1.0 Maternal and perinatal mortality

1.1 Definitions

The Queensland Maternal and Perinatal Quality Council uses the following definitions.

Fetal deaths (= stillbirth): Defined by the Registration of Births, Deaths and Marriages Act as a child whose heart has not beaten after it has been completely expelled or extracted from its mother and who is either of not less than 20 weeks gestation, or of not less than 400g by weight at birth.

Livebirths: Defined by the Registration of Births, Deaths and Marriages Act as a child whose heart has beaten after it has been completely expelled or extracted from its mother.

Mothers: Number of mothers is defined as the number of women having a pregnancy which resulted in a livebirth or fetal death.

Maternal death: A maternal death is defined by the World Health Organisation (WHO) as the death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the duration and the site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management. This definition excludes deaths from accidental or incidental causes. The definitions used in this report include, in addition to the WHO definition, incidental deaths and deaths occurring more than 42 days after termination of the pregnancy, when their origin and illness related to the pregnancy[2].

Maternal mortality ratio: The maternal mortality ratio is defined as:

$$\frac{\text{Number of maternal deaths}}{\text{Number of mothers}} \times 100{,}000$$

Late maternal death: Death of a woman within one year of giving birth or otherwise ending a pregnancy. These deaths are not included in the calculation of the maternal mortality ratio.

Classification of maternal deaths:

Direct deaths are those which result from obstetric complications of the pregnant state (pregnancy, labour and puerperium) including deaths from interventions, omissions, inappropriate treatment, or from a chain of events resulting from any of the above. They are complications of the pregnancy itself.

Indirect deaths are those which result from pre-existing disease or disease that developed during pregnancy and was not due to direct obstetric causes, but which may have been aggravated by physiological effects of pregnancy.

Incidental deaths are those due to conditions occurring during pregnancy, where the pregnancy is unlikely to have contributed significantly to the death, although it is sometimes possible to postulate a distant association.

2 Maternal Mortality Working Party, NHMRC. Report on Maternal Deaths in Australia 1991-93. Canberra: NHMRC.

1.2 Maternal deaths

Prior to this report, due to the cessation of QMPQC activity in 2005, the reviewed and published maternal death data has only been available in Queensland from 1988 to 2003 inclusive.

This report reviews 82 maternal deaths (including late maternal deaths) which occurred in Queensland in the years 2004 to 2008. An extensive case ascertainment exercise, which was undertaken by the Perinatal Data Collection Unit, Health Statistics Centre, Queensland Health, is acknowledged by this Council, along with excellent collaboration and cooperation by the Registrar of Births, Deaths and Marriages, the State Coroner, and the Forensic Pathology Service of Queensland Health. This effective ascertainment exercise may contribute to an apparently high maternal mortality ratio; it is a feature of most maternal mortality reports that there is concern regarding whether or not all maternal deaths are known.

Collection of data regarding these deaths was a difficult exercise due to the:

- time between deaths and the collection of data (due to the period of QMPQC inactivity); and
- lack of legislation in Queensland supporting reporting of maternal deaths, which allowed some practitioners to not cooperate with requests for clinical information by the QMPQC chairperson.

1.2.1 Maternal mortality ratio (MMR)

Thirty-nine (39) of the 82 deaths were consistent with the ICD-10 definition of maternal death (death of a woman while pregnant or within 42 days of the termination of pregnancy, irrespective of the duration and the site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management, but not from accidental or incidental causes), and so contribute to the calculation of the maternal mortality ratio.

To allow for comparison with other Australian jurisdictions, the five maternal deaths from 2003, consistent with the ICD-10 maternal death definition (in a total of 49,512 mothers), are included in the following maternal mortality ratio calculations.[3]

In Queensland in 2003 to 2005 there were 21 direct and indirect deaths amongst 153,900 mothers, giving a maternal mortality ratio (MMR) of 13.6 per 100,000 women giving birth (i.e. one woman died for every 7,329 mothers). The maternal mortality ratio in Australia in 2003 to 2005 was 8.4 per 100,000 women giving birth.[4]

In the following triennium, 2006 to 2008 there were 13 direct and indirect deaths amongst 175,275 Queensland mothers, giving a maternal mortality ratio (MMR) of 7.4 per 100,000 women giving birth (i.e. one woman died for every 13,483 mothers). The maternal mortality ratio for Australia for this period is not yet published.

The difference in maternal mortality ratios between 2006 to 2008 and 2003 to 2005 is statistically significantly different: Odds ratio 0.54 (95% CI 0.27, 1.09).

3 Maternal and Perinatal Morbidity and Mortality in Queensland 2002 and 2003. Report of the Queensland Maternal and Perinatal Quality Council December 2005.

4 Sullivan EA, Hall B & King JF. 2007. Maternal deaths in Australia 2003-2005. Maternal deaths series no 3. Cat no PER42. Sydney: AIHW national Perinatal Statistics Unit.

1.2.2 Classification of cause of maternal deaths 2004 to 2008

The Maternal Mortality Sub-Committee examined 11 deaths which occurred during the course of pregnancy and 28 within 42 days of the woman giving birth or the pregnancy ending. A further 43 deaths (late maternal deaths) which occurred between 43 days and 365 days of the end of the pregnancy were also reviewed.

Maternal death timing	Total	Classification
Deaths during pregnancy	11	3 Direct 6 Indirect 2 Incidental
Deaths within 42 days of end of pregnancy	28	11 Direct 9 Indirect 8 Incidental
Deaths between 43 days and 365 days of end of pregnancy	43	
Total	**82**	

Table 1: Classification of maternal deaths in Queensland 2004 to 2008

1.2.3 Cause of maternal death

Review of the available data regarding the 39 maternal deaths which occurred during pregnancy or within 0-42 days post-partum showed the most common causes of direct maternal death to be thromboembolism (4), amniotic fluid embolism (3) and haemorrhage related to abnormal placentation (2). Suicide (4) and pulmonary hypertension (2) were the most common causes of indirect maternal death, and malignancy and motor vehicle trauma the most common causes of incidental maternal death in this period.

Classification	Cause of death	Number
Direct deaths	Thromboembolism	4
	Amniotic fluid embolism	3
	Haemorrhage – placenta accreta / increta	2
	Haemorrhage – ruptured ectopic pregnancy	1
	Peripartum cardiomyopathy	1
	Air embolism	1
	Death associated with anaesthesia	1
	Chorioamnionitis	1
Indirect deaths	Suicide	4
	Pulmonary hypertension	2
	Cardiac disease – viral myocarditis	1
	Acute bacterial endocarditis	1
	Acute myocardial infarction	1
	Cardiorespiratory arrest ?arrhythmia	1
	Cardiorespiratory arrest uncertain origin	1
	Bronchopneumonia	1
	Subarachnoid haemorrhage – ruptured berry aneurysm	1
	Malignancy	1
	Septicaemia	1
Incidental deaths	Malignancy	4
	Motor vehicle trauma	3
	Haemorrhage – ruptured splenic artery aneurysm	1
	Cerebral abscess	1
	Brainstem haemorrhage and sepsis consequent on multiple sclerosis	1

Table 2: Cause of maternal deaths in Queensland, during pregnancy or within 42 days of the end of pregnancy, 2004 to 2008

Suicide (11) was the most prominent cause of death in the 43 women who died more then 42 days and less than one year after giving birth, followed by malignancy (8), motor vehicle trauma (4), cardiomyopathy (3) and myocarditis (2), and homicide (2).

Cause of death	Number
Suicide	11
Malignancy	8
Motor vehicle trauma	4
Cardiomyopathy	3
Myocarditis	2
Homicide	2
Drug overdose	1
Aspiration: drug toxicity	1
Intracerebral haemorrhage	1
Sub-arachnoid haemorrhage	1
Severe brain injury	1
Acute bronchopneumonia	1
Suppurative bronchitis asthma	1
Pulmonary thromboembolism	1
Bacterial septicaemia	1
Sepsis: lymphocytic hypophysitis	1
Small intestine infarction	1
Sudden unexplained death	1
Unknown	1

Table 3: Cause of maternal deaths in Queensland, between 42 and 365 days of the end of pregnancy, 2004 to 2008

1.2.4 Avoidability

Review of the 39 ICD-10 maternal deaths suggested that there may have been avoidable factors present in 10. The poor quality of data available to the committee did not allow for better definition of these factors.

