjuncts to other epidural analgesic drugs. However it is very difficult to deliver effective epidural pain relief throughout labour and delivery without administration of local anaesthetic (LA). This class of drug remains the principal component of epidural solutions, often in combination with an opioid such as fentanyl. Opioids produce analgesia through mu-opioid receptor agonist activity at spinal cord and more cephalad central nervous system locations, and are mainly added to reduce the LA requirement and hence undesirable sequelae of near-complete nerve conduction block. The degree of autonomic, sensory and motor fibre block of the peripheral nerve as it traverses the epidural space varies with the concentration and physical properties of the LA drug (for the 'labour epidural', most commonly bupivacaine, ropivacaine or levo-bupivacaine). The effects are also determined by the distribution of LA, which is principally dependent on dose, but effects on vascular tone, sensory modalities other than nociception (pain) and on muscle strength are inevitable.

These modifications of neurophysiology have the potential to alter maternal blood pressure (BP); reduce mobility (depending on technique, 5-70% of women cannot ambulate shortly after a 'labour epidural'); and diminish expulsive effort and power at delivery (increasing the rate of assisted vaginal delivery in nulliparous labour, although CSE and low-dose epidural techniques have less impact than a traditional high-dose LA epidural). Secondary effects may lead to changes within the feto-placental circulation that adversely affect fetal status.

Impaired uteroplacental perfusion

As there are no current means of bedside assessment of uteroplacental perfusion pressure and blood flow, maternal symptoms, maternal brachial BP and fetal heart rate monitoring are widely used to guide management and as triggers for intervention. A very common problem is failure of attending staff to understand that maternal brachial artery BP may be normal in the presence of inadequate uteroplacental perfusion because of aortocaval compression, which occurs in 90% of women at term lying in the supine position. The potential for a significant reduction in maternal cardiac output (with *or without* accompanying hypotension) is exacerbated in the presence of the 'labour epidural' because compensatory mechanisms are compromised. Although the severity of vena caval and/or aortic obstruction is attenuated in the sitting position and by lateral pelvic tilt, only the full left lateral position reliably reduces this complication. This is the initial maternal position advised for all cases of possible maternal or fetal compromise, with the exception of cardiac arrest, where uterine displacement in the supine position is recommended (to maximise the effectiveness of external cardiac compressions on cardiac output, while avoiding aortocaval compression).

A small reduction in BP is expected after a 'labour epidural', but the risk of severe maternal hypotension (5-20%) depends on patient factors, the nature of the "labour epidural" and the definition of hypotension. Commonly applied criteria are a fall of systolic BP to less than 90 mmHg or of greater than 20% from baseline. The latter appears more rational physiologically, given progressive deterioration in biochemical outcomes as maternal BP falls documented when neonates are affected by spinal anaesthesia induced hypotension before Caesarean delivery. Severe maternal hypotension occurs infrequently (a rate of approximately 1 in 20) when a CSE or low-dose LA and opioid epidural solution is used in labour. The time course also varies with technique, but in the absence of a rare complication (such as a high block) is usually within the first 30 minutes. Subsequent to the initial dose, worrisome hypotension is very uncommon especially with continuous infusion or patient-controlled epidural drug delivery.

Altered maternal respiratory physiology and placental gas exchange

It is possible that adverse effects of maternal hyperventilation (due to pain) on fetal gas exchange, demonstrated in animal models, are attenuated by the 'labour epidural'. Episodic maternal oxygen desaturation between contractions is seen in the absence of analgesics and adversely affects maternal-fetal gas exchange (Reynolds, 1998). Such episodes are increased by systemic (intramuscular or intravenous) opioids like pethidine, and are reduced by an epidural using LA. Whether intrathecal or epidural opioid contributes to maternal hypoxaemic episodes is unknown, but lower plasma concentrations of drug suggest that any secondary fetal effect is likely to be less than that of systemic opioid. Meta-analysis indicates better neonatal outcomes from women receiving a 'labour epidural' compared with those from women receiving systemic opioids (Reynolds, 2002). Severe maternal respiratory depression from epidural or intrathecal fentanyl in a 'labour epidural' is an exceptionally rare event. However, many units monitor maternal respiration and sedation routinely if an opioid is administered during labour, irrespective of the route of administration.

Pharmacological implications of the "labour epidural"

Direct Drug Effects

Both LA and opioid show significant transplacental transfer, so direct pharmacological effects on the fetus can be anticipated. The pharmacokinetic principles and specifics of transfer of "labour epidural" drugs are complex (Reynolds, 1998). Clinical studies indicate that fetal levels of the long-acting amide LA drugs are insufficient to alter neonatal neurobehaviour and that low-dose LA-opioid solutions do not change fetal electrocardiography. In general, the direct effects of LA and of intrathecal opioid are considered clinically unimportant.

Epidural opioids, in contrast, produce dose-dependent neonatal effects that are occasionally clinically relevant. Repeated or continued maternal administration of epidural fentanyl for several hours produces readily detectable neonatal plasma concentrations. However, a number of observational studies of low-dose LA-opioid solutions found no effect on neonatal Apgar score, acid-base status or neurobehavioural responses compared with epidural LA alone. At conventional dose rates (fentanyl 30 mcg/h) neonatal respiratory physiology at birth is unchanged and despite accumulative doses of up to 400 mcg no detectable effect on neonatal respiration or neurobehaviour was found compared with controls not receiving opioid (Reynolds,1998).

Indirect Drug Effects

In addition to indirect fetal and neonatal effects as a result of maternal cardiovascular changes, indirect effects may result from altered maternal respiratory physiology and from neuroendocrine responses to rapid and profound pain relief. Changes in fetal heart rate (FHR) within 30 minutes of a 'labour epidural' are well recognised after both epidural and CSE techniques and were traditionally ascribed to reduced uteroplacental perfusion secondary to maternal hypotension. Intrathecal opioid, however, has minimal effect on maternal BP and the incidence of significant FHR change remains 15-20% after a CSE 'labour epidural'. A plausible explanation for such changes is the loss of a tocolytic effect as plasma catecholamine levels fall substantially when pain is relieved. The myometrial relaxation as a result of a beta-sympathomimetic effect of adrenaline is reduced compared with the sustained alpha-adrenergic action of noradrenaline, resulting in increased uterine activity and reduced uteroplacental flow (Madirosoff, 2002; Littleford 2004). The time course of these FHR changes differs (usually within 10 minutes for a CSE versus 15-30 minutes an epidural technique) but the period of increased uterine activity is usually brief and fetal compromise is readily correctable (*vide infra*, Intrauterine Resuscitation). In some women, maternal temperature rises in response to epidural analgesia, with apparent risk factors including the pre-epidural temperature, type of epidural solution, increasing duration of epidural analgesia, time since rupture of membranes and number of vaginal examinations. The mechanism is incompletely understood. Over a period of hours, this temperature rise may result in the threshold for 'maternal pyrexia' being reached and trigger both maternal investigation and treatment, and subsequently neonatal sepsis evaluation. Additionally, fetal temperature is dependent on uterine temperature and in animal studies fetal hyperthermia is associated with hypoxia and acidosis, while case control studies suggest an increased risk of encephalopathy. Whether these potential concerns are clinically significant requires further research, but at present there is no evidence that the widespread use of epidural analgesia in labour in recent decades has led to adverse neonatal sequelae (Mercier, 1997; Banerjee, 2003).