Avoidable factors noted	2
Possibly avoidable	5
Potentially avoidable	3
No avoidable factors noted	28
Unable to determine	1

Table 4: Avoidable factors in maternal deaths in Queensland, during pregnancy or within 42 days of the end of pregnancy, 2004 to 2008

1.2.5 Data collection and quality

Significant difficulties were encountered gathering data regarding maternal deaths, and understanding the presence of possible avoidable factors due to poor quality of data related to lack of legislated requirement for practitioners to cooperatively report deaths and due to the absence of autopsy information in a number of cases.

Complete ascertainment of maternal deaths is a problem in all jurisdictions. A tick box now exists on all death certificates to indicate if a woman was pregnant or pregnant within six weeks of the time of her death, and another box identifies women who were pregnant between six weeks and twelve months prior to their death. It is hoped that this change will improve the detection rate of maternal deaths as medical officers become more familiar with these items.

Access to adequate case details is variable. Medical details are mostly gained from the maternal mortality death reporting form.

More detailed information is warranted in some cases and can be best accessed by thorough examination of the hospital medical record. This allows clinical conditions and management to be reviewed and potentially avoidable factors identified. Broad recommendations for practice can then be made available to all relevant institutions.

It is also apparent that knowledge of social and environmental issues is useful in determining why care was not accessed at an appropriate time. It is, therefore, planned that this degree of data will be available for future reports.

Though there is extensive legislated data collection regarding perinatal outcomes by the Perinatal Data Collection Unit the same is not the case for maternal outcomes (particularly maternal deaths). Legislative change, with reference to a requirement for all deaths of women during pregnancy or within one year of the end of a pregnancy being reported via the Perinatal Data Collection Unit is necessary to improve the quality of information available for review of the causation of deaths, and the possible presence of avoidable factors. Revision of the relevant section of the Public Health Act relating to the Perinatal Data Collection is recommended.[5]

1.2.6 Cardiovascular disease

Cardiovascular disease remains a significant cause of indirect maternal mortality amongst women in Queensland.

In a number of cases women died of undiagnosed cardiovascular disease. Diagnosis can be challenging because cardiovascular disease is relatively rare in women of child bearing age and the index of suspicion may be low when young women present with common symptoms such as chest pain, palpitations, syncope and shortness of breath. Furthermore, some of these symptoms, such as isolated palpitations and mild shortness of breath are common during normal pregnancy.

In some cases, the committee identified that limitations in access to specialist cardiology opinion and simple cardiac investigations such as echocardiography may also have contributed to the failure to diagnose significant cardiac lesions. All pregnant women should have access to such investigations within a clinically appropriate time frame. Efforts to increase awareness of cardiac disease amongst clinicians caring for pregnant women and provision of multidisciplinary tertiary services for management of pregnancies at high risk of materno-fetal complication due to cardiovascular disease are also likely to be of benefit.

Post-mortem examination is critically important to delineate the cause of death where cardiac disease is a possibility given that several conditions that can cause sudden cardiac death have an inherited basis. Where initial autopsy findings are negative, arrangements should be made for cardiac tissue to be examined by a pathologist with a specific interest in cardiac pathology. Finally, there is an emerging role for molecular autopsy in cases of possible arrhythmic death and consideration should be given to this, as well as referral of family members to a cardiac genetics service for further management.

1.2.7 Suicide

Amongst the 82 deaths reviewed within this report there were 19 women who died as a result of suicide, homicide or as a result of mixed drug toxicity. Fifteen (15) of these deaths were recorded as suicides and fourteen (14) of these fifteen (15) women had died by hanging. The women in this sub-group ranged in age from 19 to 40 but the number of younger women was notable (7 were 21 or younger). Seventeen (17) of the women who died within this group were reported to have had a previous history of mental health disorders including alcohol and drug dependency, depression and anxiety disorders and a smaller number of women were receiving treatment for major psychotic disorders. Seven women had a previous history of self harm or had previously expressed suicidal ideation. A small number of women were under the care of mental health services at the time of their death.

It is of significance that one third of the women who died of suicide were Indigenous and eight of these women lived in regional/rural locations. Both of these factors are known to be associated with a higher risk of death by suicide.

5 Public Health Act 2005 (Queensland) Chapter 6, Part 1, Sections 214-228

Despite a lack of available information in a number of the cases reviewed in this five year period, it was possible to ascertain that many of these women experienced considerable difficulties in their lives. Twelve of these women were known to have a dependence on drugs and alcohol and a number were reported to be victims of domestic violence. While the association between suicide and disadvantage and low socio economic status is apparent (as it is in the general population), there was a significant number of women who committed suicide with no previous risk factors identified. The paucity of clinical information in some cases precludes detailed comments on this subgroup of deaths but it would appear that attempts had been made by care providers to support a number of the women through alcohol and drug dependency. However, it was not possible to determine whether care provision was adequate in all cases.

Suicide as a leading cause of maternal mortality was highlighted in the UK enquiry into maternal deaths in 1997 and was the leading cause of death over two triennial reports between 1997 and 2002. Despite an increase in surveillance of women with known psychiatric illness and specialist education of professionals involved in the care of childbearing women, the numbers of deaths by suicide in the UK has remained constant and suicide remains a significant cause of death (Table 5).[6] The authors of the Saving Mothers' Lives Report make specific recommendations around the detection and management of psychiatric disorders in pregnancy and the puerperium, highlighting the need for the early involvement of appropriately trained specialists in the care of women with know psychotic disorders. The report also highlights the association between social vulnerability, substance abuse and the involvement of child protection services and maternal suicide.

The number of deaths within Queensland is at least comparable to those reported in the United Kingdom Enquiry and should prompt a response amongst maternity service providers in Queensland.

Method of suicide	1997 to 99	2000 to 02	2003 to 05	2006 to 09 (up to 6 months)	All
Hanging	10	8	14	9	41
Jumping from a height	5	4	4	9	22
Cut throat	4	1	0	1	6
Intentional road accident	1	2	0	0	3
Self-immolation	1	1	2	3	7
Drowning	1	1	2	2	6
Gunshot	1	0	0	0	1
Railway track	0	0	1	0	1
Carbon monoxide				1	1
Ingestion of bleach				1	1
Overdose of prescribed drugs	3	9	9	3	24
Total	**26**	**26**	**32**	**29**	**113**

Table 5: Suicidal deaths from the United Kingdom Confidential Enquiry into Maternal and Child Health.
(Adapted from www.pmmrc.health.govt.nz/moh.nsf/pagescm/7489/$File/why-mothers-die.pdf)

There has been an increased surveillance of women in the antenatal and immediate postnatal period with the introduction of routine screening for depression and appropriate referral patterns for women known to be at risk of suffering from a depressive illness. The introduction of universal screening of all women presenting to Queensland Health for maternity care, using the Edinburgh Depression Score (EPDS), the Safe Start Psychosocial Assessment tool, the Domestic Violence Identification (DVI) Assessment tool and the Antenatal Alcohol and Drug Screening tool, is seen as a very important initiative to assist with identification of women at risk, and the use of such tools is recommended in all maternity care spheres. The development and use of clear referral pathways to specialist mental health services for those women detected to be at risk is equally important and recommended.

With an improvement in reporting systems to this enquiry in the future it may be possible to offer deeper analysis of cases of suicide in future reports to determine if there are any system failures and identify areas where improvements could be made.

6 "Saving Mothers' Lives. Reviewing maternal deaths to make motherhood safer: 2006–2008". The Eighth Report of the Confidential Enquiries into Maternal Deaths in the United Kingdom. BJOG Volume 118, Supplement 1, March 2011.

1.2.8 Autopsies following maternal death

Some women, who die during or up to one year following pregnancy, die of clearly delineated disease such as metastatic malignancy. In these circumstances, it is reasonable to not proceed to an autopsy. However, many women die from medical conditions that are not clearly delineated. For example, women with asthma, thromboembolic disease and cardiomyopathy might all present with dyspnoea. Unless medical conditions are clearly delineated, autopsy is strongly recommended. In a number of cases reviewed, the reasons for maternal death were not entirely clear, and a maternal autopsy would have assisted in clarifying the cause of death.

	Deaths	Autopsies
Total deaths in the period 2004 to 2008	82	57
Deaths meeting ICD-10 definition of maternal death	39	34
Deaths not due to advanced malignancy	69	57

Table 6: Incidence of autopsy being performed in maternal deaths Queensland 2004 to 2008

There were several forensic pathology reviews where the clinical information and the decision to not proceed with coronial autopsy appeared to be dissonant. A close working relationship between the forensic pathology team and clinicians needs to be encouraged.

1.3 Perinatal deaths

Whilst this section of the report reviews all perinatal deaths in the decade 2000 to 2009 where possible, classification of perinatal deaths is only complete for the period 2000 to 2008. The "catch up" work on this element, a result of the five years of QMPQC inactivity, is a major ongoing function of the Perinatal Mortality Sub-Committee of QMPQC, in collaboration with the staff of the Perinatal Data Collection Unit (PDCU), Health Statistics Centre, Queensland Health.