Complications of the 'labour epidural'

There are a number of potential complications arising directly from either the technique or drug administration in a 'labour epidural'. Detail is beyond the scope of this article, but the management of the hypotensive mother (oxygen therapy, positioning, intravenous vasopressor and inotropic drugs, intravenous fluids, correction of the cause); resuscitation of the apnoeic woman (clear and secure the airway, oxygenation and ventilation, reversal of opioid with naloxone); the management of the convulsing patient; and cardiopulmonary resuscitation, should be familiar to those caring for these women.

Rare life-threatening complications of a 'labour epidural' include:

Severe maternal hypotension (supine position)
: cardiovascular collapse, unconsciousness

Vasovagal syncope
: bradycardic cardiovascular collapse, unconsciousness, convulsions

High autonomic, sensory and motor block (epidural, subdural or intrathecal spread of local anaesthetic)
: respiratory depression, apnoea, unconsciousness, severe hypotension, cardiac arrest

High sensory block alone (intrathecal opioid)
: mild breathing disturbance, difficulty with phonation and swallowing

Local anaesthetic toxicity (usually epidural venous injection)
: central nervous system symptoms, convulsions, hypotension, cardiac arrest

Severe respiratory depression (high spread of epidural or intrathecal opioid)
: hypoventilation, apnoea, unconsciousness, hypoxic cardiac arrest

Monitoring the "labour epidural"

The anticipated physiological and pharmacological effects of epidural analgesia may occasionally adversely affect the mother, baby or both. Routine monitoring should include maternal vital signs (including the severity of pain, 'the fifth vital sign') and the fetal heart rate, although electronic FHR monitoring is not mandated in the absence of other indications. Blood pressure is most accurately measured in the dependent arm in the lateral position using auscultation. Most anticipated effects are maximal within the first 30 minutes of establishing the 'labour epidural'. Rare and unpredictable complications (Table 2) are also likely to present within this time period. Vigilance is particularly important at this stage and continuous surveillance by medical or nursing staff is an accepted standard of safety. In special cases, additional maternal monitoring (pulse oximetry, direct arterial blood pressure) or fetal monitoring (scalp pH) may be of value.

Many units also monitor the level of sensory block after establishing epidural analgesia and continue hourly thereafter. Sensory changes due to intrathecal opioid or low-dose LA-opioid epidural solution can be subtle and the former are not of value in assessing efficacy. Later, during maintenance of the epidural analgesia, sensory block assessment proves of greater benefit, especially as a means of 'trouble-shooting' unsatisfactory neural distribution of epidural solution.

A suggested scheme for monitoring after establishing a 'labour epidural' is:

Routine
5 minutely observations for at least 20 minutes and preferably 30 minutes -
Maternal heart rate
Maternal blood pressure
Maternal respiration (rate ± pattern)
Maternal conscious state
Maternal pain (0-10 numerical rating score)
Fetal heart rate

and additional hourly observations once the 'labour epidural' is established -
Maternal sensory block (loss of cold or pinprick sensation)
Maternal temperature

Optional, determined by circumstance
Maternal pulse oximetry
Maternal arterial blood pressure and arterial blood gas analysis
Maternal central venous pressure; transthoracic echocardiography
Maternal biochemistry and haematology
Fetal scalp pH or oximetry

Intrauterine Resuscitation

Although the physiological and pharmacological effects of a 'labour epidural' may occasionally lead to a reduction of uteroplacental flow, maternal hypoxaemia and fetal compromise, which are the consequences of these effects, can almost always be rectified without the need for urgent delivery (Mardirosoff, 2002; Thurlow 2002). Severe maternal hypotension is very infrequent if the supine position is avoided and is usually readily correctable with vasopressor drugs such as ephedrine and phenylephrine.

Approximately half the FHR changes seen after a 'labour epidural' are attributable to increased uterine activity, so cessation of oxytocin and tocolysis with terbutaline often produces a rapid resolution of the changes. The availability of a 'labour epidural' service does not increase the incidence of urgent Caesarean section for fetal distress, but occasionally unmasks a compromised fetus or fetus developing hypoxaemia. This allows earlier delivery, before further deterioration occurs during labour.

Intrauterine resuscitation is an important concept that can be applied both prior to a 'labour epidural' if the fetal status is already compromised, or to the situation of worrisome FHR changes occurring after a 'labour epidural'. Strategies for intrauterine resuscitation at the time of a 'labour epidural' are to -

Stop the oxytocin infusion ± administer a tocolytic drug e.g. terbutaline 250 mcg subcutaneously

Position the woman in the full left lateral (try right lateral or knee-elbow position if required)

Give supplemental oxygen (at high-flow rates of 10-15 L/min via a face-mask)

Restore the pre-epidural maternal blood pressure e.g. ephedrine 10 mg intravenously

Consider infusion of intravenous crystalloid 1 L rapidly (caution in the preeclamptic or fluid-restricted parturient)

Further Reading

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6.2 Optimising Outcome for Women with Diabetes in Pregnancy

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Diabetes Mellitus (DM) is the commonest medical condition to complicate pregnancy. Between 0.2% and 0.5% of all pregnancies occur in women with Type 1 DM and a similar proportion in women with Type 2 DM. In addition a further 3-8% of women will develop gestational diabetes (GDM). Diabetes in pregnancy is associated with an increased risk of congenital anomaly, perinatal morbidity and mortality, and operative delivery. Access to a multidisciplinary team including obstetrician, physician, diabetes educator and dietician optimises pre-pregnancy and antenatal care, aiming to reduce perinatal mortality rates to those observed in women without diabetes.

The prevalence of Type 2 DM in young women is increasing and there needs to be an increased awareness of adverse pregnancy outcome in these women. Recent publications have highlighted that women with Type 2 DM require the same level of pre-pregnancy and antenatal care as those with Type 1 DM.[1,2] Pregnant women with Type 2 DM are more likely to come from ethnic minorities, live in deprived areas and have associated obesity. Differences in cultural background, first language, lifestyle and access to medical care need to be considered when providing health services for pre-pregnancy care, education and pregnancy care to these women.

Glycaemic control and Pregnancy Outcome

Reported perinatal mortality rates in infants born to women with pre-existing DM are 3-4 times higher than in the corresponding general population.[3] It is estimated that up to 50% of perinatal deaths in the offspring of these women are secondary to congenital anomalies. The risk of major congenital anomalies in the offspring of women with pre-existing DM is at least twice that of the general population with predominantly cardiovascular (3 times higher risk) and neural tube defects (3-4 times higher risk) accounting for the increase.[3] Antenatal diagnosis of certain cardiac conditions decreases the risk of neonatal mortality and consideration should be given to referring women with pre-existing DM for specialist fetal echocardiography, particularly where glycaemic control has been suboptimal.