1.3.1 Perinatal mortality review modus operandi

All perinatal deaths in Queensland are subject to a systematic review. Perinatal mortality data have been obtained from the Perinatal Data Collection Unit, Health Statistics Centre, Queensland Health, the Registry of Births Deaths and Marriages, and case summaries from hospital and regional perinatal mortality committees in Queensland. A number of local perinatal mortality committees collaborate with the Council in the perinatal mortality review process, submitting confidential case summaries and classifications.

1.3.2 Clinical classification

The QMPQC has adopted the Perinatal Society of Australia and New Zealand classification system including the Perinatal Death Classification (PSANZ-PDC) and, in addition for neonatal deaths, the PSANZ Neonatal Death Classification (PSANZ-NDC)[7], and all perinatal deaths in Queensland are classified accordingly. The system has been shown to perform well against other contemporary systems[8]. The purpose of classifying deaths according to the PSANZ system is to identify preventable factors associated with perinatal death, through the systematic application of clinically relevant categories to large populations.

1.3.3 Data collection and data quality

The data used to assist in classification of perinatal deaths by the Perinatal Mortality Sub-Committee are sourced from:

- MR63d forms, which are completed by all maternity hospitals in Queensland and forwarded to the Perinatal Data Collection Unit (Queensland Health). The MR63d form (a potentially rich data source containing over 50 data fields) is used to supply information to the National Perinatal Epidemiology and Statistics Unit (NPESU) and can also be used for benchmarking and other research projects.

7 Chan A, King J, Flenady V, Haslam R, Tudehope D. Classification of perinatal deaths: development of the Australian and New Zealand Classifications. J Paediatr. Child Health. 2004 Jul; 40(7):340-7.

8 Flenady V, Frøen JF, Pinar H, Torabi R, Saastad E, Guyon G, Russell L, Charles A, Harrison C, Chauke L, Pattinson R, Koshy R, Bahrin S, Gardener G, Day K, Petersson K, Gordon A, Gilshenan K. An evaluation of classification systems for stillbirth. BMC Pregnancy Childbirth. 2009; 9:24.

- The Medical Certificate of Cause of Perinatal Death (Forms 9 and 9A).
- Perinatal mortality confidential case summaries received and discharge summaries (where available) from hospitals.
- Pathology reports including autopsy and placental pathology, cytogenetics.

During the course of review of perinatal deaths, the Sub-Committee's ability to accurately classify accurately was often limited due to inadequate investigation and conflicting or lacking information in the materials provided. Low autopsy rates continue to pose a major limitation. Placental pathology, which is an essential component of investigation protocol for stillbirths and neonatal deaths, was often not performed in cases of death where this examination may have provided the only lead to reasons for the death. Despite a presumed cause of death, placental pathology should be undertaken for all stillbirths and also for births of infants at increased risk of neonatal death.

Even with advancements in investigative techniques such as Magnetic Resonance Imaging (MRI), autopsy remains the gold standard investigation and appropriate counselling should be provided to all parents following a stillbirth or neonatal death about the option of a high quality autopsy.[9] Parents should be made aware that important information about the cause of death may be missed if an autopsy is not performed. Unfortunately, insufficient number of pathologists with expertise in perinatal autopsy in Queensland is an impediment to quality and reporting. Delays in receiving autopsy reports of six months or more are not uncommon in Queensland.

Death certificate (DC) data are notoriously inaccurate worldwide[10] and, in Australia, it is largely attributed to the policy of completing the death certificate at the time of a perinatal death prior to full investigation and review of the death. The Perinatal Mortality Sub-Committee found that the information on death certificates was often inaccurate. Common errors included administrative aspects due to lack of knowledge of the requirements and assigned cause of death.

The Sub-Committee is planning a detailed review of death certificates to identify areas for clinician education to improve accuracy of this information. However, until death certificate cause of death is based on the results of investigation and review of the death by an appropriate committee, the cause of perinatal deaths based on death certificate will not be reliable. Following review and classification of perinatal deaths, clinicians are encouraged to submit a revised death certificate where information is found to be inaccurate for re-issuing to the parents. Parents should be contacted prior to receiving the revised DC to inform them of this outcome.

Through one-off funding made available by the Maternity Unit, Primary, Community and Extended Care Branch, Queensland Health, the educational program IMPROVE (IMproving Perinatal Review and Outcomes Via Education) (www.stillbirthalliance.org.au), based on the PSANZ Perinatal Mortality Guidelines, has been made available to clinicians providing maternity care in the larger Queensland maternity hospitals. With ongoing support for IMPROVE, the quality of investigation and review of death data will be greatly enhanced. Ideally, this program should be incorporated into routine educational programs for clinicians caring for women and their families around the time of a perinatal death and is being explored by the QMPQC in collaboration with key partners in both Public and Private sectors.

1.3.4 Perinatal mortality rates and trends

The perinatal mortality rate in Queensland for 2009 was 11.0 per 1,000 total births, made up of a stillbirth rate of 7.2 per 1,000 total births and a neonatal mortality rate of 3.9 per 1,000 live births. The stillbirth component of 65.7% of perinatal deaths was similar to previous years (Table 7).

Total Births	Live Births	Stillbirths		Neonatal Deaths		Perinatal Deaths	
		n	Rate (per 1,000 births)	n	Rate (per 1,000 live births)	n	Rate (per 1,000 births)
62,050	61,603	447	7.2	239	3.9	686	11.1

Table 7: Stillbirth, neonatal and perinatal death rates, Queensland 2009

9 Flenady V, King J, Charles A, et al. Clinical practice guideline for perinatal mortality. Version 2.2 April 2009. www.psanz.org.au Accessed August 2011.

10 Kirby RS. The coding of underlying cause of death from fetal death certificates: issues and policy considerations. Am J Public Health. 1993; 83: 1088-91.

Over the past two decades 1988 to 2009, subsequent to a general trend to a reduction in overall perinatal mortality until the early 2000s, there has been virtually no change in either the stillbirth or neonatal death rate. The reduction seen earlier in this period was due to a steady decline in neonatal mortality. The stillbirth rate has not shown any improvement over this 21 year period (Figure 1).

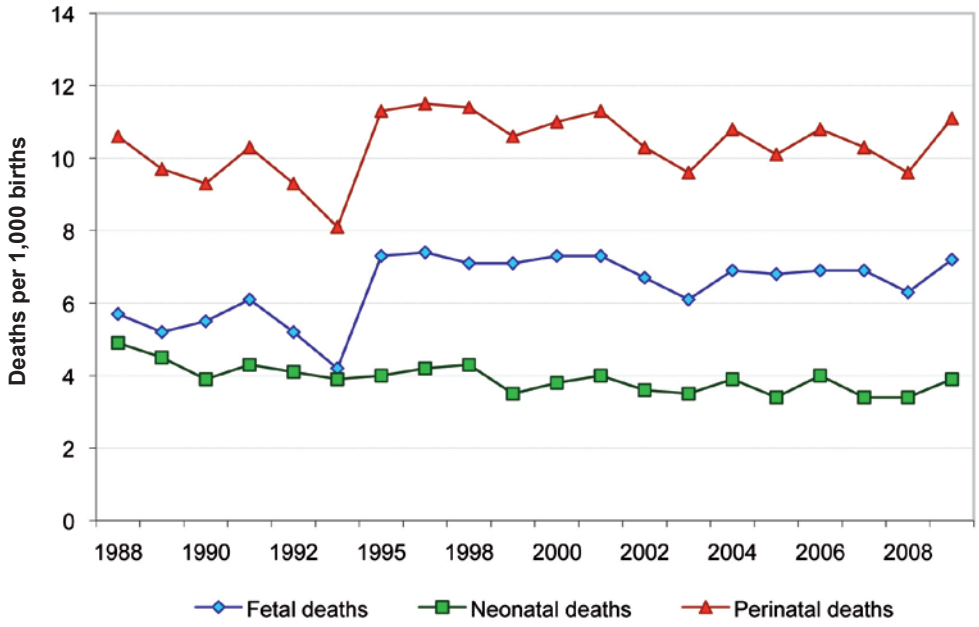

Figure 1: Perinatal mortality rates, Queensland 1988 to 2009

The perinatal mortality, stillbirth and neonatal death rate for women birthing in Private hospitals remains lower than for women in Public hospitals; 6.8 v 11.9/1000; 4.8 v 7.6; and 2.1 v 4.3 respectively. The reasons for the difference are not well understood, however the different demographic profiles of women is thought to play an important role and the influence of standards of care on this outcome requires further consideration.

	Perinatal deaths		Stillbirths		Neonatal deaths	
	n	PNMR	n	SBR	n	NMR
Public hospital care	3,998	11.9	2,560	7.6	1,438	4.3
Private hospital care	1,009	6.8	701	4.8	308	2.1
Home birth	4	5.8	2	2.9	2	2.9
Care mode not stated	10		7		3	
Total	**5,021**	**100**	**3,270**	**100**	**1,751**	**100**

Table 8: Perinatal mortality rates by facility type, Queensland 2000 to 2008
(PNMR = perinatal mortality rate per 1,000 births, SBR = stillbirth rate per 1,000 births, NMR = neonatal mortality rate per 1,000 live births)

1.3.5 PSANZ Perinatal Death Classification (PSANZ-PDC and PSANZ-NDC) of perinatal deaths

The main causes or important contributing conditions of perinatal deaths, according to the PSANZ-PDC and PSANZ-NDC classification, are shown in Tables 9 and 10, and Figures 2 to 4 for the period 2000 to 2008. Detailed sub-classifications are found in Tables 26 and 27.

	Type of Perinatal Death								
	Stillbirth			Neonatal Death			Total		
PSANZ-PDC classification	n	%	Rate[1]	n	%	Rate[2]	n	%	Rate[1]
1. Congenital abnormality	665	20.3	1.4	507	29	1.1	1,172	23.3	2.4
2. Perinatal infection	77	2.4	0.2	44	2.5	0.1	121	2.4	0.3
3. Hypertension	88	2.7	0.2	50	2.9	0.1	138	2.7	0.3
4. Antepartum haemorrhage	235	7.2	0.5	127	7.3	0.3	362	7.2	0.7
5. Maternal conditions	189	5.8	0.4	33	1.9	0.1	222	4.4	0.5
6. Specific perinatal conditions	281	8.6	0.6	94	5.4	0.2	375	7.5	0.8
7. Hypoxic peripartum deaths	64	2	0.1	91	5.2	0.2	155	3.1	0.3
8. Fetal growth restriction	164	5	0.3	30	1.7	0.1	194	3.9	0.4
9. Spontaneous preterm	468	14.3	1	668	38.1	1.4	1,136	22.6	2.4
10. Unexplained antepartum death	998	30.5	2.1		0		1,002	20.0	2.1
11. No obstetric antecedent	40	1.2	0.1	103	5.9	0.2	143	2.8	0.3
Not classified	1			4			1		
Total	**3,270**	**100**	**6.8**	**1,751**	**100**	**3.7**	**5,021**	**100**	**10.4**

Table 9: Perinatal deaths by type and PSANZ PDC, Queensland 2000 to 2008
(1 = per 1,000 births; 2 = per 1,000 live births)

	Neonatal Deaths		
PSANZ–NDC classification	n	%	Rate[1]
1. Congenital abnormality	511	29.2	1.1
2. Extreme prematurity	569	32.5	1.2
Not resuscitated	502	28.7	1.1
Unsuccessful resuscitation	63	3.6	0.1
Resuscitation not specified	4	0.2	0.0
3. Cardio-respiratory disorders	208	11.9	0.4
4. Infection	129	7.4	0.3
5. Neurological	179	10.2	0.4
6. Gastrointestinal	51	2.9	0.1
7. Other	100	5.7	0.2
Not classified	4		
Total	**1,751**	**100.0**	**3.7**

Table 10: Neonatal deaths PSANZ NDC, Queensland 2000 to 2008
(1 = per 1,000 live births)

The most frequent causes of perinatal death in the years 2000 to 2008 were *Congenital anomaly* (23.3%), *Spontaneous preterm* (22.6%) and *Unexplained antepartum death* (20.0%) (Figure 2).

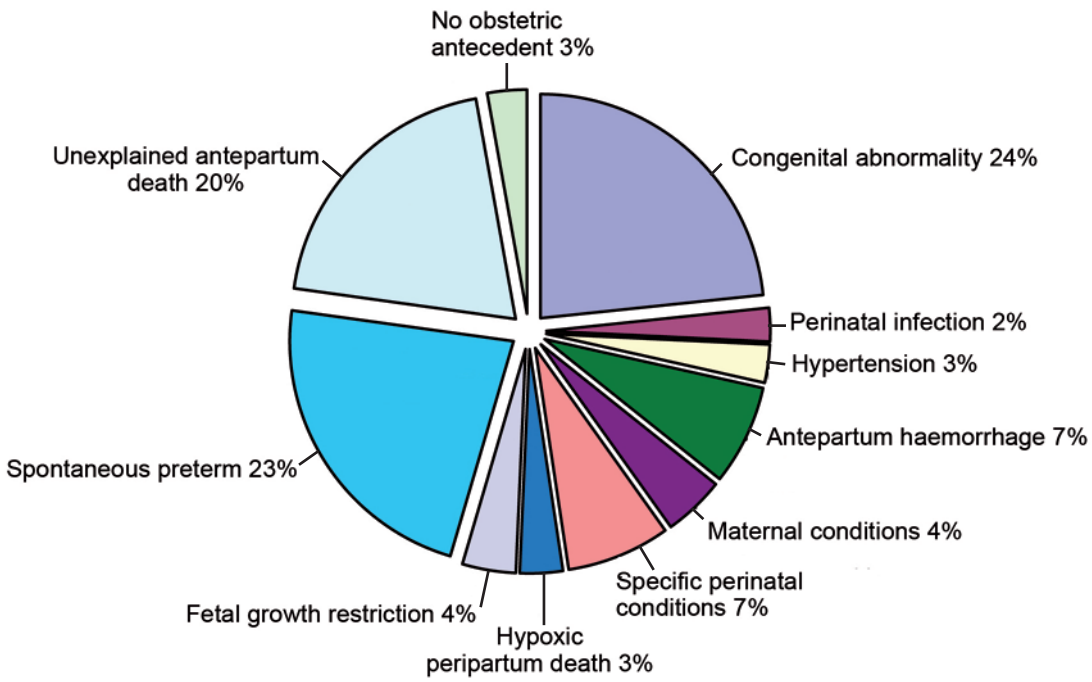

Figure 2: Perinatal death by PSANZ-PDC classification, Queensland 2000 to 2008
(n=5021)

Stillbirths were most frequently classified as being *Unexplained antepartum deaths* (30.5%), and *Congenital abnormality* (20.3%), *Spontaneous preterm* (14.3%), *Specific perinatal conditions* (8.6%) and *Antepartum haemorrhage* were the other major classified categories of cause of death (7.2%) (Figure 3).

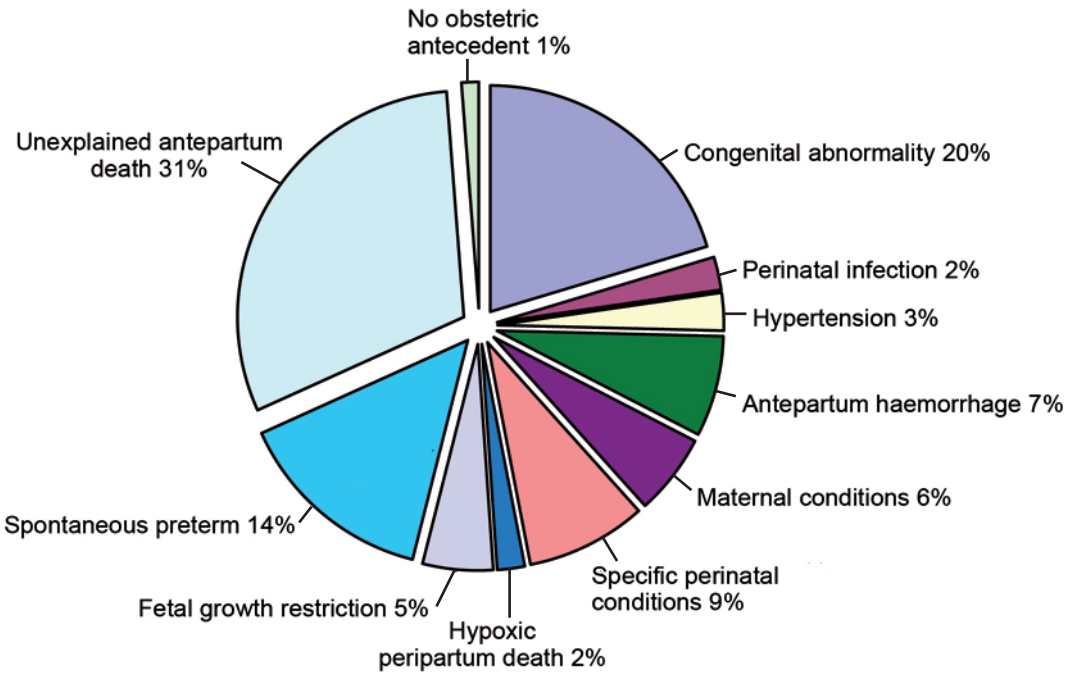

Figure 3: Stillbirths by PSANZ-PDC classification, Queensland 2000 to 2008
(n=3270)

The main conditions associated with neonatal deaths were *Spontaneous preterm* (38.1%) and *Congenital abnormality* (29%).