Periconceptional glycaemic control may be evaluated by measurement of glycosylated haemoglobin A1c (HbA1c). Although the ideal threshold for HbA1c has not been established, the risk of congenital anomaly and spontaneous miscarriage increases with increasing HbA1c level.[4-6] Preterm labour, pre-eclampsia and perinatal mortality are also related to sub-optimal periconceptional control as measured by HbA1c levels.[5-7]

Good glycaemic control throughout the antenatal period aims to reduce rates of late stillbirth and fetal macrosomia with the associated increased risk of operative delivery and shoulder dystocia.

Pre pregnancy care

For women with pre-existing DM near-normal metabolic control before and around conception reduces congenital anomaly rates, stillbirth and neonatal mortality rates and very preterm birth.[8] Unfortunately recommendations for pre-pregnancy care appear difficult to translate into practice. Even 15 years after the St Vincent declaration[9] only 30-40% of women achieve good glycaemic control by the end of the first trimester let alone during the critical time of early organogenesis, before 7 weeks gestation. Women of reproductive age with DM should be given appropriate contraceptive advice emphasising the importance of ‘pregnancy planning’ and glycaemic control. In particular women being treated for subfertility need to have good glycaemic control before conception.

Women with pre-existing DM, both Type 1 and Type 2, should be referred for pre-conception care both to optimise their glycaemic control and review co-existing medical conditions and drug therapies. In particular women with evidence of microvascular disease, e.g. nephropathy, neuropathy, retinopathy, and those with pre-existing hypertension should be referred for specialist opinion prior to pregnancy where possible or as soon as pregnancy is diagnosed for 'unplanned' pregnancies. Women should aim for good glycaemic control for a minimum of 3 months before trying to conceive. A target HbA1c of less than 7.5% is recommended prior to conception.

High dose folic acid supplementation (5mg daily) should be commenced prior to conception and continued until at least 12 weeks gestation because of the increased risk of neural tube defects. Both angiotensin-converting enzyme (ACE) inhibitors and statins are contraindicated in pregnancy and should be ceased prior to conception. For women with pre-existing hypertension methyldopa is the antihypertensive drug of choice. Low dose Aspirin (100mg daily) should be considered once pregnancy has been confirmed, especially for those women with microvascular disease to try to reduce the risk of pre-eclampsia.

In addition to routine 'pregnancy screening blood tests' the following baseline investigations are recommended: HbA1c, thyroid function and thyroid autoantibody screen, renal function and urine protein/creatinine ratio.

Blood glucose levels: Monitoring, Goals and Treatment

Women with pre-existing DM should be encouraged to increase the frequency of blood glucose level (BGL) monitoring. As a minimum, a fasting level and three '2 hour postprandial' levels should be documented daily particularly during the first and third trimesters. This allows for prompt adjustment of insulin doses to optimise glycaemic control. Those not already on a four times daily insulin regimen should be changed to such a regimen with a short acting insulin (e.g. Novorapid) immediately before the three main meals and an intermediate long acting insulin (e.g. Protophane) in the late evening.

Target BGL's are a fasting level of <5.5 mmol/l and 4-7 mmol/l for the two hour postprandial level. There should be close liaison between the supervising specialist or diabetes educator and the woman. She should be advised to contact her health care professional if levels are elevated for more than two days or if her levels are >8mM fasting or >10mM postprandial on one occasion. Review of the BGL record book and also the glucose meter is recommended as women frequently mis-report their BGL's.

Frequency of testing will depend on patient motivation and the level of BGL control. Women should be encouraged by advice that good glycaemic control within these targets (achieved by frequent monitoring and appropriate adjustment of treatment) will significantly reduce fetal anomalies and macrosomia, reduce episodes of maternal hypoglycaemia/hyperglycaemia and reduce rates of neonatal hypoglycaemia.

Gestational Diabetes

Gestational diabetes (GDM) affects 5-8% of women in Australia. The incidence is likely to increase with the anticipated obesity epidemic. GDM refers to women who are diagnosed with diabetes for the first time in pregnancy, regardless of whether DM persists into the postpartum period.

Screening for Gestational Diabetes

Identification and appropriate intervention for women who develop GDM has been shown to improve pregnancy outcome.[10] Consequently all women should be offered screening for GDM. The table below contains a suggested screening strategy by level of risk and gestation. Screening for GDM identifies women at risk for Type 2 DM in later life and the opportunity to address health and lifestyle issues to prolong the disease free interval can be taken.

Table I: Screening for Gestational Diabetes

	Pre 24 weeks*	24 - 28	29 - 32
Low Risk		**GCT**	**GCT** If no prior testing
Medium Risk • Maternal age of > 30 years • Women with a family history of diabetes • In cases of maternal obesity • Hypertension prior to 20 weeks • Previous macrosomic baby (> 4000 grams)	1. Perform a random blood glucose (RBG)* Interpretation of RBG • If >5.5 mmol/L proceed to a GTT. • If ≤ 5.5 mmol/L repeat RBG every 6-8 weeks and request GTT at 26-28 weeks	**GCT** If abnormal proceed to GTT Or >11 = GDM	**GTT** If no prior testing
High Risk • All of the above • History of unexplained stillbirth • Previous baby with congenital anomalies • Previous Gestational Diabetes • Ethnicity • Aboriginal, Asian, Indian and Middle Eastern groups.		**GTT**	**GTT** If no prior testing

Abbreviations:
GCT - glucose challenge test
GTT - glucose tolerance test

Management of GDM

Women found to have GDM should be promptly referred to a diabetes educator and dietician. The importance of regular exercise and a healthy diet on glycaemic control is emphasised and self capillary glucose monitoring commenced. Food and exercise diaries may act as motivational tools and assist in identifying those women who require medication to achieve good glycaemic control. The same target levels for BGL's are used and review of BGL's should continue at every antenatal visit. If the BGL's are within the target range then the '4-point profile' may be undertaken 2-3 times weekly. If they are outside the target range then referral to a diabetes physician should be arranged and treatment commenced. Women should be encouraged to report BGL's outside the target range early and given an appropriate point of contact so that they may easily do so. Dietary modification is unlikely to address high fasting glucose levels and medication should be considered early in these women.

Randomised controlled trials comparing oral hypoglycaemic agents and insulin for the management of GDM are currently in progress. Until these data are available insulin remains the recommended medication for women with GDM (and Type 2 DM) requiring treatment to achieve good glycaemic control.

Fetal Growth and Surveillance

Glycaemic control in the second and third trimester is closely related to the degree of fetal macrosomia with the percentage of glucose readings above target in the third trimester being the best indicator.[11] Fetal abdominal circumference (AC) >90th centile at 34 weeks is strongly correlated with birth weight.[12] Serial ultrasound assessment is routinely used to identify fetuses with accelerated or suboptimal growth. However, the accuracy of ultrasound estimation of fetal weight decreases with increasing birthweight. Generally there tends to be an over-estimation of the weight of small infants and an underestimation of the weight of "large for

gestational age" infants. Both large and average weight infants of women with DM tend to have their weight underestimated.[13] For pregnancies in women with pre-existing DM, serial fetal growth surveillance should commence at 28 weeks. This may act as a motivational tool for women with suboptimal glycaemic control. Women with GDM requiring medical treatment should also commence serial fetal growth surveillance once medical treatment is deemed necessary. For women with GDM and borderline glycaemic control, estimation of fetal weight may assist in the decision to commence hypoglycaemic treatment.

Women with GDM controlled by diet should have an ultrasound for fetal growth parameters at 34 weeks or sooner if there is clinical suspicion of macrosomia. If the abdominal circumference (AC) is >90th centile an additional scan at 38 weeks is recommended to determine the estimated fetal weight.

A policy of increased fetal surveillance is recommended in the third trimester to attempt to reduce stillbirth rates, however there is little evidence to guide either the modality or frequency of surveillance. Fetal heart rate monitoring (CTG), biophysical profile and umbilical artery Doppler are all used to assess fetal wellbeing in diabetes pregnancies. Stillbirth unrelated to congenital anomalies occurs across all birth weights suggesting that factors other than placental insufficiency are involved. Umbilical artery Doppler should still be used to identify those pregnancies at risk from placental insufficiency, however significant compromise may occur in those with a normal Doppler wave form. Twice-weekly CTG monitoring in the third trimester is associated with a low perinatal mortality rate though this method of surveillance has not been proven in large clinical studies . Certainly women with poor glycaemic control (both hypoglycaemia and hyperglycaemia), hypertension, fetal growth restriction or fetal macrosomia should commence CTG monitoring twice weekly from 34 weeks gestation. Falling insulin requirements in the late third trimester are thought to be an indication for increased fetal surveillance.

Timing of birth

For women with pre-existing diabetes and for those with GDM requiring medication delivery at 38-39 weeks is recommended. For those with diet controlled GDM birth should be planned around 40 weeks.

Maternal diabetes is a risk factor for operative delivery and Caesarean section rates range from 25-80% representing wide variation in obstetric practice. Shoulder dystocia rates are increased in pregnancies with DM (3.2% cf 0.5%) and for infants with birth weight >4,000g shoulder dystocia occurs in 5%. Although EFW by ultrasound assessment is less reliable in large infants and infants of women with DM, consideration should be given to an elective Caesarean section for those with an EFW >4,250g.[14] Elective Caesarean section should also be considered where the AC is >95th centile and there is a difference in the AC/HC measurement of more than 40mm because of the increased risk of shoulder dystocia.

Health professionals caring for women in labour should be confident in performing the recommended additional manoeuvres required to manage shoulder dystocia and regular multidisciplinary 'drills' should be undertaken to maintain confidence and skill levels.

Intrapartum Considerations

All women with Type 1 DM should commence a glucose/insulin infusion in labour. Women with Type 2 DM or GDM should have BGL estimation 2 hourly and a glucose/insulin infusion commenced if the BGL is >7 mmol/l. The rate of insulin infusion should be adjusted to maintain BGL's between 4-7 mmol/l. Maternal hyperglycaemia and thus fetal hyperglycaemia results in a fetal lactic acidemia which is usually compensated. However if the fetus becomes hypoxic

there is rapid decompensation with associated acidosis. Optimal intrapartum glycaemic control reduces the frequency of abnormal fetal heart rate patterns and improves neonatal outcome. Continuous electronic fetal monitoring is recommended for all women with diabetes in pregnancy. In addition macrosomic fetuses have increased oxygen requirements so these babies in particular are at increased risk of intrapartum hypoxia. Prompt evaluation and intervention of any non-normal fetal heart rate pattern should be undertaken.

Postpartum care

Type 1 DM

Insulin requirements fall immediately after birth and many women return to their pre-pregnancy doses or lower for some time postpartum. The main risk is hypoglycaemia particularly with breastfeeding. BGL's should continue to be monitored with additional checks overnight during breast-feeding. Target BGL's are 5-10mmol/l whilst breast-feeding and insulin doses adjusted accordingly. Women should receive appropriate advice regarding contraception and the importance of pre-pregnancy care and glycaemic control emphasised. Follow up with their usual diabetes specialist should continue.

Type 2 DM

Women with Type 2 DM may not require hypoglycaemic agents for some time after the birth. Both glibenclamide and metformin appear in small amounts in the breast milk but it is reasonable to use these with breastfeeding if required. The woman should continue to monitor her BGL's 2-3 days per week and have appropriate follow-up with her GP or Diabetes specialist.

GDM

Most women with GDM revert to normoglycaemia at the time of birth. A 4-point BGL should be undertaken on day 2 or 3 postpartum. Blood glucose monitoring may then be ceased if in the normal range. It is recommended that women with GDM have diabetes (consider change to DM screening (GTT) 6-12 weeks postpartum and thereafter fasting or random blood glucose every 1-2 years. Prompt referral to a diabetes or medical clinic is recommended for women who remain hyperglycaemic after the birth.

As 40-50% of women who have had GDM will develop Type 2 DM later in life, the opportunity for lifestyle counselling for the prevention of Type 2 DM should be taken. This includes advice regarding healthy eating patterns, weight control and regular physical activity of moderate intensity for 30 minutes each day, contraception, pre-pregnancy planning and the need for annual check on their blood glucose levels. Effective contraception is essential for women with GDM. However there is an increased risk of developing Type 2 DM in women with GDM who receive either the progesterone only pill or injectable progestin postpartum.[15,16] Alternative non-hormonal contraception should be considered for women who are breastfeeding.

Summary

There is no doubt that optimising pre-pregnancy and antenatal glycaemic control improves outcomes for women with DM and their offspring. Education, motivation and improving both contraception and pre-pregnancy care in women with DM is a priority. For those women found to have GDM, modification to their lifestyle should be made not only to improve pregnancy

outcome but also to reduce the risk of developing Type 2 DM later in life. Health professionals and those planning health care provision should ensure that there is easy access to pre-pregnancy and antenatal care for these women both with pre-existing DM and those at risk of GDM.

Summary Points:
The prevalence of diabetes is increasing in pregnancy.
Tight control of diabetes before and during pregnancy significantly improves outcomes.
Team management is recommended.
Optimal intrapartum glycaemic control reduces the frequency of abnormal fetal heart rate patterns and improves neonatal outcome.

Pre-existing DM in pregnancy:	• Refer pre-pregnancy for specialist review and optimise control • High dose folic acid - 5mg daily • Four times per day insulin regimen with frequent monitoring • Target glucose levels fasting <5.5mM and 2 hr post-prandial 4-7mM • Team management (including exercise and dietary advice)
GDM:	• Screening for all women • Team management and tight control, as for those with pre-existing DM
Fetal Surveillance:	• for those on treatment for DM, serial ultrasound assessment from 28 weeks • for those with diet-controlled GDM, ultrasound at 34 weeks or earlier and repeat ultrasound at 38 weeks for infants with AC>90th centile • CTG twice weekly from 34 weeks
Peripartum management:	• for those on treatment for DM, deliver 38-39 weeks • for those on diet-controlled GDM, deliver by 40 weeks • be watchful for increased risk of operative delivery and shoulder dystocia • consider elective Caesarean section for macrosomia * glucose/insulin infusion in labour for all those with type 1 DM • monitor BGL in labour and glucose/insulin infusion if hyperglycaemic • continuous electronic fetal monitoring • watch for hypoglycaemia postpartum
Postpartum followup:	• screen for type 2 DM in those with GDM

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6.3 Monochorionic Twin Pregnancies

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Although zygosity refers to the type of conception, what principally impacts upon fetal outcome in multiple pregnancies is chorionicity. Monozygotic twins result from the splitting of one fertilised ovum during the first two weeks of embryogenesis. Approximately 75% of monozygotic twins are monochorionic diamniotic (MCDA), with an overall incidence of one in 400 pregnancies, although this incidence is thought to be increasing due to advanced reproductive techniques such as intracytoplasmic sperm injection (ICSI).[1] The majority of the remaining 25% of monozygous twin pregnancies are dichorionic diamniotic (DCDA) where cleavage has occurred before day 3 post-conception. A very small number of monozygotic twin pregnancies are monochorionic monoamniotic where cleavage has occurred after 8 post conception days.