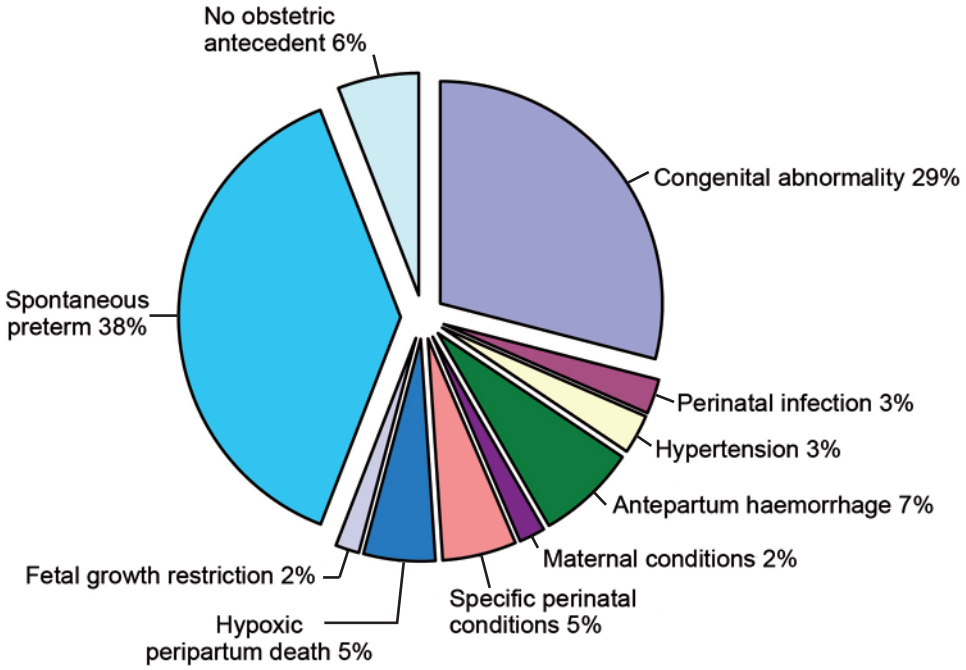

Figure 4: Neonatal deaths by PSANZ-PDC classification, Queensland 2000 to 2008
(n=1751)

Congenital abnormality

Of the 1,172 perinatal deaths classified as due to congenital abnormalities, there were 665 stillbirths and 506 neonatal deaths. Overall, congenital abnormalities contributed 23.3% of all perinatal deaths, (2.4 per 1,000 total births) and 20.3% and 29.0% respectively of all stillbirths and neonatal deaths. The leading types of congenital abnormality were chromosomal (n=253), central nervous system (CNS) (n=252), cardiovascular system (n=184), and other multiple congenital abnormality (n=166). 80% of perinatal death due to congenital abnormalities occurred prior to 37 weeks gestation and 60% prior to 28 weeks.

Spontaneous preterm

Of the 1,136 (22.6%) perinatal deaths assigned to the category of spontaneous preterm, 14.3% were stillbirths and 38.1% were neonatal deaths. Chorioamnionitis was identified in almost 50% of these deaths and in a further 14% it was unknown whether placental pathology was undertaken. Thirty-eight per cent (38%) of these deaths occurred prior to 28 weeks gestation.

Unexplained antepartum stillbirth

There were 998 antepartum stillbirths classified as unexplained, making up 20% of perinatal deaths and 30.5% of all stillbirths. The overall rate of unexplained stillbirth is 2.1 per 1,000 births, which is approximately 4 or 5 times greater than the rate of Sudden Infant Death Syndrome[11]. In 5% of cases potentially contributory or causal placental pathology was identified and in almost 8% no placental report was available (either unknown if performed or not performed). Autopsy rates were not analysed by PSANZ category; however previous reports have shown the autopsy rate for unexplained stillbirths to be 62%.[12] It is likely that the contribution of unexplained stillbirths is an overestimate due to inadequate investigation.[13]

11 Australian Bureau of Statistics. Deaths Australia, November 2008. Vol. Catalogue No. 3302.0 – 2007 Canberra: Australian Bureau of Statistics; 2010.
12 Maternal and perinatal mortality in Queensland 2000, Report of the Queensland Maternal and Perinatal Quality Council, June 2003.
13 Flenady V, Middleton P, Smith GC, Duke W, Erwich JJ, Khong TY, Neilson J, Ezzati M, Koopmans L, Ellwood D, Fretts R, Frøen FJ, for The Lancet's Stillbirths Series steering committee. Stillbirth: the way forward in high-income countries. Lancet. 2011 May 14; 377(9778):1703-17.

The final paper in *The Lancet's* stillbirth series[14] makes a strong call for improved data quality for stillbirths and Queensland Health is addressing this need through clinician education on the guidelines from the Perinatal Society of Australia and New Zealand, with the IMPROVE (IMproving Perinatal Review and Outcomes Via Education) program.

1.3.6 Multiple pregnancy

The perinatal mortality rate for babies born in multiple pregnancies was 38.8 per 1,000 births compared with the rate for singletons of 9.3 per 1,000 births. The categories accounting for the higher perinatal mortality rates in multiple pregnancy were *Specific perinatal conditions* (largely made up of Twin-Twin Transfusion Syndrome) (Relative risk (RR) 6.21, 95% Confidence Interval (CI) 5.16-7.47)) and *Spontaneous preterm* (RR 1.94, 95% CI 1.72-2.17) (Table 11).

	Plurality						
	Singleton			Multiple			
PSANZ-PDC	n	%	Rate	n	%	Rate	Relative Risk (95% CI)
1. Congenital abnormality	1,097	25.2	2.3	75	12.0	4.6	0.47 (0.38, 0.59) †
2. Perinatal infection	115	2.6	0.2	6	1.0	0.4	0.36 (0.16, 0.82) †
3. Hypertension	118	2.7	0.3	20	3.2	1.2	1.18 (0.74, 1.88)
4. Antepartum haemorrhage	325	7.5	0.7	37	5.9	2.3	0.79 (0.57, 1.10)
5. Maternal conditions	214	4.9	0.5	8	1.3	0.5	0.26 (0.13, 0.52) †
6. Specific perinatal conditions	198	4.5	0.4	177	28.2	11.0	6.21 (5.16, 7.47) †
7. Hypoxic peripartum deaths	148	3.4	0.3	7	1.1	0.4	0.33 (0.15, 0.70) †
8. Fetal growth restriction	173	4.0	0.4	21	3.3	1.3	0.84 (0.54, 1.32)
9. Spontaneous preterm	888	20.4	1.9	248	39.6	15.3	1.94 (1.72, 2.17) †
10. Unexplained antepartum death	949	21.8	2.0	53	8.5	3.3	0.39 (0.30, 0.50) †
11. No Obstetric antecedent	128	2.9	0.3	15	2.4	0.9	0.81 (0.48, 1.38)
Not Classified	1						
Total	**4,354**	**100.0**	**9.3**	**627**	**100.0**	**38.8**	

Table 11: Perinatal deaths by PSANZ PDC and plurality, Queensland 2000 to 2008
(Rate = per 1,000 births, † = statistically significant) (Total babies born 2000 to 2008 = 483,116. Total singletons born 2000 to 2008 = 466,959. Total multiples born 2000 to 2008 = 16,157)

1.3.7 Indigenous perinatal mortality

In the period 2000 to 2008 in Queensland there were 26,391 births to Indigenous women and 497 perinatal deaths made up of 306 stillbirths and 191 neonatal deaths, giving perinatal mortality, stillbirth and neonatal death rates for Indigenous women of 18.8, 11.6, and 7.3 per 1000 births respectively. This compares unfavorably with rates for non-Indigenous women of 10.1, 6.6, and 3.5 respectively (Table 12).

	Total Births	Live Births	Stillbirths		Neonatal Deaths		Perinatal Deaths	
			n	Rate[1]	n	Rate[2]	n	Rate[1]
Indigenous	26,391	26,085	306	11.6	191	7.3	497	18.8
Non-Indigenous3	448,407	445,447	2,960	6.6	1,557	3.5	4,517	10.1
Relative risk for Indigenous (95% confidence interval)				1.76 (1.56, 1.98)		2.10 (1.80, 2.43)		1.87 (1.71, 2.05)

Table 12: Perinatal deaths by Indigenous status, Queensland 2000 to 2008
(1 = per 1,000 births; 2 = per 1,000 live births, 3: excludes 10 live births where the Indigenous status was not stated)

The perinatal death classification accounting for most of the increased perinatal mortality in Indigenous populations was *Spontaneous preterm*, which was almost three times more frequent than in the non-Indigenous population (RR 2.69 (95% CI 2.27, 3.18) occurring at a rate of 5.9/1000 births. Other important contributors to this disparity were *Hypertension* and deaths where *No obstetric antecedent* was identified (Table 13).

14 Goldenberg RL, McClure EM, Bhutta ZA, Belizan JM, Reddy UM, Rubens CE, Mabeya H, Flenady V, Darmstadt G, for The Lancet's Stillbirths Series steering committee. Stillbirths: the vision for 2020. Lancet. 2011 May 21; 377(9779):1798-1805.

A recent meta-analysis showed that, when controlling for confounders (such as medical conditions), the risk of stillbirth is similar for Indigenous and non-Indigenous women, highlighting that the excess in these deaths for Indigenous women is potentially preventable.[15]

	Indigenous status						
	Non-Indigenous			Indigenous			
PSANZ-PDC	n	%	Rate	n	%	Rate	Relative Risk (95% CI)
1. Congenital abnormality	1,090	24.1	2.4	81	16.3	3.1	1.26 (1.01, 1.58) †
2. Perinatal infection	107	2.4	0.2	14	2.8	0.5	2.22 (1.27, 3.88) †
3. Hypertension	109	2.4	0.2	29	5.8	1.1	4.52 (3.00, 6.81) †
4. Antepartum haemorrhage	329	7.3	0.7	33	6.6	1.3	1.70 (1.19, 2.44) †
5. Maternal conditions	199	4.4	0.4	23	4.6	0.9	1.96 (1.28, 3.02) †
6. Specific perinatal conditions	347	7.7	0.8	27	5.4	1.0	1.32 (0.89, 1.96)
7. Hypoxic peripartum deaths	148	3.3	0.3	7	1.4	0.3	0.80 (0.38, 1.72)
8. Fetal growth restriction	175	3.9	0.4	18	3.6	0.7	1.75 (1.08, 2.84) †
9. Spontaneous preterm	981	21.7	2.2	155	31.2	5.9	2.69 (2.27, 3.18) †
10. Unexplained antepartum death	910	20.1	2.0	86	17.3	3.3	1.61 (1.29, 2.00) †
11. No obstetric antecedent	119	2.6	0.3	23	4.6	0.9	3.28 (2.10, 5.13) †
Not classified	3	0.1	0.0	1	0.2	0.0	
Total	**4,517**	**100.0**	**10.1**	**497**	**100.0**	**18.8**	**1.87 (1.71, 2.05)**

Table 13: Perinatal deaths by PSANZ PDC and Indigenous status, Queensland 2000 to 2008
(Rate = per 1,000 births, † = statistically significant) (Total babies born 2000 to 2008 = 483,116. Total Indigenous babies born 2000 to 2008 = 26,391, Total non-Indigenous babies born 2000 to 2008 = 448,407, Indigenous status not stated = 133)

1.3.8 Gestational age and birth weight specific perinatal mortality rates

Seventy-nine per cent (79.0%) of perinatal deaths occur in the 8.6% of births which occur at or before 36 weeks gestation, and 55.5% occur in the 0.9% of births which occur before 28 weeks (Table 14).

Births at term (37-41 weeks) made up 90% of births and 20% of all perinatal deaths. Over this period there were 4,733 births (1% of all births) and 27 perinatal deaths at 42 weeks or more gestation giving a perinatal mortality rate of 5.7/1000 in this group compared with 2.3/1000 for births at 37-41 weeks. Using the more appropriate denominator of the number of ongoing pregnancies to calculate risk at each gestational age week clearly reveals the increased risk of perinatal death after 41 weeks[16] and induction of labour for women beyond 41 weeks gestation reduces this risk.[17]

Gestation (weeks)	Number of perinatal deaths at this gestation	Number of babies born at this gestation	Percentage of perinatal deaths	Percentage of babies born	Perinatal mortality rate
< 22	1,057	1,057	21.1	0.2	1,000.0
22-23	964	989	19.2	0.2	974.7
24-25	486	913	9.7	0.2	532.3
26-27	280	1,163	5.6	0.2	240.8
28-29	242	1,716	4.8	0.4	141.0
30-32	347	4,979	6.9	1.0	69.7
33-36	589	30,885	11.7	6.4	19.1
37-41	1,022	436,631	20.4	90.4	2.3
42 +	27	4,733	0.5	1.0	5.7
Not stated	7	50			
Total	**5,021**	**483,116**	**100.0**	**100.0**	**10.4**

Table 14: Perinatal deaths by gestation, Queensland 2000 to 2008

15 Flenady V, Koopmans L, Middleton P, Frøen FJ, Smith GC, Gibbons K, Coory M, Gordon A, Ellwood D, McIntyre HD, Fretts R, Ezzati M. Major risk factors for stillbirth in high-income countries: a systematic review and meta-analysis. Lancet. 2011 Apr 16; 377(9774):1331-40.

16 Yudkin PL, Wood L, Redman CW. Risk of unexplained stillbirth at different gestational ages. Lancet. 1987 May 23;329(8543):1192-4.

17 Gülmezoglu AM, Crowther CA, Middleton P. Induction of labour for improving birth outcomes for women at or beyond term. Cochrane Database of Systematic Reviews 2006, Issue 4. Art. No.: CD004945. DOI: 10.1002/14651858.CD004945.pub2.

The perinatal mortality rate, and its constituent stillbirth and neonatal mortality rates are seen to reach a nadir at 37-41 weeks gestation (Figure 4).