Monochorionic diamniotic twins have a 3-10 fold higher perinatal mortality rate and a higher rate of morbidity than dichorionic twins, who have a higher perinatal mortality rate than singletons. This is mainly due to congenital anomalies, complications of prematurity and placental abnormalities including twin to twin transfusion syndrome (TTTS) and intrauterine growth restriction (IUGR).

Diagnosis

The diagnosis of chorionicity is best made in the first trimester and can be made as early as 7 weeks on transvaginal ultrasound. The most reliable ultrasound indicator of dichorionicity is a combination of the 'lambda sign' or 'twin peak' and/or the presence of two separate placentae (Figure I). The most useful indicator of monochorionicity is the 'T' sign (Figure II).[2] In the second and third trimesters determination of chorionicity may be less accurate and is based on identification of fetal gender, number of placentae, intertwin membrane thickness and the presence or absence of the 'T' or 'lambda' signs. There have been no prospective studies showing that knowledge of chorionicity and management of complications has improved fetal outcomes.[3]

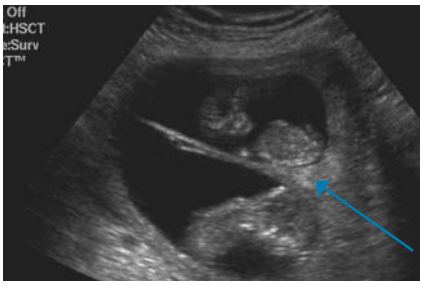

Figure I. Dichorionic diamniotic twin pregnancy. Arrow shows 'twin peak' sign

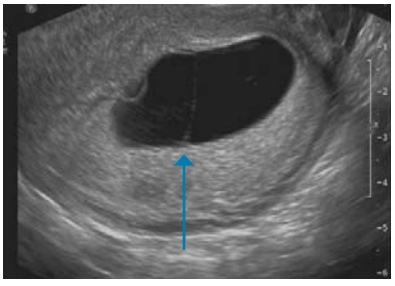

Figure II. Monochorionic diamniotic twin pregnancy. Arrow shows 'T sign' and thin inter-twin membrane

Prematurity

Of the 25,111 women who gave birth in Western Australia in 2004, 58.6% of multiple births were delivered preterm (<37 weeks gestation) compared to 7.1% of singleton births.[4] Prematurity is associated with adverse perinatal outcomes including perinatal death, respiratory distress syndrome, chronic lung disease, cerebral palsy, neurological morbidity,

hearing problems and visual problems. In a study by Sebire et al MCDA twins had a higher rate of being born before 32 weeks than DCDA twins (9% vs. 5.5%).[5] This was similar to a study by Leduc et al, where even after twins with TTTS were excluded, 34.4% of MCDA twins delivered less than 34 weeks compared to 22.5% of DCDA twins.[6]

Growth restriction

Monochorionic twins are twice as likely to have a 25% birth weight discordance than dichorionic twins and to be less than the 10th centile at birth (31.2% vs. 15.4%).[6] Twins with IUGR (defined as an estimated fetal weight less than the 10th centile for gestational age) require close monitoring to assist in the correct timing of delivery. Ultrasound with Doppler has been shown in high risk pregnancies to improve perinatal outcomes.[7] The exact timing of screening multiple pregnancies at risk of IUGR is uncertain. There is no treatment to prevent IUGR.

Congenital anomalies are more common in twin pregnancies than in singleton pregnancies. In dizygous twins the risk of congenital malformations in at least one twin is twice that of singletons. In monozygous twins there is an increased rate of structural malformations (not chromosomal or genetic abnormalities) and twins may be discordant for anomalies. Brain, facial, gastrointestinal, anterior abdominal wall, neural tube and cardiac abnormalities are the more common abnormalities reported.

Screening for aneuploidy in twin pregnancies is best performed in the first trimester with nuchal translucency. Amniocentesis has similar miscarriage rates to that of singleton pregnancies. Chorionic villus sampling is technically possible however may be difficult, with the potential for contamination and for inadequate sampling of both fetuses.[8] Selective termination of pregnancy is more difficult due to the need for cord occlusion in monochorionic twin pregnancies.

Twin to twin transfusion syndrome (TTTS) is a particular complication of monochorionic twin placentation and occurs in up to 15% of monochorionic twin pregnancies.[5] TTTS usually occurs in the midtrimester and untreated it results in 80-90% perinatal mortality and a 15-50% risk of handicap in the survivors.

The diagnosis of TTTS is made on ultrasound with polyhydramnios (maximum vertical pocket >=8cm) in the recipient twin and oliguric oligohydramnios (maximum vertical pocket <=2cm) in the donor being the basic standard criteria.[9] Sonographic staging includes amniotic fluid volume assessment, assessment of the presence or absence of the donor twin bladder, monitoring of Doppler flow in the umbilical artery and ductus venosus and presence of hydrops fetalis and/ or fetal death in one or both twins.[9]

Contemporary treatment of TTTS is with laser ablation of the inter-twin vascular anastamoses and/or amnioreduction.The goal of treatment of TTTS is to prolong pregnancy, prevent preterm labour and prevent the death of one twin in utero because of the subsequent risk of neurological injury to the surviving co-twin. Fetoscopic laser ablation of anastomoses has been shown to be better than amnioreduction in treating TTTS in a randomised controlled trial. 10 However laser treatment lead to only one survivor at birth in 76% of pregnancies treated with laser as compared to a 56% rate of one twin survival in cases treated by amnioreduction (relative risk of the death of both fetuses, 0.63; 95 percent confidence interval, 0.25 to 0.93; P=0.009).[10]

Death of one or both twins may be caused by preterm labour which may be as a result of preterm prelabour rupture of the membranes, infection, abruption or polyhydramnios. Fetal demise may also be caused by placental insufficiency or continuing fetal-fetal blood transfusion leading to anaemia/polycythaemia.

Laser ablation is currently being performed in Australia in Perth, Brisbane, Sydney and Melbourne. It is a highly specialised treatment that can be performed as early as 16 weeks gestation and has a steep learning curve.[11]

Neonatal Morbidity

Twins have a 5 fold increased risk of cerebral palsy compared to singletons.[12] Fetal death of a twin is frequently associated with severe neurological morbidity, including cerebral palsy, in the surviving co-twin. There have been no studies determining the effect of chorionicity in cerebral palsy however twin studies using concurrent gender and non-concurrent gender as a surrogate marker have shown that cerebral palsy is much more common in twins of similar gender when the co-twin dies in-utero.[12] Monochorionic twins are more likely to be admitted to the neonatal intensive care unit and have an intraventricular haemorrhage, even after twins with TTTS are excluded.[6]

Maternal morbidity

Women with twin pregnancies are more likely to have pre-eclampsia, gestational diabetes, anaemia and need an operative delivery or Caesarean section. Antepartum haemorrhage and postpartum haemorrhage are more common. A small number of women (4%) will require a Caesarean section for the delivery of the second twin after a vaginal delivery for the first twin.[13]

Timing and mode of delivery

For vaginal delivery to be considered in a twin pregnancy the presenting twin should be in a cephalic presentation, continuous electronic fetal monitoring and an epidural should be available and experienced obstetric, paediatric and midwifery staff should be present. It is still unclear whether vaginal delivery or Caesarean section is the optimal mode of delivery in twin pregnancies and further studies are currently underway to address this issue. Although some authors believe that all monochorionic twins should be delivered by Caesarean section because of the risk of intrapartum twin to twin transfusion, others have found no increased neonatal mortality or morbidity with vaginal delivery in MCDA twins compared to DCDA twins.[14]

Timing of delivery in MCDA twins is also controversial. Retrospective data show an increasing risk of adverse pregnancy outcomes for all twins with advancing gestational age with the lowest risk of perinatal mortality and morbidity occurring between 36 and 38 weeks gestation.[3,13] A recent retrospective study by Barigye et al of 151 uncomplicated monochorionic twin pregnancies showed a 4.6% rate of unexpected intrauterine deaths at a median gestational age of 34+1 weeks.[15] Although some authors advocate elective preterm delivery for monochorionic twins, insufficient information is currently available to recommend this.[3,16]

Conclusion

MCDA twin pregnancies are uncommon but are associated with a significantly increased risk of perinatal morbidity and mortality. The diagnosis of multiple pregnancy and the determination of chorionicity is best made in the first trimester. Although there is no evidence from randomised controlled trials that screening for TTTS and IUGR improves perinatal outcomes, the complications of MCDA twin pregnancies can be monitored with ultrasound in order to ensure the appropriate antenatal management, such as steroids to mature fetal lungs, transfer to a unit with tertiary neonatal care facilities, elective preterm delivery and treatment for TTTS.

Suggested management of MCDA twin pregnancies	
Ultrasound	
1.	Determine chorionicity in all twins in the first trimester
2.	Offer nuchal translucency screening to all mothers with twin pregnancies
3.	16 week scan
4.	19 week tertiary scan
5.	22 week scan
6.	25 week scan
7.	2-4 weekly scans until delivery if <20% growth discordance
8.	Aim for delivery after 37 weeks
9.	Consider vaginal delivery if 1st twin cephalic, and appropriate obstetric, anaesthetic, paediatric and midwifery support available
10.	Refer if any signs of TTTS to tertiary centre
11.	Consider referral to tertiary centre if growth discordance > 20% or IUGR or abnormal umbilical artery Doppler studies, and/or oligohydramnios

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7 Appendices

7.1 Appendix I: Abbreviations and Definitions

Abbreviations:	
ABS	Australian Bureau of Statistics
AC	abdominal circumference
AIHW	Australian Institute of Health and Welfare
AMA	Australian Medical Association
BGL	blood glucose level
BP	blood pressure
CI	confidence interval
CSE	combined spinal epidural
CTG	cardiotocograph
DCDA	dichorionic diamniotic twin pregnancy
DIA	Department of Indigenous Affairs
DM	diabetes mellitus
DVAS	Domestic Violence Advocacy Support
EDPH	Executive Director of Public Health
FHR	fetal heart rate
GCT	glucose challenge test
GDM	gestational diabetes mellitus
GTT	glucose tolerance test
GP-obstetrician	General Practitioner with obstetric skills
HbA1C	glycated (glycosylated) Haemoglobin
HIC	Health Information Centre of Western Australia
ICSI	intracytoplasmic sperm injection
IUGR	intrauterine growth restriction
IVF	in vitro fertilisation
KEMH	King Edward Memorial Hospital
LA	local anaesthetic
MCDA	monochorionic diamniotic twin pregnancy
NPDC	National Perinatal Data Collection
NRP	Neonatal Resuscitation Program
PATS	Patient assisted transport scheme
PEPISU	Pregnancy and Parenting Substance Use Program
PIMC	Perinatal and Infant Mortality Committee of Western Australia
PMH	Princess Margaret Hospital
PSANZ	Perinatal Society of Australia and New Zealand
PSANZ PDC	Perinatal Society of Australia and New Zealand Perinatal Death Classification
PSANZ NDC	Perinatal Society of Australia and New Zealand Neonatal Death Classification
RFDS	Royal Flying Doctor Service
RANZCOG	The Royal Australian and New Zealand College of Obstetricians and Gynaecologists
ReCoDe	Relevant Condition at Death, classification system
RBG	random blood glucose
RR	relative risk
SEIFA	Socio-economic Indexes for Areas
SIDS	Sudden Infant Death Syndrome
SIDS and kids	Support group for families affected by sudden infant or childhood death
SOSU	Statewide Obstetric Support Unit
TSI	Torres Strait Islander
TTTS	Twin to twin transfusion syndrome
WA	Western Australia
WANTS	Western Australian Neonatal Transport Service
WHO	World Health Organization

Definitions:	
Aboriginal/Indigenous:	A person who identifies themselves as an Aboriginal or Torres Strait Islander, or who is identified as such by the community within which he/she lives.
Aboriginal/Indigenous infant:	Born to a parent who identifies as an Aboriginal or Torres Strait Islander, or is identified as such by a responsible person on admission to hospital.
Livebirth:	The complete expulsion or extraction from its mother of a product of conception, irrespective of the duration of the pregnancy which, after such separation, breathes or shows any other evidence of life such as beating of the heart, pulsation of the umbilical cord or definite movement of voluntary muscles, whether or not the umbilical cord has been cut or the placenta is attached; each product of such a birth is considered liveborn.
Stillbirth/Fetal Death:	Death prior to the complete expulsion or extraction from its mother of a product of conception of 20 or more completed weeks of gestation or of 400g or more birthweight. The death is indicated by the fact that after such separation the fetus does not breathe or show any other evidence of life such as beating of the heart, pulsation of the umbilical cord, or definite movement of voluntary muscles.[iv]
Stillbirth rate:	The number of stillbirths per 1,000 total births.
Neonatal death:	The death of a liveborn infant within 28 days of birth.
Neonatal mortality rate:	The number of deaths of liveborn infants under 28 days of age per 1,000 livebirths.
Perinatal death:	A stillbirth or neonatal death.
Perinatal mortality rate:	The number of fetal and neonatal deaths per 1,000 total births.
Infant death:	The death of a liveborn infant within the first year of life (prior to the first birthday).
[iv]This definition of stillbirth is used by the Health Information Centre of WA, the PIMC, and the National perinatal data collection (NPDC). There are differences in definitions used by other institutions, e.g. ABS definition: A fetus that does not have a heart beat or any sign of life, which is 400g or more in birthweight or, if birthweight is unavailable, greater or equal to 20 weeks in gestation. WHO definition: for fetal death is for infants with birthweight greater or equal to 500g, or 22 weeks gestation where birthweight is unknown.	
Infant mortality rate:	The number of deaths of infants under one year of age per 1,000 livebirths.
Post-neonatal death:	The death of a liveborn infant occurring in the remainder of the first year (28 – 364 days).
Post-neonatal mortality rate:	The number of deaths of liveborn infants from 28 days to one year of age per 1,000 livebirths.