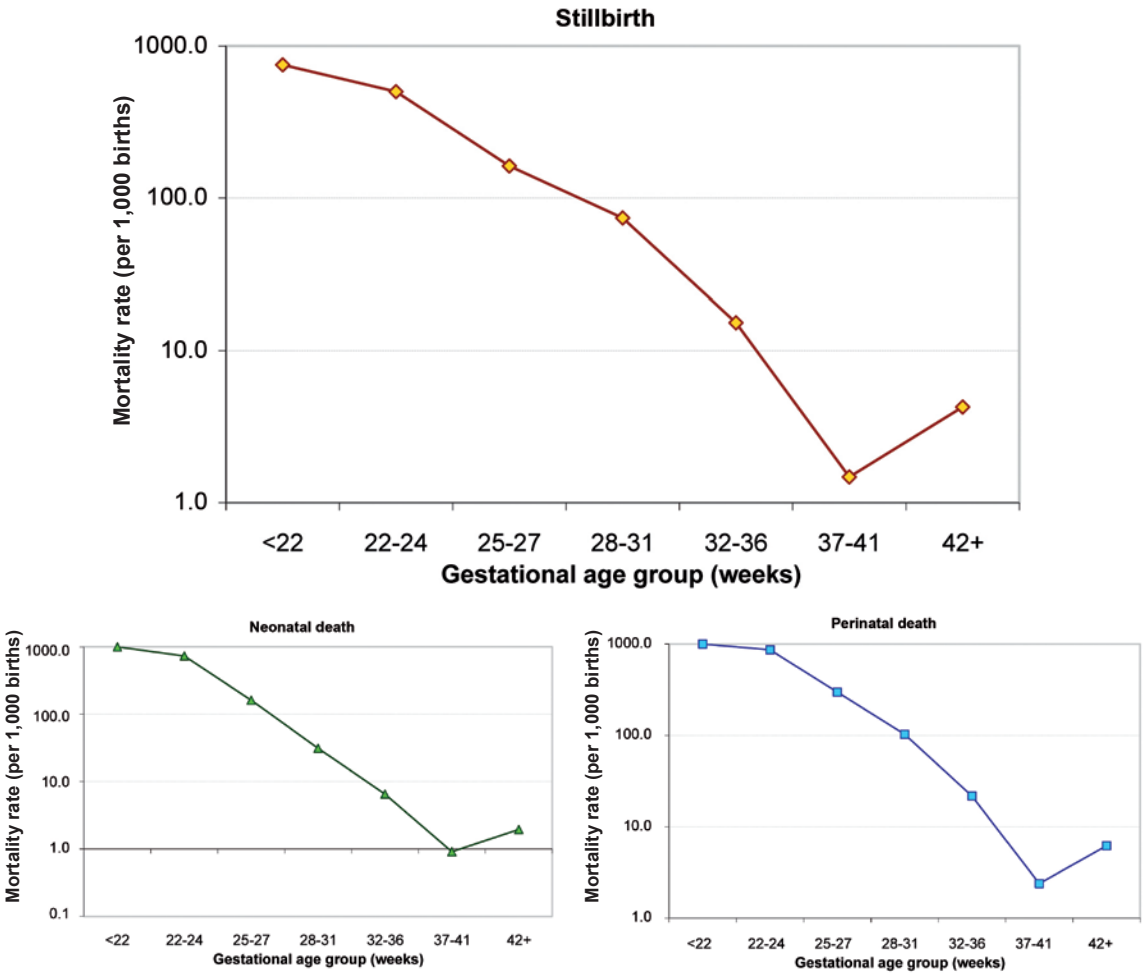

Figure 5: Perinatal, stillbirth and neonatal mortality rates by gestation, Queensland 2000 to 2008 *(logarithmic scale)*

Seventy-seven per cent (77.1%) of perinatal deaths occur in the 7.0% of births where birth weight is less than 2,500g, and 64.5% where the birth weight is less than 1,500g (1.6% of babies born) (Table 15).

Birth weight (g)	Number of perinatal deaths in this birth weight group	Number of babies born in this birth weight group	Percentage of perinatal deaths	Percentage of babies born	Perinatal mortality rate
‹ 500	1,681	1,707	33.5	0.4	984.8
500-999	1,200	2,526	23.9	0.5	475.1
1000-1499	359	3,352	7.1	0.7	107.1
1500-1999	315	6,715	6.3	1.4	46.9
2000-2499	315	19,543	6.3	4.0	16.1
2500-2999	412	69,365	8.2	14.4	5.9
3000-3499	360	167,681	7.2	34.7	2.1
3500-3999	237	151,079	4.7	31.3	1.6
4000-4499	79	51,842	1.6	10.7	1.5
4500-4999	20	8,376	0.4	1.7	2.4
5000+	7	851	0.1	0.2	8.2
Not stated	36	79			
Total	**5,021**	**483,116**	**100**	**100**	**10.4**

Table 15: Perinatal deaths by birth weight, Queensland 2000 to 2008

In a similar fashion to the changes seen with perinatal mortality rate in relation to gestation, the perinatal mortality rate and its constituent stillbirth and neonatal mortality rates are seen to reach a nadir at 3,500 to 4,000g (Figure 5).

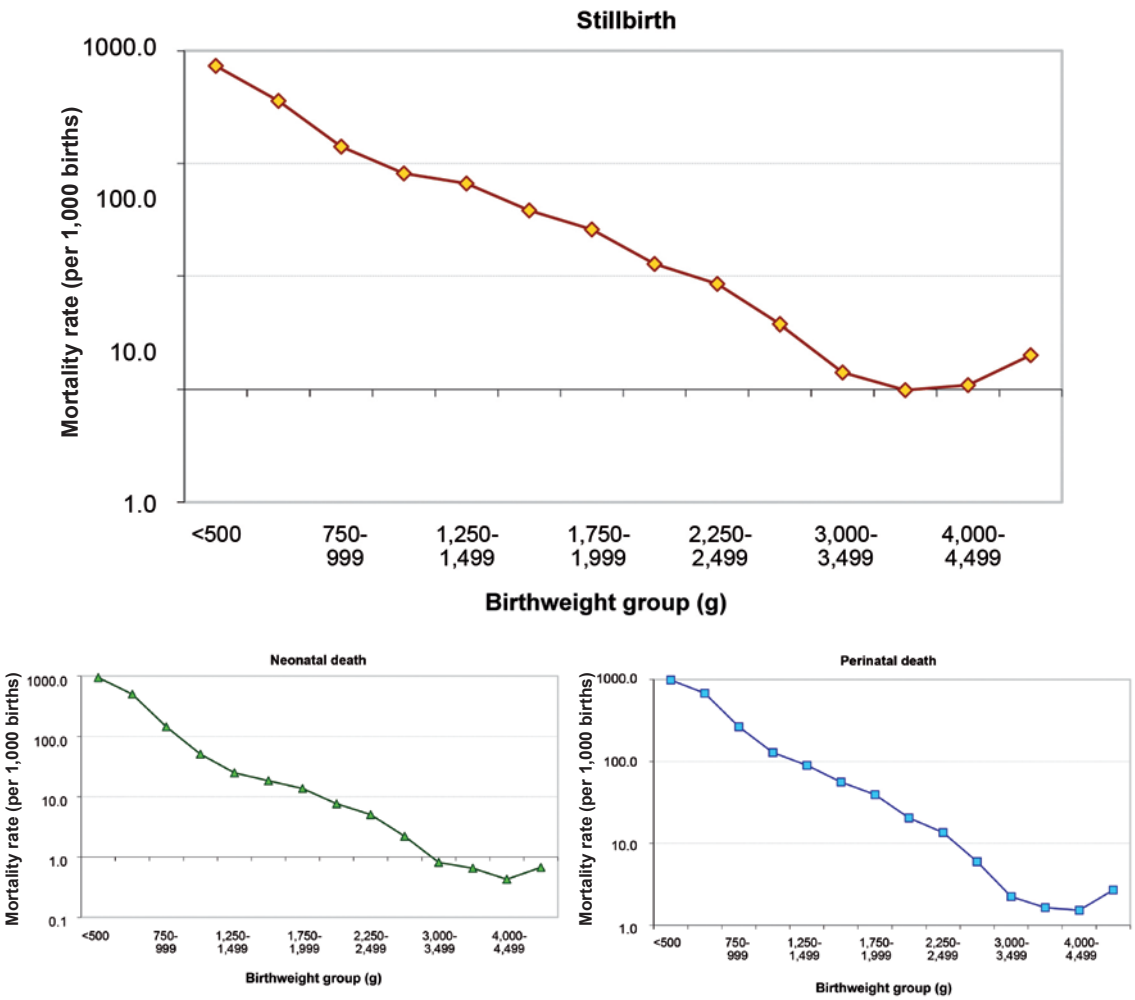

Figure 6: Perinatal, stillbirth and neonatal mortality rates by birth weight, Queensland 2000 to 2008 *(logarithmic scale)*

The major classifications of cause of perinatal death and neonatal death are shown in tables 16 and 17, related to gestation at birth, and according to birth weight in Tables 18 and 19.

Congenital abnormality was an important contributor to perinatal death across all gestational age and birth weight groups examined. The contribution of *Unexplained* stillbirth increased with increasing gestation contributing 35.4% to all perinatal deaths at 37 weeks or more. The category of *Hypoxic peripartum death* made up 11.8% of deaths at 37 weeks or more gestation.

The main cause of neonatal deaths according to the PSANZ-NDC was *Extreme prematurity*, making up almost one-third of all neonatal deaths and almost 60% of those less than 28 weeks. The majority (49%) of these deaths were not actively resuscitated. *Cardio-respiratory conditions* (mainly Respiratory Distress Syndrome) were most prominent in the ‹28 week group making up 17% of deaths in this gestational age group.

The contribution of *Neurological* conditions increased with increasing gestation contributing 24% to neonatal deaths occurring for infants born at 37 weeks or more. These deaths were mainly due to the clinical picture of hypoxic ischemic encephalopathy and further examination into the factors surrounding these deaths is required. Another important contributor to neonatal deaths was *Infection* (mostly acquired bacterial); making up 7.4% of all deaths and 8.1% of those at 37 weeks or more.

Of the 100 (5.7%) of neonatal deaths classified in the *Other* category, 27 deaths were attributed to SIDS, two to unclassified sudden infant death and a further 38 were classified as other, unknown or undetermined.

	Gestational age at birth (weeks)							
	<28		28-36		37+		Total	
PSANZ –PDC classification	n	%	n	%	n	%	n	%
1. Congenital abnormality	637	22.9	303	25.7	231	22	1,172	23.3
2. Perinatal infection	59	2.1	33	2.8	29	2.8	121	2.4
3. Hypertension	77	2.8	52	4.4	8	0.8	138	2.7
4. Antepartum haemorrhage	215	7.7	102	8.7	45	4.3	362	7.2
5. Maternal conditions	122	4.4	57	4.8	42	4	222	4.4
6. Specific perinatal conditions	215	7.7	102	8.7	58	5.5	375	7.5
7. Hypoxic peripartum deaths	5	0.2	25	2.1	124	11.8	155	3.1
8. Fetal growth restriction	66	2.4	77	6.5	51	4.9	194	3.9
9. Spontaneous preterm	1,069	38.4	65	5.5	2	0.2	1,136	22.6
10. Unexplained antepartum death	286	10.3	343	29.1	371	35.4	1,002	20
11. No obstetric antecedent	35	1.3	19	1.6	88	8.4	143	2.8
Not classified	1						1	
Total	**2,787**	**100**	**1,178**	**100**	**1,049**	**100**	**5,021**	**100**
Rate per 1,000 births	**676.1**		**31.3**		**2.4**		**10.4**	

Table 16: Perinatal deaths by PSANZ-PDC and gestational age, Queensland 2000 to 2008
(7 cases excluded in the gestational age analysis due to missing gestation data)

	Gestational age at birth (weeks)							
	<28		28-36		37+		Total	
PSANZ –NDC classification	n	%	n	%	n	%	n	%
1. Congenital abnormality	124	12.3	193	55.5	194	49.2	511	29.2
2. Extreme prematurity	560	55.5	9	2.6	0	0.0	569	32.5
Not resuscitated	494	49.0	8	2.3	0	0.0	502	28.7
Unsuccessful resuscitation	62	6.1	1	0.3	0	0.0	63	3.6
Resuscitation not specified	4	0.4	0	0.0	0	0.0	4	0.2
3. Cardio-respiratory disorders	166	16.5	27	7.8	15	3.8	208	11.9
4. Infection	63	6.2	34	9.8	32	8.1	129	7.4
5. Neurological	39	3.9	45	12.9	95	24.1	179	10.2
6. Gastrointestinal	32	3.2	14	4.0	5	1.3	51	2.9
7. Other	24	2.4	26	7.5	50	12.7	100	5.7
Not classified	1		0		3		4	
Total	**1,009**	**100.0**	**348**	**100.0**	**394**	**100.0**	**1,751**	**100.0**
Rate per 1,000 live births	**430.6**		**9.5**		**0.9**		**3.7**	

Table 17: Neonatal deaths by PSANZ-PDC and gestational age, Queensland 2000 to 2008

	Birth Weight (g)							
	<1000		1000-2499		2500+		Total	
PSANZ-PDC	n	%	n	%	n	%	n	%
1. Congenital abnormality	651	22.6	286	27.9	235	21.1	1,172	23.3
2. Perinatal infection	58	2	25	2.4	38	3.4	121	2.4
3. Hypertension	90	3.1	40	3.9	8	0.7	138	2.7
4. Antepartum haemorrhage	206	7.2	102	10	54	4.8	362	7.2
5. Maternal conditions	121	4.2	42	4.1	59	5.3	222	4.4
6. Specific perinatal conditions	226	7.8	74	7.2	75	6.7	375	7.5
7. Hypoxic peripartum deaths	4	0.1	20	2	131	11.7	155	3.1
8. Fetal growth restriction	105	3.6	62	6	27	2.4	194	3.9
9. Spontaneous preterm	1,046	36.3	85	8.3	5	0.4	1,136	22.6
10. Unexplained antepartum death	341	11.8	263	25.7	398	35.7	1,002	20
11. No obstetric antecedent	33	1.1	25	2.4	85	7.6	143	2.8
Not classified			1				1	
Total	**2,881**	**100**	**1,025**	**100**	**1,115**	**100**	**5,021**	**100**
Rate per 1,000 births	**680.6**		**34.6**		**2.5**		**10.4**	

Table 18: Perinatal deaths by PSANZ-PDC and birth weight, Queensland 2000 to 2008

	Birth Weight (g)								
	<1000		1000-2499		2500+		Birth weight not specified	Total	
PSANZ –NDC classification	n	%	n	%	n	%		n	%
1. Congenital abnormality	127	12.7	186	54.9	196	48.8	2	511	29.2
2. Extreme prematurity	556	55.5	11	3.2			2	569	32.5
Not resuscitated	496	49.5	5	1.5				502	28.7
Unsuccessful resuscitation	57	5.7	6	1.8				63	3.6
Resuscitation not specified	3	0.3		0.0				4	0.2
3. Cardio-respiratory disorders	159	15.9	33	9.7	16	4.0		208	11.9
4. Infection	66	6.6	28	8.3	33	8.2	2	129	7.4
5. Neurological	35	3.5	42	12.4	100	24.9	2	179	10.2
6. Gastrointestinal	31	3.1	16	4.7	4	1.0		51	2.9
7. Other	26	2.6	23	6.8	51	12.7		100	5.7
Not classified	2				2	0.5		4	
Total	**1,002**	**100.0**	**339**	**100.0**	**402**	**100.0**	**8**	**1,751**	**100.0**
Rate per 1,000 live births	**425.8**		**11.7**		**0.9**			**3.7**	

Table 19: Neonatal deaths by PSANZ-NDC and birth weight, Queensland 2000 to 2008

1.3.9 Perinatal autopsies

Autopsy rates for perinatal deaths over the period 2000 to 2009 are shown in Figure 7 and Table 25. Following a decline from 37.3% in 2000 to a very low rate of 20.7% in 2004 there was a steady increase to 33.8% in 2009. However, while it is encouraging to see the stillbirth autopsy rate continue to increase to 37.4% in 2009, over more recent times the neonatal death rate has declined to 24.5% in 2009 from 31.2% in 2007. Autopsy remains the gold standard investigation for perinatal deaths[18] and while an optimal autopsy rate is unclear, the Royal College of Obstetricians and Gynaecologists, and the Royal College of Pathologists has recommended a rate of 75%[19].

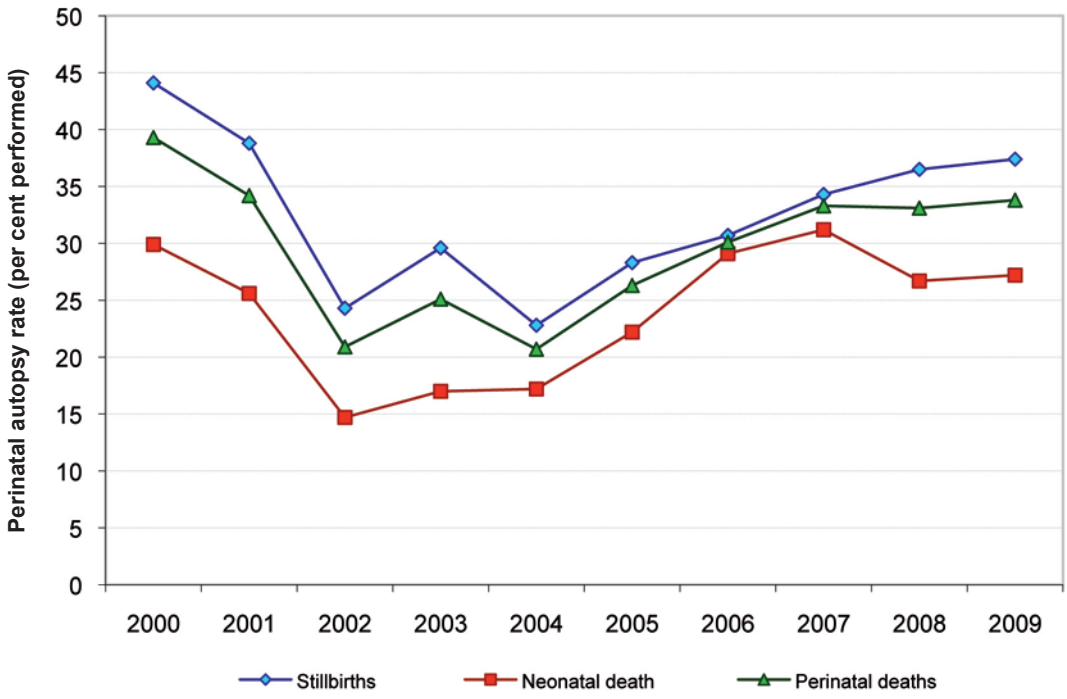

Figure 7: Perinatal autopsies by type of death, Queensland 2000 to 2008

18 Khong TY. Pathology investigations. In: Facchinetti F, Dekker GA, Baronciani D, Saade G, eds. Stillbirth: Understanding and management. London: Informa Healthcare; 2009:91-96.

19 Royal College of Pathologists. Guidlines of Autopsy Practise: Report of a working group of the Royal College of Pathologists London: Royal College of Pathologists; 2002.