7.2 Appendix II: Appropriate Investigations Following Stillbirth and Infant Death

Stillbirths

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 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 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 Kleihaeur-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.

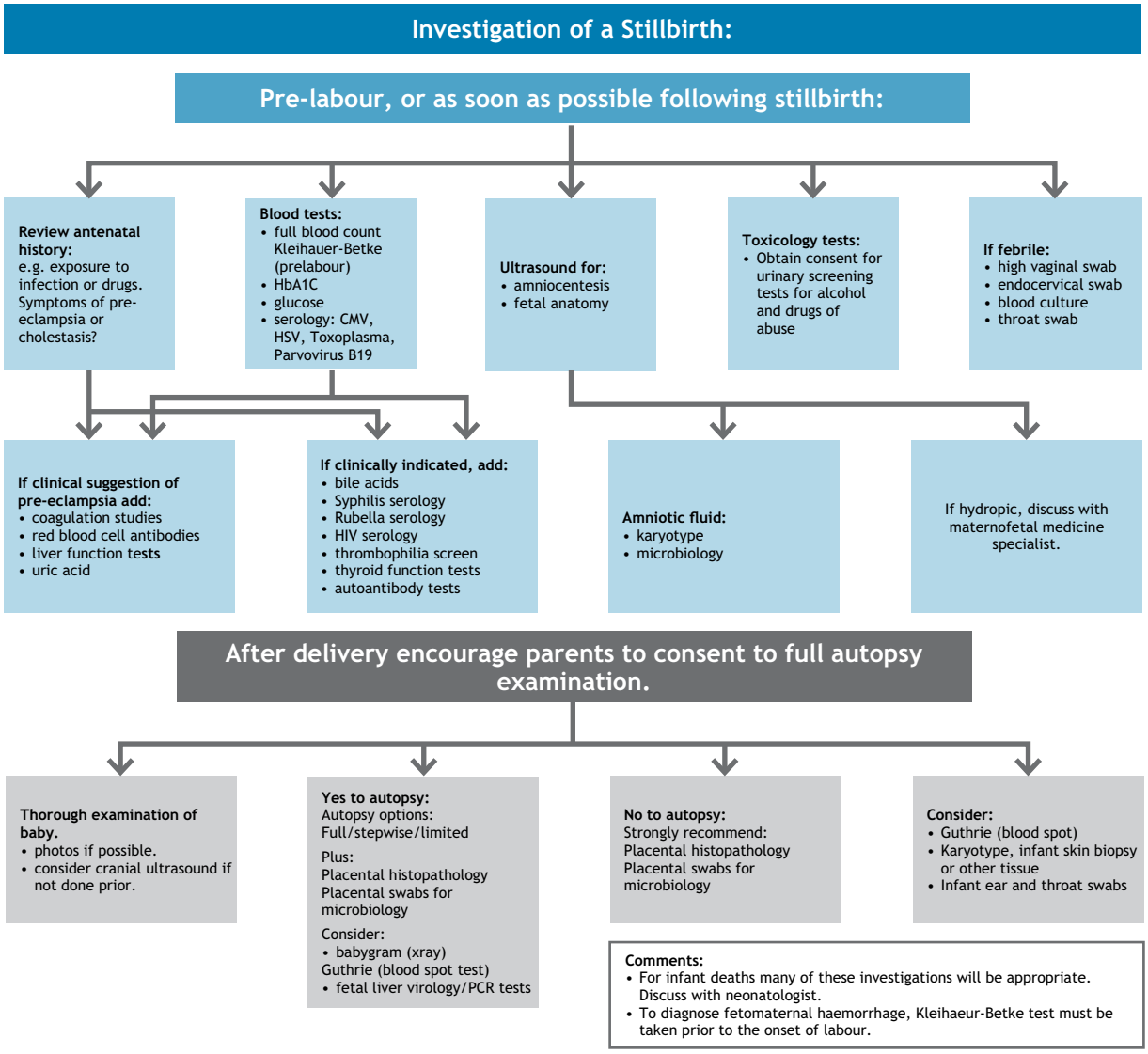
In the presence of pre-eclampsia, maternal liver function, uric acid and coagulation studies may be indicated. In the presence of maternal pruritus, check maternal serum bile acids and liver function. It is recommended to routinely perform urine toxicology screening for illicit substances but consent 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.

Infant deaths

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

Approved multi-lingual copies of the **Post Mortem Examination Consent Form** and the **Non-Coronial Post Mortem Examinations, Information for Relatives** booklet are available on the web at: http://www.health.wa.gov.au/postmortem/

7.3 Appendix III: Perinatal and Infant Deaths by PSANZ PDC, WA 2002-04

PSANZ PDC CODE		Type of Death			Total Deaths	PND	All Deaths
		SB	NND	PNND		%	%
1	**Congenital abnormality**	**145**	**38**	**22**	**205**	**25.7**	**25.4**
	1.1 Central nervous system	36	2	4	42	5.3	5.2
	1.2 Cardiovascular system	21	11	4	36	4.5	4.5
	1.3 Urinary system	13	3	0	16	2.2	2.0
	1.4 Gastrointestinal system	4	1	2	7	0.7	0.9
	1.5 Chromosomal	33	9	4	46	5.9	5.7
	1.6 Metabolic	0	2	1	3	0.3	0.4
	1.7 Multiple/non-chromosomal	22	3	1	26	3.5	3.2
	1.8 Other congenital abnormality	2	2	0	4	0.6	0.5
	1.81 Musculoskeletal	6	1	1	8	1.0	1.0
	1.82 Respiratory	0	2	1	3	0.3	0.4
	1.83 Diaphragmatic hernia	2	2	2	6	0.6	0.7
	1.85 Tumours	3	0	1	4	0.4	0.5
	1.88 Other specified congenital abnormality	3	0	1	4	0.4	0.5
2	**Perinatal Infection**	**23**	**12**	**2**	**36**	**4.9**	**4.5**
	2.11 Group B Streptococcus	4	5	1	10	1.3	1.2
	2.12 E coli	1	0	0	1	0.1	0.1
	2.13 Listeria monocytogenes	1	0	0	1	0.1	0.1
	2.14 Spirochaetal (syphilis)	1	0	0	1	0.1	0.1
	2.18 Other bacterial	6	2	1	9	1.1	1.1
	2.19 Unspecified bacterial	0	2	0	2	0.3	0.2
	2.2 Viral	1	0	0	1	0.1	0.1
	2.21 Cytomegalovirus	4	0	0	4	0.6	0.5
	2.22 Parvovirus	1	0	0	1	0.1	0.1
	2.23 Herpes simplex virus	1	1	0	2	0.3	0.2
	2.24 Rubellavirus	0	1	0	1	0.1	0.1
	2.3 Protozoal (Toxoplasma)	1	0	0	1	0.1	0.1
	2.9 Other unspecified organism	2	1	0	2	0.4	0.2
3	**Hypertension**	**38**	**1**	**1**	**40**	**5.5**	**5.0**
	3.4 Gestational hypertension	2	0	0	2	0.3	0.2
	3.5 Pre-eclampsia	32	1	1	34	4.6	4.2
	3.6 Pre-eclampsia superimposed on chronic	4	0	0	4	0.6	0.5
4	**Antepartum haemorrhage**	**40**	**6**	**1**	**47**	**6.5**	**5.8**
	4.1 Placental abruption	39	6	1	46	6.3	5.7
	4.3 Vasa praevia	1	0	0	1	0.1	0.1
5	**Maternal conditions**	**20**	**1**	**0**	**21**	**2.9**	**2.6**
	5.1, 5.3, 5.5, 5.8: “other” maternal conditions	5	1	0	6	0.8	0.7
	5.2 Diabetes mellitus	15	0	0	15	2.1	1.9
6	**Specific perinatal conditions**	**42**	**11**	**3**	**56**	**7.4**	**6.9**
	6.1 Twin-twin transfusion syndrome	18	5	0	23	3.2	2.9
	6.2 Fetomaternal haemorrhage	9	1	0	10	1.4	1.2
	6.3 Antepartum cord complication	3	0	0	3	0.4	0.4
	6.4 Uterine abnormality	3	3	1	7	0.8	0.9
	6.5 Birth trauma	0	1	0	1	0.1	0.1
	6.61 Rhesus	3	0	0	3	0.4	0.4
	6.7 Idiopathic hydrops	3	0	0	3	0.4	0.4
	6.8 Other specific perinatal conditions	3	1	2	6	0.6	0.7

PSANZ PDC CODE		Type of Death			Total Deaths	PND	All Deaths
		SB	NND	PNND		%	%
7	**Hypoxic peripartum death**	**17**	**15**	**2**	**34**	**4.5**	**4.2**
	7.1 With intrapartum complications	5	9	1	15	2.0	1.9
	7.11 Uterine rupture	1	0	0	1	0.1	0.1
	7.12 Cord prolapse	1	1	1	3	0.3	0.4
	7.18 Other intrapartum complication	1	0	0	1	0.1	0.1
	7.2 Evidence non-reassuring fetal status	2	2	0	4	0.6	0.5
	7.9 Unspecified hypoxic peripartum death	7	3	0	10	1.4	1.2
8	**Fetal Growth Restriction**	**37**	**5**	**1**	**42**	**5.9**	**5.2**
	8.1 With reduced vascular perfusion	17	4	0	21	2.9	2.6
	8.2 With chronic villitis	1	0	0	1	0.1	0.1
	8.3 No placental pathology	14	1	0	15	2.1	1.9
	8.4 No examination of placenta	5	0	0	5	0.7	0.6
9	**Spontaneous preterm birth**	**85**	**67**	**6**	**158**	**21.3**	**19.6**
10	**Unexplained antepartum death**	**100**	**0**	**0**	**101**	**14.0**	**12.5**
	10.1 With reduced perfusion/placental pathology	5	0	0	5	0.7	0.6
	10.2 With chronic villitis	2	0	0	2	0.3	0.2
	10.3 No placental pathology	59	0	0	60	8.3	7.4
	10.4 No examination of placenta	26	0	0	26	3.7	3.2
	10.5 With other specified placental pathology	7	0	0	7	1.0	0.9
	10.9 Unspecified or not known if placenta examined	1	0	0	1	0.1	0.1
11	**No obstetric antecedent**	**0**	**11**	**57**	**67**	**1.5**	**8.3**
	11.1 SIDS	0	1	19	20	0.1	2.5
	11.2 Postnatally acquired infection	0	0	12	12	0.0	1.5
	11.3 Accidental asphyxiation	0	5	9	14	0.7	1.7
	11.4 Other accident, poisoning or violence (postnatal)	0	0	8	8	0.0	1.0
	11.8 Other specified	0	0	1	1	0.0	0.1
	11.9 Unknown/undetermined	0	4	8	12	0.6	1.5

7.4 Appendix IV: Infant Deaths by PSANZ NDC, WA 2002-04

PSANZ NDC CODE		Type of Death		Infant Deaths	
		Neonatal	Post-Neonatal	N	%
1	**Congenital Abnormalities**	**37**	**22**	**59**	**22.7**
	1.1 Central nervous system	2	4	6	2.3
	1.2 Cardiovascular system	11	4	15	5.8
	1.3 Urinary system	3	0	3	1.2
	1.4 Gastrointestinal	1	2	3	1.2
	1.5 Chromosomal	8	4	12	4.6
	1.6 Metabolic	2	1	3	1.2
	1.7 Multiple/non chromosomal syndromes	3	1	4	1.5
	1.8 Other congenital abnormality	7	4	11	4.2
	1.83 Diaphragmatic hernia	0	1	1	0.4
	1.85 Tumours	0	1	1	0.4
2	**Extreme prematurity (typically <24 wks)**	**42**	**3**	**45**	**17.3**
	2.1 Not resuscitated	11	0	11	4.2
	2.2 Unsuccessful resuscitation	17	3	20	7.7
	2.9 Unspecified if resuscitation attempted	14	0	14	5.4
3	**Cardio-respiratory disorders**	**26**	**3**	**29**	**11.2**
	3.1 Hyaline membrane disease/Respiratory distress	16	0	16	6.2
	3.2 Meconium aspiration syndrome	2	0	2	0.8
	3.3 Primary persistent pulmonary hypertension	1	0	1	0.4
	3.4 Pulmonary hypoplasia	4	1	5	1.9
	3.5 Chronic neonatal lung disease	0	2	2	0.8
	3.8 Other	3	0	3	1.2
4	**Infection**	**18**	**16**	**34**	**13.1**
	4.1 Bacterial	1	0	1	0.4
	4.11 Congenital bacterial	12	1	12	5.0
	4.12 Acquired bacterial	1	13	14	5.4
	4.2 Viral	0	1	1	0.4
	4.21 Congenital viral	2	0	2	0.8
	4.5 Fungal	0	1	1	0.4
	4.8 Other	1	0	1	0.4
	4.9 Unspecified organism	1	0	1	0.4
5	**Neurological**	**24**	**1**	**25**	**9.6**
	5.1 Hypoxic ischaemic encephalopathy/perinatal asphyxia	21	1	22	8.5
	5.2 Intracranial haemorrhage	3	0	3	1.2
6	**Gastrointestinal**	**5**	**1**	**6**	**2.3**
	6.1 Necrotising enterocolitis	5	1	6	2.3
7	**Other**	**14**	**58**	**62**	**23.8**
	7.1 SIDS	0	5	5	1.9
	7.11 Consistent with SIDS	0	4	4	1.5
	7.12 Possible SIDS	1	13	14	5.4
	7.2 Multisystem failure	3	1	4	1.5
	7.3 Trauma	2	8	10	3.8
	7.8 Other	5	9	14	5.4
	7.9 Undetermined/Unknown	3	8	11	4.2

Abbreviations:
SB – stillbirth
NND – neonatal death
PND – perinatal death
PNND – post-neonatal death

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